UNITED STATES
SECURITIES AND EXCHANGE COMMISSION
Washington, D.C. 20549

FORM 10-K

X ANNUAL REPORT PURSUANT TO SECTION 13 OR 15(d) OF THE SECURITIES EXCHANGE ACT OF 1934

For the fiscal year ended December 31, 2022

☐ TRANSITION REPORT PURSUANT TO SECTION 13 OR 15 (D) OF THE SECURITIES EXCHANGE ACT OF 1934

For the transition period from ________________________ to ________________________

Commission file number: **001-40766**

Lightwave Logic, Inc.

(Exact name of registrant as specified in its charter)

Nevada	**82-0497368**
(State or other jurisdiction of incorporation or organization)	(I.R.S. Employer Identification No.)
369 Inverness Parkway, Suite 350, Englewood, CO	**80112**
(Address of principal executive offices)	(Zip Code)

(Registrant's Telephone Number, including Area Code): **720-340-4949**

Securities registered pursuant to Section 12(b) of the Act:

Title of each class registered	Trading Symbol(s)	Name of each exchange on which registered
Common Stock, $0.001 par value per share	LWLG	The NASDAQ Stock Market

Securities registered pursuant to section 12(g) of the Act: None

Indicate by check mark if the Registrant is a well-known seasoned issuer, as defined in Rule 405 of the Securities Act. Yes X No ☐

Indicate by check mark if the Registrant is not required to file reports pursuant to Section 13 or 15(d) of the Act. Yes ☐ No X

Indicate by check mark whether the registrant (1) has filed all reports required to be filed by Section 13 or 15(d) of the Securities Exchange Act of 1934 during the preceding 12 months (or for such shorter period that the registrant was required to file such reports), and (2) has been subject to such filing requirements for the past 90 days. Yes X No ☐

Indicate by check mark whether the registrant has submitted electronically every Interactive Data File required to be submitted pursuant to Rule 405 of Regulation S-T (§ 232.405 of this chapter) during the preceding 12 months (or for such shorter period that the registrant was required to submit such files). Yes X No ☐

Indicate by check mark whether the registrant is a large accelerated filer, an accelerated filer, a non-accelerated filer, smaller reporting company, or an emerging growth company. See the definitions of "large accelerated filer," "accelerated filer," "smaller reporting company," and "emerging growth company" in Rule 12b-2 of the Exchange Act.

Large accelerated filer X	Accelerated filer ☐
Non-accelerated filer ☐	Smaller reporting company ☐
	Emerging growth company ☐

If an emerging growth company, indicate by checkmark if the registrant has elected not to use the extended transition period for complying with any new or revised financial accounting standards provided pursuant to Section 13(a) of the Exchange Act. ☐

Indicate by check mark whether the registrant has filed a report on and attestation to its management's assessment of the effectiveness of its internal control over financial reporting under Section 404(b) of the Sarbanes-Oxley Act (15 U.S.C. 7262(b)) by the registered public accounting firm that prepared or issued its audit report. X

If securities are registered pursuant to Section 12(b) of the Act, indicate by check mark whether the financial statements of the registrant included in the filing reflect the correction of an error to previously issued financial statements. ☐

Indicate by check mark whether any of those error corrections are restatements that required a recovery analysis of incentive-based compensation received by any of the registrant's executive officers during the relevant recovery period pursuant to § 240.10D-1(b). ☐

Indicate by check mark whether the registrant is a shell company (as defined in Rule 12b-2 of the Exchange Act of 1934). Yes ☐ No X

The aggregate market value of the voting and non-voting common equity held by non-affiliates of the registrant was approximately $728,318,971 as of June 30, 2022.

As of February 28, 2023, there were 113,220,954 shares outstanding of the registrant's common stock, $.001 par value.

Documents incorporated by reference. Portions of the registrant's Definitive Proxy Statement for the registrant's 2023 Annual Meeting of Shareholders are incorporated by reference in Part III of this report. The Definitive Proxy Statement or an amendment to this Form 10-K will be filed with the Securities and Exchange Commission within 120 days after the registrant's fiscal year ended December 31, 2022.

Table of Contents

Forward-Looking Statements

This report on Form 10-K contains forward-looking statements. Forward-looking statements involve risks and uncertainties, such as statements about our plans, objectives, expectations, assumptions or future events. In some cases, you can identify forward-looking statements by terminology such as "anticipate," "estimate," "plan," "project," "continuing," "ongoing," "expect," "we believe," "we intend," "may," "should," "will," "could" and similar expressions denoting uncertainty or an action that may, will or is expected to occur in the future. These statements involve estimates, assumptions, known and unknown risks, uncertainties and other factors that could cause actual results to differ materially from any future results, performances or achievements expressed or implied by the forward-looking statements. You should not place undue reliance on these forward-looking statements.

Factors that are known to us that could cause a different result than projected by the forward-looking statement, include, but are not limited to:

- inability to generate revenue or to manage growth;
- lack of available funding;
- lack of a market for or market acceptance of our products;
- competition from third parties;
- general economic and business conditions;
- intellectual property rights of third parties;
- changes in the price of our stock and dilution;
- regulatory constraints and potential legal liability;
- ability to maintain effective internal controls;
- security breaches, cybersecurity attacks and other significant disruptions in our information technology systems;
- changes in technology and methods of marketing;
- delays in completing various engineering and manufacturing programs;
- changes in customer order patterns and qualification of new customers;
- changes in product mix;
- success in technological advances and delivering technological innovations;
- shortages in components;
- production delays due to performance quality issues with outsourced components;
- the novel coronavirus ("COVID-19") and its potential impact on our business;
- those events and factors described by us in Item 1.A "Risk Factors";
- other risks to which our Company is subject; and
- other factors beyond the Company's control.

Any forward-looking statement made by us in this report on Form 10-K is based only on information currently available to us and speaks only as of the date on which it is made. We undertake no obligation to publicly update any forward-looking statement, whether written or oral, that may be made from time to time, whether as a result of new information, future developments or otherwise.

PART I

Item 1. Business.

Overview

Lightwave Logic, Inc. is a development stage company moving toward commercialization of next generation electro-optic photonic devices made on its P^2IC™ technology platform which we have detailed as: 1) Polymer Stack™, 2) Polymer Plus™, and 3) Polymer Slot™. Our unique polymer technology platform uses in-house proprietary high-activity and high-stability organic polymers. Electro-optical devices called modulators convert data from electric signals into optical signals for multiple applications.

Our differentiation at the modulator device level is in higher speed, lower power consumption, simplicity of manufacturing, small footprint (size), and reliability. We have demonstrated higher speed and lower power consumption in packaged devices, and during 2022, we continued to make advances in techniques to translate material properties to efficient, reliable modulator devices with commercial foundries. We are currently focused on testing and demonstrating the simplicity of manufacturability and reliability of our devices, including in conjunction with the silicon photonics manufacturing ecosystem. In 2022 we discussed the addition of several silicon-based foundry partners to help scale in volume our polymer modulator devices. Silicon-based foundries are large semiconductor fabrication plants developed for the electronics IC business, that are now engaging with silicon photonics to increase their wafer throughput. Partnering with silicon-based foundries not only demonstrates that our polymer technology can be transferred into standard production lines using standard equipment, it also allows us to efficiently utilize our capital. The foundry partnerships will allow us to scale our high-performance polymer optical engines quickly and efficiently.

Our extremely strong and broad patent portfolio allows us to optimize our business model in three areas: 1) Traditional focus on product development, 2) Patent licensing and 3) Technology transfer to foundries. We are continually looking to strengthen our patent portfolio both by internal inventions and acquisition of intellectual property.

We are initially targeting applications in fiber optic data communications and telecommunications markets and are exploring other applications that include automotive/LIDAR, sensing, displays etc., for our polymer technology platform. Our goal is to have our unique polymer technology platform become ubiquitous.

Unless the context otherwise requires, all references to the "Company," "we," "our" or "us" and other similar terms means Lightwave Logic, Inc. Also, this Form 10-K Annual Report includes the names of various government agencies and the trade names of other companies. Unless specifically stated otherwise, the use or display by us of such other parties' names and trade names in this report is not intended to and does not imply a relationship with, or endorsement or sponsorship of us by, any of these other parties.

Materials Development

Our Company designs and synthesizes organic chromophores for use in its own proprietary electro-optic *polymer systems* and photonic device designs. A polymer system is not solely a material, but also encompasses various technical enhancements necessary for its implementation. These include host polymers, poling methodologies, and molecular spacer systems that are customized to achieve specific optical properties. Our organic electro-optic polymer systems compounds are mixed into solution form that allows for thin film application. Our proprietary electro-optic polymers are designed at the molecular level for potentially superior performance, stability, and cost-efficiency. We believe our proprietary and unique polymers have the potential to replace more expensive, higher power consuming, slower-performance materials such as semiconductor modulator devices that are used in fiber-optic communication networks today.

Our patented and patent pending molecular architectures are based on a well-understood chemical and quantum mechanical occurrence known as *aromaticity*. Aromaticity provides a high degree of molecular stability that enables our core molecular structures to maintain stability under a broad range of operating conditions.

We expect our patented and patent-pending optical materials along with trade secrets and licensed materials, to be the core of and the enabling technology for future generations of optical devices, modules, sub-systems, and systems that we will develop or potentially out-license to electro-optic device manufacturers, contract manufacturers, original equipment manufacturers, etc. Our Company contemplates future applications that may address the needs of semiconductor companies, optical network companies, Web 2.0/3.0 media companies, high performance computing companies, telecommunications companies, aerospace companies, automotive companies, as well as for example, government agencies.

Device Design and Development

Electro-optic Modulators

Our Company designs its own proprietary electro-optical modulation devices. Electro-optical modulators convert data from electric signals into optical signals that can then be transmitted over high-speed fiber-optic cables. Our modulators are electro-optic, meaning they work because the optical properties of the polymers are affected by electric fields applied by means of electrodes. Modulators are key components that are used in fiber optic telecommunications, data communications, and data centers networks etc., to convey the high data flows that have been driven by applications such as pictures, video streaming, movies etc., that are being transmitted through the Internet. Electro-optical modulators are expected to continue to be an essential element as the appetite and hunger for data increases every year as well as the drive towards lower power consumption, and smaller footprint (size).

Polymer Photonic Integrated Circuits

Our Company also designs its own proprietary Photonic Integrated Circuits (otherwise termed a polymer PIC). A polymer PIC is a photonic device that integrates several photonic functions on a single chip. We believe that our technology can enable the ultra-miniaturization footprint needed to increase the number of photonic functions residing on a semiconductor chip to create a progression like what was seen in the computer integrated circuits, commonly referred to as Moore's Law. One type of integration is to combine several instances of the same photonic functions such as a plurality of modulators to create a multi-channel polymer PIC. The number of channels can be varied depending on application. For example, the number of photonic components could increase by a factor of 4, 8, or 16. Another type of integration is to combine different types of devices including from different technology bases such as the combination of a semiconductor laser with a polymer modulator. Our P^2IC™ platform encompasses both these types of architecture.

Current semiconductor photonic technology today is struggling to reach faster device speeds. Our modulator devices, enabled by our electro-optic polymer material systems, work at extremely high frequencies (wide bandwidths) and possess inherent advantages over current crystalline electro-optic material contained in most modulator devices such as bulk lithium niobate (LiNbO3), indium phosphide (InP), silicon (Si), and gallium arsenide GaAs). Our advanced electro-optic polymer platform is creating a new class of modulators such as the Polymer Stack ™, Polymer Plus™, Polymer Slot™, and associated PIC platforms that can address higher data rates in a lower cost, lower power consuming manner, smaller footprint (size) with much simpler data encoding techniques. Our electro-optic polymer material will boost the performance of standard PIC platforms such as silicon photonics and indium phosphide.

Our electro-optic polymers can be integrated with other materials platforms because they can be applied as a thin film coating in a fabrication clean room such as may be found in semiconductor foundries using standard clean room tooling. This approach we call Polymer Plus™. Our polymers are unique in that they are stable enough to seamlessly integrate into existing CMOS, Indium Phosphide (InP), Gallium Arsenide (GaAs), and other semiconductor manufacturing lines. Of relevance are the integrated silicon photonics platforms that combine optical and electronic functions. These include a miniaturized modulator for ultra-small footprint applications in which we term the Polymer Slot™. This design is based on a slot modulator fabricated into semiconductor wafers that include both silicon and indium phosphide.

Our Company has a fabrication facility in Colorado to apply standard fabrication processes to our electro-optic polymers which create modulator devices. While our internal fabrication facility is capable of manufacturing modulator devices, we have partnered with commercial silicon-based fabrication companies that are called foundries who can scale our technology with volume quickly and efficiently. The process recipe for fabrication plants or foundries is called a 'process development kit' or PDK. We are currently working with commercial foundries to implement our electro-optic polymers into accepted PDKs by the foundries. Our work with the foundries is being focused with the Polymer Plus™ and the Polymer Slot™ polymer modulators.

Glossary

Glossary of select technology terms to provide you with a better understanding our Company's technology and devices:

Electro-optic devices - Electro-optic devices convert data from electric signals into optical signals for use in communications systems and in optical interconnects for high-speed data transfer.

Electro-optic material - Electro-optic material is the core active ingredient in high-speed fiber-optic telecommunication systems. Electro-optic materials are materials that are engineered at the molecular level. Molecular level engineering is commonly referred to as "nanotechnology."

Electro-optic modulators - Electro-optic (E/O) modulators are electro-optic devices that perform electric-to-optic conversions within the infrastructure of the internet. Data centers may also benefit from this technology through devices that could significantly increase bandwidth and speed while decreasing costs. Polymer E/O modulators can be designed and fabricated with multiple structures such as Ridge waveguide (Polymer™ Stack) and slot waveguide (Polymer Slot™). The waveguides allow the light to be efficiently coupled into and out of the modulators, and provide a basis for integrating modulators together.

Gbaud - The rate of symbol changes in data transmission in billions of symbol changes per second. Each symbol can support one or more bits, the number of bits depending on the modulation format.

NRZ – See PAM2.

PAM2 – 2 level Pulse Amplitude Modulation, a modulation format in which the optical power in each symbol can assume either of two different levels, low or high, representing, respectively, a 0 or a 1. PAM2 supports 1 bit per symbol so the bit rate is equal to the baud rate or symbol rate. For example, a modulator capable of supporting 100 Gbaud can transmit 100 Gbps with PAM2 modulation. This modulation format is often called NRZ (Non Return to Zero).

PAM4 - 4 level Pulse Amplitude Modulation, a modulation format in which the optical power in each symbol can assume any one of 4 different levels. PAM4 supports 2 bits per symbol so the bit rate is equal to two times the baud rate or symbol rate. For example, a modulator capable of supporting 100 Gbaud can transmit 200 Gbps with PAM4 modulation.

PAM8 - 8 level Pulse Amplitude Modulation, a modulation format in which the optical power in each symbol can assume any one of 8 different levels. PAM4 supports 3 bits per symbol so the bit rate is equal to three times the baud rate or symbol rate. For example, a modulator capable of supporting 100 Gbaud can transmit 300 Gbps with PAM8 modulation.

Photonic Devices - Photonic devices are components for creating, manipulating, or detecting light. This can include modulators, laser diodes, light-emitting diodes, solar and photovoltaic cells, displays and optical amplifiers. Other examples are devices for modulating a beam of light and for combining and separating beams of light of different wavelength.

Polymers - Polymers, also known as plastics, are large carbon-based molecules that bond many small molecules together to form a long chain. Polymer materials can be engineered and optimized using nanotechnology to create a system in which unique surface, electrical, chemical, and electro-optic characteristics can be controlled. Materials based on polymers are used in a multitude of industrial and consumer products, from automotive parts to home appliances and furniture, as well as scientific and medical equipment.

Our Business Opportunity

Lightwave Logic, Inc. is developing next generation proprietary photonic devices that are based on our advanced electro-optical polymer material systems. Current legacy technology is based on inorganic crystalline materials, which has allowed for the proliferation of data over fiber optic cables. However, there are inherent molecular deficiencies that have prevented this technology from scaling down in price and up in functionality, especially in terms of $/Gbps. This is primarily due to a closed valence structure that does not allow for the molecular improvements. The valence or valency of an element is a measure of its combining power with other atoms when it forms chemical compounds or molecules. Also, the physical properties of a crystal do not allow for its implementation into highly miniaturize slot structures that are in simple terms the pathways that light travels through in the device.

Organic polymer materials on the other hand, have free electrons that allow for limitless potential to combine with other molecular structures, which allows for multiple options and combinations to improving performance characteristics. Importantly, because they can be applied to optical structures in thin-film liquid form, it is possible to imbue electro-optic ability to highly miniaturized slot structures. Organic polymer materials are also vastly cheaper to manufacture in comparison to growing exotic crystals that are prone to contamination and further must be sliced into thin wafers. Our Company believes that the combination of less expensive manufacturing cost, ease of application, and better scalability, together with a lower cost of ownership due to lower heat dissipation (requiring less cooling), will create enormous demand for our products.

Many companies' early attempts at developing commercially reliable organic polymers were stymied due to the difficulty of creating organic molecules that could remain electro-optically active after being subjected to the high heat of semiconductor manufacturing temperatures (such as silicon CMOS, InP, GaAs etc.). These early attempts also encountered difficulty synthesizing materials that could withstand photochemical bleaching (loss of sensitivity to specific frequencies) and material degradation due to high operating temperatures.

Over the last several years, our Company has made various scientific breakthroughs that have allowed for the synthesis of proprietary organic polymer materials that can withstand extremely high process temperatures that exceed 175^{0}C. Additionally, these materials have demonstrated photochemical stability, even after being subjected to high intensity light for over 5,000 hours and exhibited little electro optic degradation even after being continuously exposed at 110^{0}C. This operating temperature exceeds the maximum commercial operating temperatures of approximately 85^{0}C, found in large data centers. After successfully achieving material test results that either met or exceeded commercial requirements (subsequently confirmed by an outside entity), in late 2016, the Company began production of its first photonic prototype device, a ***ridge waveguide modulator*** which is called a Polymer Stack™.

Our First Product – The Ridge Waveguide Modulator

A ridge waveguide modulator is a type of modulator where the waveguide is fabricated within a layer of our electro-optic polymer system. Various cladding materials and electrodes are layered over the core polymer. The polymer materials are then part of an integrated photonics platform that can house other photonic devices, such as lasers, waveguides etc.

In April 2017 we achieved bandwidth suitable for 25Gbps data rates in an all-organic polymer ridge waveguide intensity modulator prototype, a significant improvement over our initial 10Gbps device modulator prototype that was announced in 2016. This breakthrough was significant because a 25Gbps data rate is important to the optical networking industry because this data rate is a key requirement for achieving 100 Gbps (using 4 channels of 25 Gbps). In July 2017 we advanced our high-speed modulation performance to satisfy 28Gbps data rates for QSFP28 standards which are also utilized for 100Gbps data center applications.

In September 2017 we achieved outstanding performance of our ridge waveguide Mach-Zehnder modulators ahead of schedule, with bandwidth performance levels that will enable 50Gbaud modulation in fiber-optic communications. This important achievement will allow users to utilize arrays of 4 x 50Gbaud polymer modulators using PAM-4 encoding to access 400Gbps data rate systems. Pulse-Amplitude Modulation (PAM-4) is an encoding scheme that can double the amount of data that can be transmitted.

We are now further optimizing our high-performance modulators for additional specifications that are beginning to be required by the fiber communications industry for applications such as networks running at data rates of 800Gbps. 800Gbps will require combining 4 channels of 200Gbps utilizing PAM4 encoding schemes which will prove challenging for many existing modulator technologies. Furthermore, we are collaborating with industry partners to optimize the packaging our modulators so that potential customers can evaluate our high-performance modulators in their systems. This effort will also aid in addressing one of the most under-evaluated processes of developing high speed devices onto a new and novel technology platform which is robustness and reliability. We have already made extensive progress with our polymer materials on this front, and now we are integrating our robust polymer materials onto an integrated photonics platform to provide customers with a more miniaturized, higher performance solution for their data rich systems.

While our initial focus is to address data communications and telecommunications network applications along with cloud computing/data center needs, we believe that in the future we will have additional opportunities to address other applications such as: backplane optical interconnects, photovoltaic cells, medical applications, satellite reconnaissance, navigation systems, radar applications, optical filters, spatial light modulators; and all-optical switches.

Electro-Optic Polymer Production – Our Approach vs. the BLA Approach

Our Electro-Optic Material Approach

Our core material expertise relates to the production of high-performance, high-stability electro-optic polymers for high-speed (wide bandwidth) telecommunication and data communications applications. More specifically, it lies in a less mainstream, yet firmly established, scientific phenomenon called aromaticity. Aromaticity causes a high degree of molecular stability. It is a molecular arrangement wherein atoms combine into multi-membered rings and share their electrons among each other. Aromatic compounds are stable because the electronic charge distributes evenly over a great area preventing hostile moieties, such as oxygen and free radicals, from finding an opening to attack.

Previous and Current Competitive Organic Electro-Optic Polymer Efforts

For the past several decades, diverse corporate interests, including, to our knowledge, IBM, Lockheed Martin, DuPont, AT&T Bell Labs, Honeywell, Motorola, HP, 3M, and others in addition to numerous universities and U.S. Government Agencies, have attempted to produce high-performance, high-stability electro-optic polymers for high-speed (wide bandwidth) telecommunication applications. These efforts were largely unsuccessful due, in our opinion, to the industry's singular adherence to an industry pervasive engineering model known as the Bond Length Alternation ("BLA") theory model, which none of our patented molecular designs rely upon. The BLA model, like all other current industry-standard molecular designs, consists of molecular designs containing long strings of atoms called polyene chains. Longer polyene chains provide higher electro-optic performance, but are also more susceptible to environmental threats, which result in unacceptably low-performing, thermally unstable electro-optic polymers.

As a result, high frequency modulators engineered with electro-optic polymers designed on the BLA model or any other polyene chain design models are unstable over typical operating temperature ranges, and often exhibit performance degradation within days, hours or even minutes. Similarly, lower frequency modulators exhibit comparable failings, but to a lesser extent. These flaws, in most cases, have prevented commercial quality polymer-based modulators from entering the commercial marketplace. The thermal stability of these devices does not generally meet the minimum Telcordia GR-468 operating temperature range (-40 degrees Celsius to +85 degrees Celsius) much less the harsher MILSPEC 883D (military specification) range of -55 degrees Celsius to 150 degrees Celsius. While many new applications do not require meeting full military or Telcordia GR-468 specifications for polymers, many potential customers prefer to see polymer operate at or near these conditions to convey confidence in the material system. We understand from initial conversations with data center architects and designers that the temperature specifications that our materials achieve are compliant with their equipment design needs.

We are aware of other academic and commercial development efforts—some by larger companies with vastly more financial resources than we possess. However, we believe that no one yet has developed organic polymer materials that have demonstrated the combination of thermal stability and photochemical stability that can meet or exceed commercial specifications.

Our Electro-Optic Photonic P^{2}IC™ Device Approach

Our electro-optic devices are built around our proprietary organic polymer material systems that we believe will enable better performance than the current embedded legacy technology built around inorganic materials. We also believe that the inherent flexibility of being able to apply our organic polymer materials in liquid thin-film form will accelerate the move toward ultra-miniaturization of Polymer Photonic Integrated Circuits (P^{2}IC^{TM}) by increasing the number of photonic circuits on a single chip. Polymer photonics (previously referred in industry as silicon organic hybrid (SOH)) is the application of polymers on to a platform such as silicon where there are both active and passive photonic component designs. In polymer photonics, polymer devices such as modulators, waveguides, and multiplexers can be fabricated on to a silicon platform that acts as a package as well as a base for mounting lasers (which are needed to source the light).

Our initial device, a ridge waveguide modulator, though highly miniaturized utilizes conventional design and fabrication techniques in the industry. Our future devices will utilize silicon photonics (SiPh) technology, which can support highly miniaturized slot waveguides structures etched in large format, low cost, and less expensive silicon wafers coated with our organic electro-optic polymers. The low-cost structure compares well to compound semiconductor technologies such as GaAs (Gallium arsenide) and InP (Indium Phosphide), which suffer from small format wafers that do not allow the economies of scale in high volume fabrication plants. The degree of miniaturization possible of the slot modulator using SiPh is not technically feasible to accomplish with inorganic crystalline materials. Although this may not always remain the case, presently there are nearly insurmountable technical difficulties that are inherent to a crystalline molecule.

Although we believe that our polymers will be the key differentiating factor in Polymer photonic devices, we do not currently possess the technical skills and instrumentation necessary to fabricate and test PICs at this dramatically reduced scale and intend to seek an external partner to assist with development.

Our Intellectual Property

Our research and development efforts over the last 10+ years have yielded our Company an extensive patent portfolio as well as critical trade secrets, unpatented technology and proprietary knowledge related to our optical polymer materials. Our intellectual property portfolio has expanded significantly over the last year as we are developing our P^{2}IC™ into prototypes. We actively filed technical utility patents over the past few years, and are currently in the process of readying a number of other inventions for formal filings in 2023. We expect to continue innovating with our P^{2}IC platform for the next couple of years. We had a number of patents issued over the past few months indicating that our technology is being recognized as being unique.

In 2018, we acquired the polymer technology intellectual property assets of BrPhotonics Productos Optoelectrónicos S.A., a Brazilian corporation, which significantly advanced our patent portfolio of electro-optic polymer technology with 15 polymer chemistry materials, devices, packaging and subsystems patents and further strengthened our design capabilities to solidify our market position as we prepare to enter the 400Gbps integrated photonics marketplace with a highly competitive, scalable alternative to installed legacy systems.

In 2022, we acquired the polymer technology and intellectual property assets of Chromosol Ltd (UK), which significantly strengthened our Company's design capabilities with foundry PDKs with extremely low temperature atomic layer deposition (ALD) processes that effectively hermetically seal polymer devices that have been prepared for high volume manufacturing. The advanced fabrication processes of ALD with temperatures below 100C will solidify our market position with both the Company's manufacturing foundry partners as well as end-users as we prepare to enter the 800Gbps integrated photonics marketplace. The acquisition also advanced our Company's patent portfolio of electro-optic polymer technology with an innovative polymer chemistry device patent that has potential to increase the performance of integrated modulators through optical amplification in a photonic integrated circuit (PIC) and enhance the functionality of the PIC by integrating laser light sources made using the polymer-based gain and a laser optical cavity defined on the Silicon photonic platform, with our Company's high speed, high efficiency modulators.

In total, our patent portfolio currently consists of 66 granted patents that include 52 from the US, 1 from Canada, 6 from the EU, 2 from Japan and 3 from China.

Our materials patent portfolio has also strengthened significantly with the filing of additional new patent applications on our core Perkinamine™ molecular compounds as well as recent, innovative inventions that are expected to protect our P^{2}IC polymer PIC platform from potential competition.

Included in our patent portfolio are the following nonlinear optic chromophore designs:

- Stable Free Radical Chromophores, processes for preparing the same
- Stable Free Radical Chromophores, processes for preparing the same
- Tricyclic Spacer Systems for Nonlinear Optical Devices
- Anti-Aromatic Chromophore Architectures
- Heterocyclical Anti-Aromatic Chromophore Architectures
- Heterocyclical Chromophore Architectures
- Heterocyclical Chromophore Architectures with Novel Electronic Acceptor Systems
- Multi-fiber/port hermetic capsule sealed by metallization and method

Our patent portfolio includes patents not only on nonlinear optic chromophore designs, but also device designs and inventions, fabrication process inventions, packaging design inventions, as well as novel chemistry to enable high performance, low power, small footprint polymer PIC technology.

Our strategic plan is to utilize our core proprietary technology and leverage our proprietary optical materials to be the core of and the enabling technology for future generations of optical devices, modules, sub-systems and systems that we will develop or potentially out-license to electro-optic device manufacturers. Our Company contemplates future applications that may address the needs of semiconductor companies, automotive/LiDAR companies, sensing companies, aerospace companies and government agencies.

We rely on a combination of patents, patent applications, trademarks, trade secrets and contractual provisions to protect our technologies. Further, employees are required to surrender any inventions or intellectual property developed as part of their employment agreements. We also have a policy of requiring prospective business partners to enter into non-disclosure agreements (NDAs) before disclosure of any of our confidential or proprietary information. Our Company can make no assurances that we will be able to effectively protect our technologies and know-how or that third parties will not be able to develop similar technologies and know-how independently.

The anti-aromatic nature of these structures dramatically improves the "zwitterionic-aromatic push-pull" of the systems, providing for low energy charge transfer. Low energy charge transfer is important for the production of extremely high electro-optic character.

Heterocyclical Steric Hindering System This patent describes a nitrogenous heterocyclical structure for the integration of steric hindering groups that are necessary for the nanoscale material integration. Due to the [pi]-orbital configuration of the nitrogen bridge, this structure has been demonstrated not to interfere with the conductive nature of the electronic conductive pathway and thus is non-disruptive to the electro-optic character of the core molecular construction. The quantum mechanical design of the system is designed to establish complete molecular planarity (flatness) for optimal performance.

Totally Integrated Material Engineering System. This patent covers material integration structures under a design strategy known as Totally Integrated Material Engineering. These integration structures provide for the "wrapping" of the core molecule in sterically hindering groups that maximally protect the molecule from environmental threats and maximally protect it from microscopic aggregation (which is a major cause of performance degradation and optical loss) within a minimal molecular volume. These structures also provide for the integration of polymerizable groups for integration of materials into a highly stable cross-linked material matrix.

Recent Significant Events and Milestones Achieved

During February and March 2018, we moved our Newark, Delaware synthetic laboratory and our Longmont, Colorado optical testing laboratory and corporate headquarters to office, laboratory and research and development space located at 369 Inverness Parkway, Suite 350, Englewood, Colorado. The 13,420 square feet Englewood facility includes fully functional 1,000 square feet of class 1,000 cleanroom, 500 square feet of class 10,000 cleanroom, chemistry laboratories, and analytic laboratories. The Englewood facility streamlines all of our Company's research and development workflow for greater operational efficiencies.

During March 2018, our Company, together with our packaging partner, successfully demonstrated packaged polymer modulators designed for 50Gbaud, which we believe will allow us to scale our P^2IC™ platform with our Mach-Zehnder ridge waveguide modulator design as well as other photonics devices competitively in the 100Gbps and 400Gbps datacom and telecommunications applications market. We are currently fine-tuning the performance parameters of these prototypes in preparation for customer evaluations.

During June 2018, our Company Acquired the Polymer Technology Intellectual Property Assets of BrPhotonics Productos Optoelectrónicos S.A., a Brazilian corporation, which significantly advanced our patent portfolio of electro-optic polymer technology with 15 polymer chemistry materials, devices, packaging and subsystems patent and further strengthened our design capabilities to solidify our market position as we prepare to enter the 400Gbps integrated photonics marketplace with a highly competitive, scalable alternative to installed legacy systems.

Also, during June 2018, our Company promoted polymer PICs and Solidified Polymer PICs as Part of the Photonics Roadmap at the World Technology Mapping Forum in Enschede, Netherlands, which includes our Company's technology of polymers and polymer PICs that have the potential to drive not only 400Gbps aggregate data rate solutions, but also 800Gbps and beyond.

In August 2018 we announced the completion (ahead of schedule) of our fully equipped on-site fabrication facility, where we are expanding our high-speed test and design capabilities. We also announced the continuation of the building of our internal expertise with the hiring of world-class technical personnel with 100Gbps experience.

In February 2019 we announced a major breakthrough in our development of clean technology polymer materials that target the insatiable demand for fast and efficient data communications in the multi-billion-dollar telecom and data markets supporting Internet, 5G and IoT (Internet of Things) webscale services. The improved thermally stable polymer has more than double the electro-optic response of our previous materials, enabling optical device performance of well over 100 GHz with extremely low power requirements. This addition to the family of Perkinamine™ polymers will hold back run-away consumption of resources and energy needed to support ever-growing data consumption demands. We continue to conduct testing of the material and assessment of associated manufacturing processes and device structures prior to release to full development.

In March 2019 we created an Advisory Board comprised of three world-class leaders in the photonics industry: Dr. Craig Ciesla, Dr. Christoph S. Harder, and Mr. Andreas Umbach. In January 2022 Dr. Ciesla was named to our Board of Directors, and our Advisory Board is currently comprised of Dr. Franky So, Dr. Christoph S. Harder, Mr. Andreas Umbach and Dr. Joseph A. Miller, who is a former member of our Board of directors. The Advisory Board is working closely with our Company leadership to enhance our Company's product positioning and promote our polymer modulator made on our proprietary *Faster by Design*™ polymer P^2IC™ platform. The mission of the Advisory Board is initially to increase our Company's outreach into the datacenter interconnect market and later to support expansion into other billion-dollar markets. The Advisory Board members have each been chosen for their combination of deep technical expertise, breadth of experience and industry relationships in the fields of fiber optics communications, polymer and semiconductor materials. Each of the Advisory Board members has experience at both innovators like Lightwave Logic and large industry leaders of the type most likely to adopt game-changing polymer-based products. In addition, they possess operational experience with semiconductor and polymer businesses.

Also, in March 2019, our Company received the "Best Achievement in PIC Platform" award for our 100 GHz polymer platform from the PIC International Conference. The award recognizes innovative advances in the development and application of key materials systems driving today's photonic integrated circuits (PICs) and providing a steppingstone to future devices.

During the second quarter of 2019, our Company promoted its polymers at CoInnovate in May and the World Technology Mapping Forum in June. CoInnovate is a meeting of semiconductor industry experts. The World Technology Mapping Forum is a group authoring a photonics roadmap out to 2030.

In September 2019 at the prestigious European Conference on Communications (ECOC) in Dublin, Ireland, we showed measured material response over frequency and the resulting optical data bits stream on our clean technology polymer materials, the newest addition to our family of Perkinamine™ polymers, that meet and exceed of our near-term target speed of 80 GHz. We also released data demonstrating stability under elevated temperatures in the activated (poled to create data carrying capability) state.

In October 2019, we reported that energy-saving polymer technology is highlighted in the recently published Integrated Photonics Systems Roadmap - International (IPSR-I). The roadmap validates the need for low-voltage, high-speed technologies such as ours.

In May 2020, we announced that our latest electro-optic polymer material has exceeded target performance metrics at 1310 nanometers (nm), a wavelength commonly used in high-volume datacenter fiber optics. This material demonstrates an attractive combination at 1310 nm of high electro-optic coefficient, low optical loss and good thermal stability at 85^0 Celsius. The material is expected to enable modulators with 80 GHz bandwidth and low drive power, and has an electro-optic coefficient of 200 pm/V, an industry measure of how responsive a material is to an applied electrical signal. This metric, otherwise known as r33, is very important in lowering power consumption when the material is used in modulator devices. This technology is applicable to shorter reach datacenter operators, for whom decreasing power consumption is imperative to the bottom line of a facility. We considered this a truly historic moment—not only in our Company's history, but in our industry–as we have demonstrated a polymer material that provides the basis for a world-class solution at the 1310 nm wavelength, something which other companies have spent decades attempting to achieve.

In July 2020, we announced the official launch of our new corporate website www.lightwavelogic.com, reflecting ongoing efforts to provide up-to-date information for investors and potential strategic partners. The revamped website offers a clean, modern design integrated with helpful tools and investor relations resources, including a new corporate explainer video, to illustrate the target markets and advantages of Lightwave Logic's proprietary electro-optic polymers.

In August 2020, we announced the addition of Dr. Franky So, a leading authority in the OLED industry, to our Advisory Board. Dr. So is the Walter and Ida Freeman Distinguished Professor in the Department of Materials Science and Engineering at North Carolina State University. Previously, he was the Head of Materials and Device research for OLEDs at OSRAM Opto Semiconductors, as well as Motorola's corporate research lab in the 1990s. Dr. So was an early researcher in electro-optic (EO) polymer modulators at Hoechst Celanese. As a member of the

Company's advisory board, Dr. So will work closely with management to enhance Lightwave's product positioning for, as well as the promotion of, its polymer modulators made on its proprietary platform. In addition, he will provide technical support and advisory services to the Lightwave materials and device teams.

On October 7, 2020 we announced the receipt of U.S. Patent number 10,754,093 that improves both the performance and reliability of our high-speed, low-power electro-optic polymer modulators intended for datacenter and telecommunications applications. The patent allows multi-layered electro-optic polymer modulators to perform more efficiently through the design of custom interfaces. These interfaces are designed into the cladding layers that allow optical transmission, electrical conductivity, material integrity, as well as a prevention of solvents affecting adjacent polymer materials. The net impact of all of this allows for our Company's modulators to improve performance across the board, enabling higher reliability in the fiber optic communications environment.

On October 15, 2020, we announced that our proprietary polymer technologies are compatible with currently available integrated photonics platforms. Our proprietary electro-optic materials are currently in the prototyping phase and are fabricated onto standard silicon wafers, and this Polymer Plus™ advancement, driven by the feedback our Company received from potential customers to-date, has allowed our materials to be suitable for additive integration to integrated photonics platforms such as silicon photonics, as well as indium phosphide and other standard platforms – therefore enabling simpler integration by customers. We believe this breakthrough allows a polymer modulator to enhance the performance of existing integrated photonics solutions in the marketplace, enabling higher speed and lower power consumption on foundry-fabricated photonics designs. Since our technology is additive to existing platforms such as silicon photonics, our electro-optic polymers are not actually competing with integrated photonic platforms, but rather enabling them to be more competitive in the marketplace, and it further validates our EO polymer platform as ideally suited to enable optical networking more efficiently than ever.

On October 21, 2020, we announced that we have optimized a robust, photo-stable organic polymer material for use in our next-generation modulators intended to be trialed with potential customers under NDA. Our materials show high tolerance to high-intensity infrared light, common in a fiber optic communications environment and increasingly important as higher density of devices access the network, directly resulting in higher intensity infrared light levels. Our preliminary results suggest that our recently developed electro-optic polymer material, designed based on potential customer input, displays unrivaled light tolerance (also known as photostability) compared to any organic commercial solution in use today. Our results meet both our current internal criteria and address potential customer feedback.

On November 2, 2020, we disclosed results on our polymer material stability testing including further results for electro-optic efficiency for our Company's materials that operate both at 1550nm as well as 1310nm. We demonstrated test materials results for electro-optic efficiency to 4000hrs, improvement in sensitivity to oxygen as part of a broadband exposure test, and stability for polymers exposed to 1310nm light at 100mW.

On November 20, 2020 we announced the receipt of U.S. Patent number 10,591,755 that details an important invention that allows users of electro-optic polymer modulators to not only operate the devices with high speed and low power directly from CMOS IC chips, but gives them the opportunity to avoid the expense, physical footprint and power consumption of high-speed modulator driver ICs. Furthermore, this patent strengthens our freedom of manufacturing, and directly enables our modulators to become more competitive in the marketplace.

On December 16, 2020 we announced the development of a new sealant for our future Chip-on-Board (COB) packaged polymer platform. The sealant, which blocks oxygen and other atmospheric gases, is a key step in our Company's development towards a polymer modulator without a package, an important enabling technology for the industry. We plan to develop the sealant for commercial implementation in our future modulators. Recent results suggest that our electro-optic polymer sealant material displays encouraging barrier properties and is expected to translate to significant improvement in bare chip robustness against atmospheric gases, as compared to existing EO polymer commercial solutions in use today. While the initial measurements are highly promising, our Company plans to continue development work to further optimize the sealant material and barrier performance towards the chip-on-board goal.

On January 13, 2021, we announced the receipt of U.S. Patent number 10,886,694 that details an invention that allows electro-optic polymer modulators to be packaged in a hermetic environment using well-known, high-volume and low-cost fabrication processes that are available in a typical semiconductor fabrication foundry – improving suitability for mass production. Further, the design of this capsule package can improve both the reliability and the coupling interface between fiber optic cables and their laser sources for arrayed photonic integrated circuit solutions. The package can also interpose signals from an underlying circuit board to the polymer modulators, lasers, and other components for data transfer. The hermetic capsule is built from a semiconductor base that contains electrical and optical circuits and components. A hermetic capsule chamber is created by the design of a semiconductor lid that is sealed to the semiconductor base platform by a metallization process. Using standardized fabrication techniques we can now create a package that achieves the performance, reliability, cost, and volume requirements that has been a challenge for the photonics industry for years.

On May 11, 2021, we announced the receipt of U.S. Patent number 10,989,871 that details an invention that allows for improved protective polymer layers in modulators when designed into advanced integrated photonic platforms, better positioning them for high-volume manufacturing processes. The protective layers will enhance electro-optic polymer devices' performance through higher reliability, better optical performance and enable the use of standardized manufacturing processes best suited for mass-production.

On June 7, 2021, we announced that our company's common stock was added to the Solactive EPIC Core Photonics EUR Index NTR as part of the index's semi-annual additions. The index includes global public companies with a common theme of optoelectronics, photonics, and optical technologies in general that range from components, modules, manufacturers, and optical network system companies. This inclusion broadens our exposure to the capital markets community, as well as credibility with potential partners and customers.

On June 16, 2021, we announced test results from new modulators fabricated in 2021, which exceeded bandwidth design targets and achieved triple the data rate as compared to competing devices in use today. The breakthrough new devices demonstrated 3dB electro-optical with electrical bandwidths that exceed 100GHz – with measurements coming close to our Company's state-of-the-art 110GHz test equipment capability. We expect this advancement to have a profound impact on the traffic flow on the internet.

On June 24, 2021, we announced the receipt of U.S. patent number 11,042,051 that details a breakthrough new device design that enables mass-volume manufacturing when designed into advanced integrated photonic platforms. The device design enhances reliability, improves optical mode control and most important, lowers by consumption through the use of direct-drive, low-voltage operation. The patent is entitled, "Direct drive region-less polymer modulator methods of fabricating and materials therefor" and is expected to open the opportunity for low power consumption electro-optic polymers to be developed into large foundry PDKs (process development kits) and be ready for mass volume commercialization. The patent emphasizes our technology platform using fabrication techniques that would naturally fit into foundry PDKs.

On August 4, 2021, we announced that we developed improved thermal design properties for electro-optic polymers used in our Polymer Plus™ and Polymer Slot™ modulators, enabling the speed, flexibility and stability needed for high-volume silicon foundry processes. We successfully created a 2x improvement in r33, while allowing higher stability during poling and post-poling. This provides better thermal performance and enables greater design flexibility in high-volume silicon foundry PDK (process development kit) processes.

On August 9, 2021, we announced the receipt of U.S. patent number 11,067,748 entitled "Guide Transition Device and Method" that covers a new invention that enables enhanced optical routing architectures for polymer-based integrated photonics that can be scaled with partner foundries. This new invention will enable innovative, highly scalable optical routing architectures for integrated photonic platforms. The patent provides novel optical waveguide transition designs using two planes of optical waveguides that are expected to be critical for optical signal routing and optical switching, opening the opportunity for high speed, energy efficient electro-optic polymers to be implemented into foundry PDKs (process development kits) to improve the performance of integrated photonic circuits. This breakthrough technology opens the door for advanced integrated photonics architectural design. We believe the simplicity of the design is ideal for production in foundries and will best position our Company to enable increased data traffic on the internet while using less power.

On September 1, 2021, our Company's common shares began trading on the Nasdaq Capital Market ("Nasdaq"). The Company's Nasdaq listing will help to expand our potential shareholder base, improve liquidity, elevate our public profile within the industry and should ultimately enhance shareholder value.

On September 15, 2021, we announced the receipt of the 2021 Industry Award for Optical Integration from the European Conference on Optical Communications (ECOC), a premier industry exhibition that was held in Bordeaux from September 13-15, 2021. ECOC created the fiber communication industry awards in six categories to put the spotlight on innovation happening within the industry. The awards recognize and highlight key industry achievements in advancing optical components, photonic integration, optical transport and data center innovation. The awards are selected from top industry players, representing significant innovation in photonics integration at our prestigious exhibition.

On September 16, 2021, we announced the achievement of world-record performance for a polymer modulator, as demonstrated in an optical transmission experiment by ETH Zurich, using our Company's proprietary, advanced Perkinamine™ chromophores and Polariton Technologies Ltd.'s newest plasmonic EO modulator, a silicon-photonics-based plasmonic racetrack modulator offering energy-efficient, low-loss, and high-speed modulation in a compact footprint. The groundbreaking results were presented as a post-deadline paper at the prestigious European Conference on Optical Communications (ECOC) industry exhibition and conference in Bordeaux on September 16, 2021. Polariton's plasmonic modulator transmitted 220 Gbit/s OOK and 408 Gbit/s 8PAM. Transmission of an optical signal was conducted over 100 m using a low-voltage electrical drive of 0.6Vp, an on-chip loss of 1 dB, and an optical 3 dB bandwidth of beyond 110 GHz.

On January 3, 2022, we announced the publication of our patent application 20210405504A1 by the United States Patent and Trademark Office (USPTO) – entitled *'Nonlinear Optical Chromophores Having a Diamondoid Group Attached Thereto, Methods of Preparing the Same, and Uses Thereof'* – which significantly improves the overall stability and performance of our electro-optic polymers. The Company's electro-optic chromophores are designed to have one or more diamondiod molecular groups attached to the chromophore. When such chromophores are dispersed in a host polymer matrix, the electro-optic materials result in improved macroscopic electro-optic properties, increased poling efficiency, increased loading as well as increased stability of these materials after poling. The impact of this technology is that it will accelerate the path for very high-speed, low-power electro-optic polymers to be implemented into large foundry process development kits ("**PDKs**") to boost performance of integrated photonic circuits.

On January 3, 2022, we announced that we enhanced our Company's Foundry Process Development Kit Offering with the addition of Optical Grating Couplers. This expanded design tool kit will enable silicon foundries to implement PDKs and fabricate modulators and optical gratings in a single fab run, further enhancing modulator efficacy. We are continuing to work on additional design tool kit components to enable an expedited commercialization process through a more simplified manufacturing process for our foundry partners.

On January 3, 2022, we announced that we appointed respected industry leader Dr. Craig Ciesla to our Board of Directors and that retired director Dr. Joseph A. Miller transitioned to our Company's Advisory Board. Dr. Ciesla is currently the Vice President, Head of the Advanced Platforms and Devices Group at Illumina, a leading provider of DNA sequencing and array technologies. There he leads a team driving innovation in sequencing platforms, microfluidics, electronics, and nanofabrication. Prior to Illumina, he was Vice President of Engineering at Kaiam, where he was responsible for the development and production of 100G transceivers for the data-center market. He was also the founding CEO of Tactus Technology, an innovator in the user interface industry, where he was the co-inventor of Tactus' polymer morphing screen technology. Before Tactus he had a variety of roles at Intel, JDSU (now Lumentum), Bookham (now Oclaro) and Ignis Optics developing a wide range of products in the fiber-optics market. He started his career at Toshiba Research Europe, where he performed early terahertz images of skin cancer. Dr. Ciesla holds a BSc (Hons.) in Applied Physics and Ph.D. in Physics from Heriot-Watt University in Edinburgh.

On February 10, 2022, we announced breakthrough photostability results on our electro-optic polymer modulators that are compatible with high-volume silicon foundry processes. The improved photostability of our polymers are expected to minimize any optical losses and provide a more robust platform for silicon foundries. This breakthrough photostability performance is incredibly important as we optimize our polymers for high-volume silicon foundry processes.

On March 7, 2022, we announced the receipt of U.S. patent number 11,262,605 entitled, "Active region-less polymer modulator integrated on a common PIC platform and method." This invention will simplify modulator integration for high-volume foundry manufacturing operations while enhancing polymer reliability to enable a more effective photonic engine. The essence of the invention is a complete optical engine that fits into fiber optic transceivers (either pluggable or co-packaged) that are used in routers, servers and elsewhere in optical networks. The engine is designed for high-volume manufacturing operations using silicon foundry infrastructure. The patent illustrates the use of our polymer modulators as a high speed, low power engine not only for data communication and telecommunication applications, but other new market opportunities as well.

On March 22, 2022 we announced the achievement of world-class results for a polymer modulator, as demonstrated in an enhanced stability and high-speed measurement by Polariton Technologies and ETH Zurich. The results were generated using the Company's proprietary, advanced Perkinamine™ chromophores in Polariton's silicon-photonics-based plasmonic racetrack modulator that offers energy-efficient, low-loss, and high-speed modulation in a compact footprint that is ideal for pluggable and/or co-packaging transceiver modules. The plasmonic modulator performance was compared to that of silicon photonic microring modulators. The plasmonic device, using Lightwave Logic's electro-optic polymer material, was shown to be 250-3000x more stable than the silicon devices relative to operating condition changes. In addition, the plasmonic modulator was tested for 70+ minutes at 100 Gbps NRZ at 80C with no decrease in performance. The world-class results were presented as a contributed peer-reviewed paper at the prestigious 2022 Optical Fiber Conference (OFC2022), the optical communication industry's leading international technical conference and trade show, in San Diego on March 10, 2022.

On April 19, 2022, we announced the publication of our patent application 2022/0113566 A1 entitled "TFP (thin film polymer) optical transition device and method" that illustrates the design of a simpler to fabricate, lower cost hybrid integrated photonics chip using electro-optic polymers which are more advantageous for high-volume production. The invention will simplify polymer modulator fabrication when integrated with silicon photonics for high-volume foundry manufacturing applications. The simplified fabrication approach enables us to simplify the production of very high speed, low power proprietary polymer modulators that will enable significantly faster data rates in the internet environment. The essence of the invention is a hybrid polymer-silicon photonics engine that fits into fiber optic transceivers (either pluggable or co-packaged) that are used in the routers, servers and network equipment that are proliferating with the growth of data centers, cloud computing and optical communications capacity. The hybrid polymer-silicon photonics engine is designed to use high-volume silicon foundry infrastructure.

On May 25, 2022, we announced enhanced photostability results on our Company's proprietary electro-optic polymer modulators – demonstrating the reliability necessary for commercial deployments – all based on a technology which can be ported into high-volume silicon foundries and integrated onto a silicon photonics platform with other optical devices. Photostability is a critical performance metric required both in high volume manufacturing processes (such as photolithography) and in offering the high reliability and network availability required for commercial deployments. In the tests conducted, subjecting the Company's latest polymers to high intensity optical power for over 3000 hours produced no change in device performance. The ability of our proprietary polymers to pass this accelerated photostability aging test provides assurance that they will both tolerate the optical exposures which occur in high-volume manufacturing and support the reliability over the required operating life of optical transceivers and network elements.

On June 21, 2022, we announced the publication of our patent application 2022/0187637A1 entitled "Hybrid electro-optic polymer modulator with silicon photonics" that details a novel fabrication process that allows our Company's proprietary polymers to be fabricated by silicon foundries in a high-volume manufacturing environment. The published patent application also details a more efficient process that allows for high yielding, high stability poling of polymers in a high-volume foundry manufacturing environment. The development of the PDK for this new optical hybrid optical modulator design is now in progress with our Company's foundry partners.

June 23, 2022, we announced the publication of our patent application 2022/0187638A1 entitled " Hybrid electro-optic polymer modulator with atomic layer deposition (ALD) sealant layer" that allows our Company's proprietary polymers to be sealed to moisture and other atmospheric gases in a very low temperature and quasi-hermetic environment through the use of a chip-scale packaging approach that can be applied in parallel at wafer level (i.e. in volume) and that eliminates the need for a separate hermetic enclosure or "gold box." Chip-scale packaging is a technique that has been gathering momentum in the silicon electronics industry for the past decade to reduce device chip packaging costs and increase device performance – enabling high-volume front and back-end manufacturing as well as extremely small sizes in miniaturization. Specifically, our electro-optic polymer modulators are sealed with a low-temperature conformal atomic layer deposition dielectic layers that are supported on a silicon substrate with passive silicon photonics waveguides.

On June 27, 2022 our Company's common stock was added to the Russell 3000® Index. We expect that the awareness of being included in one of the most widely followed benchmarks will not only benefit our existing shareholders but will lead to a broader base of institutional investors. The annual Russell index reconstitution captures the 4,000 largest US stocks as of May 6, ranking them by total market capitalization. Our membership in the US all-cap Russell 3000® Index, which remains in place for one year, means automatic inclusion in the small-cap Russell 2000® Index as well as the appropriate growth and value style indexes.

On June 30, 2022, we announced that our CEO, Dr. Michael Lebby, was again invited to co-chair the Photonic Integrated Circuits (PIC) International Conference that took place June 28-29, 2022 in Brussels, Belgium. At the conference, Dr. Lebby led an invited talk entitled, "Enabling lower power consumption optical networking using high speed, low power polymer modulators", focusing on the issue of reducing power consumption in datacenters and optical networks. He also contributed to a panel session, "Hybrid PICs technology challenges and solutions," on the need for hybrid integration addressing the volume production of 3D and 2.5 integrated electronic and photonic integrated circuits (PICs) based on the utilization of large silicon foundries. This included a discussion on the use of silicon photonics with hybrid technologies such as electro-optic polymers, polymer based plasmonics, silicon nitride and III-V laser sources.

On September 22, 2022, we announced the achievement of world record performance for low-power consumption ultra-high-speed 'green' slot modulators in collaboration with Karlsruhe Institute of Technology (KIT) and its spin-off SilOriX as part of a peer-reviewed post-deadline paper presented at the prestigious 2022 European Conference on Optical Communications (ECOC) in Basel, Switzerland on September 22, 2022. The team presented the first sub-1mm Mach Zehnder-type modulators with sub-1V drive voltage that rely on Lightwave's proprietary advanced Perkinamine™ chromophores. The devices rely on the slot-waveguide device concept developed at KIT and commercialized through SilOriX. Further, the material has experimentally proven thermal stability at 85°C and offers extreme energy-efficiency along with high-speed modulation in a compact footprint. Additionally, this shows that our material can perform in a variety of device structures and designs and is positioned to significantly reduce power consumption of optical networking and to become a true 'green photonics' enabler for the industry.

On September 22, 2022, we announced the achievement of a world-record demonstration of a 250GHz super high bandwidth electro-optical-electrical (EOE) link through a collaboration with ETH Zurich. The link was demonstrated by ETH Zurich and uses Polariton's high-speed plasmonic modulators containing Lightwave's proprietary Perkinamine™ chromophores and ETH Zurich's high-speed graphene photodetectors. The link contained a plasmonic modulator using electro-optic polymer material as well as a novel metamaterial enhanced graphene photodetector featuring a 200 nm spectral window and a setup-limited[1] bandwidth of 500 GHz. The EOE link achieved a world record and unprecedented 250 GHz 3dB bandwidth[2]. This is an optical link that utilizes devices with extremely high bandwidths, and the plasmonic demonstration shows that hybrid technologies such as our electro-optic polymers and graphene together form an important technology platform for volume scalability using large silicon foundries for mass commercialization. The groundbreaking results were presented by Stephan Koepfli as part of a peer-reviewed post-deadline paper presented at the prestigious 2022 European Conference on Optical Communications (ECOC) in Basel, Switzerland on September 22, 2022.

On November 15, 2022, we announced the receipt of U.S. patent number 11,435,603 B2 entitled "TFP (thin film polymer) optical transition device and method," which illustrates the design of a simpler to fabricate, lower cost hybrid integrated photonics chip using electro-optic polymers which are more advantageous for high-volume production. The simplified fabrication approach enables streamlined production of very high speed, low power proprietary polymer modulators that will enable significantly faster data rates in the internet environment. The essence of the invention is a hybrid polymer-silicon photonics engine that fits into fiber optic transceivers (either pluggable or co-packaged) that are used in the routers, servers and network equipment that are proliferating with the growth of data centers, cloud computing and optical communications capacity.

On November 17, 2022, we announced the receipt of U.S. patent number 11,435,604 B2 entitled "Hybrid electro-optic polymer modulator with silicon photonics," which allows Lightwave Logic's proprietary polymers to be fabricated by silicon foundries in a high-volume manufacturing environment. The patent also details a more efficient process that allows for high yielding, high stability poling of polymers in a high-volume foundry manufacturing environment. From a commercial standpoint, this patent enables our polymers to be mass-produced using existing silicon foundry equipment, simplifying production for the foundry's we are working with.

On November 29, 2022, we announced our acquisition of the polymer technology and intellectual property assets of Chromosol Ltd (UK). The acquisition significantly strengthened our Company's design capabilities with foundry PDKs with extremely low temperature atomic layer deposition (ALD) processes that effectively hermetically seal polymer devices that have been prepared for high volume manufacturing. The advanced fabrication processes of ALD with temperatures below 100C will solidify our Company's market position with both the Company's manufacturing foundry partners as well as end-users as we prepare to enter the 800Gbps integrated photonics marketplace. The acquisition also advanced our Company's patent portfolio of electro-optic polymer technology with an innovative polymer chemistry device patent that has potential to increase the performance of integrated modulators through optical amplification in a photonic integrated circuit (PIC) and enhance the functionality of the PIC by integrating laser light sources made using the polymer-based gain and a laser optical cavity defined on the Silicon photonic platform, with our Company's high speed, high efficiency modulators. Having access to extremely low temperature ALD allows our Company's polymer modulators to be protected from the environment without the need for expensive and large footprint gold box packaging, propelling our Company forward with chip-scale packaging as required by major hyper-scaler end-users. The patent opens a new class of PICs which expands our variety of devices. The Patent is US patent number 9837794, EU patent number 3017489, China registration number 201480048236 & 201910230856, and is entitled, "Optoelectronic devices, methods of fabrication thereof and materials therefor."

[1] Set-up limited' indicates that the measurement was limited by the testing equipment.

[2] University of Kiel, Germany supported the digital signal processor (DSP), and ETHZ supported the photodetector.

On December 12, 2022, we announced the receipt of U.S. patent number 11,506,918 B2 entitled "Hybrid electro-optic polymer modulator with atomic layer deposition (ALD) sealant layer," which allows our proprietary polymers to be sealed to moisture and atmospheric gases in a very low temperature and quasi-hermetic environment through the use of a chip-scale packaging approach that can be applied in parallel at wafer level (i.e. in volume) and that eliminates the need for a separate hermetic enclosure or "gold box." Specifically, our electro-optic polymer modulators will be sealed with low-temperature conformal atomic layer deposition dielectric layers that are supported on a silicon substrate with passive silicon photonics waveguides. The sealant process will enable lower cost system implementation in a high-volume foundry environment.

On December 13, 2022, we provided a world-class figure-of merit performance for modulators using electro-optical polymers and a plasmonic device design in conjunction with Polariton Technologies. Building from the world record performance and demonstration of a 250 GHz super high bandwidth electro-optical-electrical (EOE) link that was presented at the 2022 European Conference on Optical Communications (ECOC)[3] through a collaboration with ETH Zurich, these latest figure of merit results show the potential for extreme power savings for optical network equipment and demonstrated clearly that polymer-based technology platforms are positioned well for general implementation. These results were achieved using Polariton's electro-optic polymer-based plasmonic devices with Lightwave's electro-optic materials, with a bandwidth greater than 250 GHz. While these high-speed results have been reported previously, here Lightwave Logic reported for the first time that the voltage-length product Figure of Merit (FoM) for this modulator is just 60 Vum, which is approximately 10X better than the performance of the optical semiconductor modulators that are incumbent in the optical network and internet today. This figure of merit will allow ultra-low voltage operation and, enabled by Polariton's plasmonic modulator, the ability to carry significantly more data per modulator while consuming much less power. The net positive effect on system level equipment is expected not only to be significant, but perhaps more importantly, also a strong driver of a "green photonics" platform. These results position our Company extremely well for next generation ultra-high-capacity interconnects for the hyper-scale market. The combination of electro-optic polymers and plasmonics is becoming an ideal sunrise technology platform to address the 'Achilles heel' of the data industry: high power consumption. As the industry contemplates the implementation of PAM4 200G lanes for 2023 and 2024, these optical devices already have shown capability for at least 2X these lane speeds.

On January 12, 2023, our Chief Executive Officer, Dr. Michael Lebby, hosted a presentation and participated in an industry panel discussion at the 2023 Photonics Spectra Conference, a prominent virtual conference within the photonics industry. In the panel discussion, Dr. Lebby and a panel of industry experts from the entire photonics integrated chip (PIC) value chain, discussed lessons learned when scaling PIC production for volume applications. In his presentation, Dr. Lebby reviewed the potential solutions that electro-optical polymer modulators offer to integrated and hybrid photonics integrated chips (PICs), discussing their relevance to PIC packaging operations as well as how electro-optic polymers boost PIC speed and power efficiency.

On January 30, 2023, our Chief Executive Officer, Dr. Michael Lebby, participated in an industry panel discussion at the 2023 Laser Focus World Executive Forum. The Laser Focus World Executive Forum is one of the industry's premier events for senior-level executives, technology directors, and business managers from technology companies around the world, delivering an in-depth analysis of the global laser and photonics market. In this discussion, Dr. Lebby joined a panel of industry experts to discuss how the success of Silicon Photonics is based on the premise that it is a semiconductor technology, and hence it can be manufactured in volume by semiconductor fabs. The panel addressed the manufacturing plans of photonic integrated circuits (PICs) by semiconductor fabs and how the photonic industry can transfer their processes to the semiconductor industry.

As we move forward to diligently meet our goals, we continue to work closely with our packaging and foundry partners for 112Gbaud prototypes, and we are advancing our reliability and characterization efforts to support our prototyping. Depending on electrical encoding schemes such as PAM4, or PAM8, or wavelength optical multiplexing, these Gigabaud rates roughly translate to 200Gbps and 300Gbps per lane, and are the key speed rates for emerging 800Gbps to future possible 1200Gbps applications. Our partnership with silicon-based foundries will allow us to scale commercial volumes of electro-optic polymer modulator devices using large silicon wafers, and we are currently working to have our fabrication processes accepted into foundry PDKs (process development kits). These are the recipes that foundries use to manufacture devices in their fabrication plants.

We are actively engaged with test equipment manufacturers of the most advanced test equipment to test our state-of-the-art polymer devices. We continue to engage with multiple industry bodies to promote our roadmap. We continue to fine tune our business model with target markets, customers, and technical specifications. Our business model includes the licensing of our strong IP and Patent portfolio, as well as technology transfer to entities such as foundries. Discussions with prospective customers are validating that our modulators are ideally suited for the datacenter and telecommunications markets that are over 10km in length. Details and feedback of what these prospective customers are seeking from a prototype are delivered to our technical team.

[3] The groundbreaking results were presented by Stefan Koepfli (ETH Zurich) as part of a peer-reviewed post-deadline paper presented at the prestigious 2022 European Conference on Optical Communications

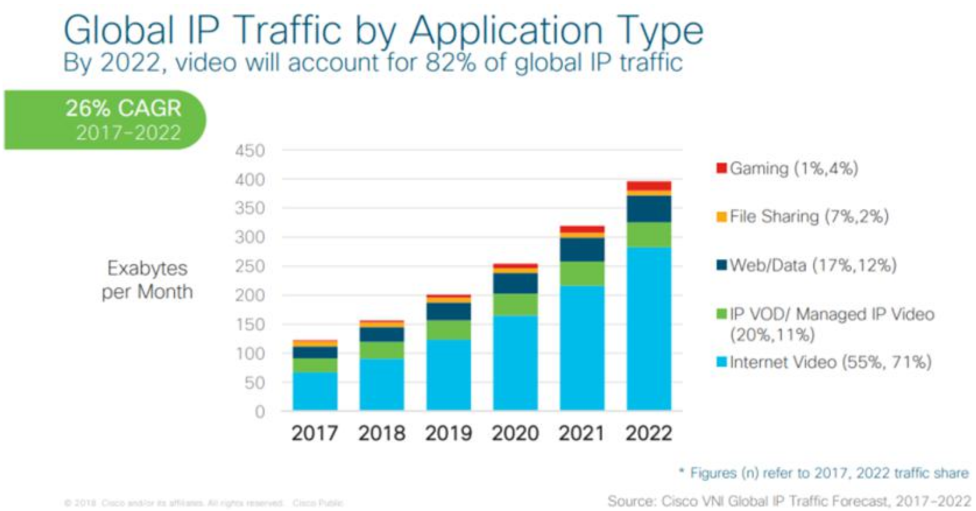
(ECOC) in Basel, Switzerland on September 22, 2022. The post-deadline paper is titled ">500 GHz Bandwidth Graphene Photodetector Enabling Highest-Capacity Plasmonic-to-Plasmonic Links."

The Global Photonic Device Market

General Overview

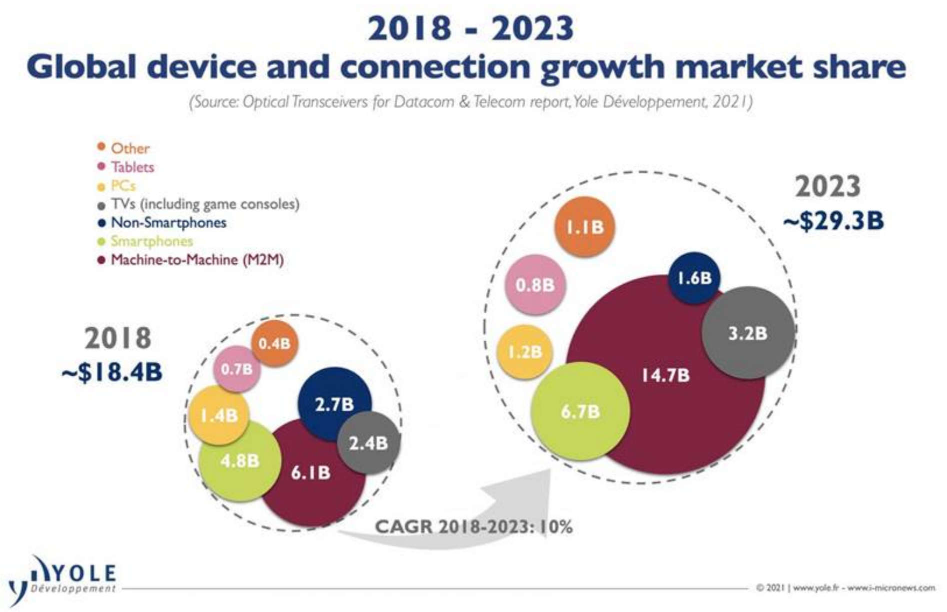
Lightwave Logic has been reviewing the latest market data as well as its own internal data for its business strategy, and below we detail the global market dynamics both in terms of data traffic as well as how co-packaged optical solutions which will require optimized modulators will grow in the fiber communications segment of the market.

As we have already seen with products such as smart phones, lap top computers, and personal digital assistants (PDAs), Internet traffic, and especially mobile internet traffic is one of the important metrics that is being used to show activity in fiber communications, and particularly telecommunications as well as data communications (which includes datacenters and high-performance computing). Internet Protocol (IP) traffic has typically been used to gauge the amount of data that is being used on the internet as shown in the graph below (sourced from Cisco VNI in 2022). The metric is Exabytes per month. An Exabyte is 1E18 which is 1000 Petabytes, or 1000,000 Terabytes or a billion Gigabytes of data. As seen from the graph which has a strong growth of 26% CAGR (2017-2022) of global IP traffic, with the majority traffic being driven by internet video. The traffic rates are fast approaching the metric of Zetta which is 1E21 bytes of data. Some estimates are discussing the further metric of Yotta which is 1E24 bytes of data over the next decade, which is also expected to be driven for the most part by internet video.

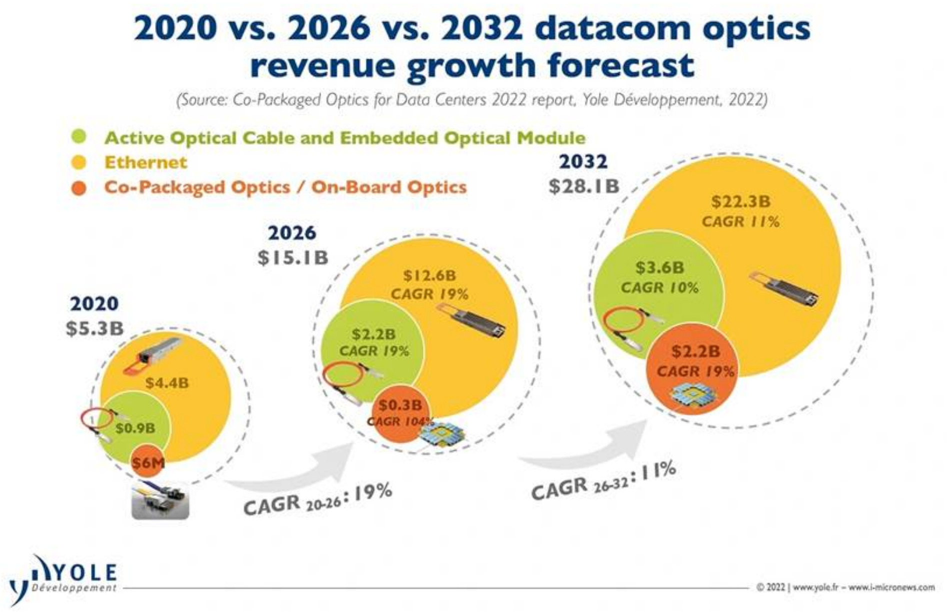


Within the overall market trends of IP traffic growth and in particular mobile video, the internet will need to be able to support high volumes of data traffic. To do this, the fiber-optic infrastructure that allows data to be communicated between network nodes such as datacenters, within datacenters, and optical network switches etc., needs to be upgraded. Today, fiber-optic networks are a combination of long, medium and short optical interconnects that range from 3 meters (or 1yard) to over 1000km depending on application in the optical network. Optical components, typically known as photonics components are used to build the fiber-optic infrastructure and consist of things such as: laser diodes, photodetectors, multipliers, modulators, transceivers etc. These are known as discrete components, while a mix of these components that are integrated or connected on a single substrate (such as silicon, InP, GaAs etc.) are called PICs (Photonic Integrated Components). All of these components are packaged and put into transceivers.

The global device and connection growth market share as forecasted by Yole Developpment in their optical transceivers for datacom and telecom report (2021) is expected to grow from $18B in 2018 to approximately $30B in 2023 as can be seen by the figure below (Source: Yole Developpment). The compound annual growth is expected to reach a healthy 10% for the period 2018 to 2023. This market has machine to machine market vertical at nearly 50% of the market share by 2023, followed by smartphones, TVs and game consoles, non-smartphones, Personal computers, other, and tablets.

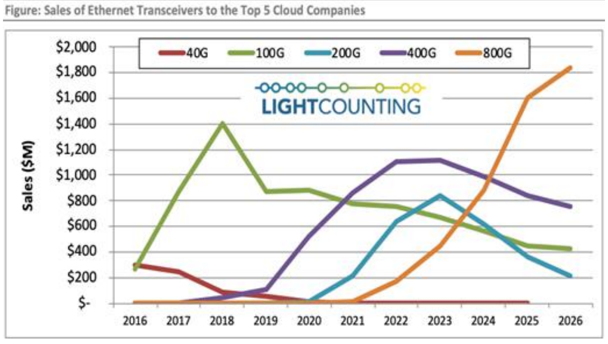


The datacom optics revenue forecast ranging from 2020 through 2026, and onto 2032 is shown in the figure below. This data is also sourced from Yole Developpment, and is reported in their co-packaged optics for data centers report in 2022. The data shows that the datacom optics revenues have grown from nearly $6B in 2020 to a forecast that exceeds $15B in 2026, and over $28B by 2032. The respective compound annual growth rates are a very healthy 19% for 2020-2026, and a healthy 11% for the period 2026-2032. The market is segmented into three major categories that include: Active optical cable and embed optical modules, ethernet, and co-packaged optics/on-board optics. In all of these categories the growth of PIC based engines for optical transceivers being utilized in datacom optics is expected to grow quickly. In all of these segments today, many of the optical engines are either indium phosphide or silicon photonics based. These optical engines are expected to be upgraded with hybrid PIC solutions that improve the overall performance of the PIC.



The optical transceiver revenue forecast ranging from 2020 through 2026 by market segment is shown in the figure below. This data is also sourced from Yole Developpment, and is reported in their optical transceivers for datacom and telecom market report published in 2021. The data shows that the optical transceiver revenues have grown from nearly $10B in 2020 to forecast that approaches $21B in 2026. The respective compound annual growth rates are a healthy 14% for the period 2020-2026. The market is segmented into two major categories that include: Datacom and telecom. In these categories the growth of PIC based engines for optical transceivers being utilized in both datacom and telecom is expected to grow quickly using hybrid solutions that are expected to incorporate electro-optic polymer technologies.

A large driver of the growth of the optical transceiver market is the corresponding growth of - and the "need for speed" by - the large data center operators lead by Amazon. Data sourced from Lightcounting shows the rapid adoption and growth of each generation of speed. As noted earlier, our unique polymer technology platform has inherent advantages for the requirements of 800Gbps.



As the Company is developing polymer based photonic devices such as fiber-optic modulators, these devices translate electric signals into optical signals and allow laser-based technology to operate effectively at, 100G, 200G, and beyond. Lasers with modulators are used in fiber communication systems to transfer data over fiber-optic networks today and are expected to be a key driver in photonics components for PIC based technological solutions over the next decade. Optical data transfer using lasers and modulators is significantly faster and more efficient than transfer technologies using only electric signals, permitting more cost-effective use of bandwidth for broadband Internet and voice services.

Our Target Markets

Cloud computing and data centers

Big data is a general term used to describe the voluminous amount of unstructured and semi-structured data a Company creates – data that would take too much time and cost too much money to load into a relational database for analysis. Companies are looking to cloud computing in their data centers to access all the data. Inherent speed and bandwidth limits of traditional solutions and the potential of organic polymer devices offer an opportunity to increase the bandwidth, reduce costs, improve speed of access, and to reduce power consumption both at the device as well as the system level.

Datacenters have grown to enormous sizes with hundreds of thousands and even millions of servers in a single datacenter. The number of so-called "hyperscale" datacenters are expected to continue to increase in number. Due to their size, a single "datacenter" may consist of multiple large warehouse-size buildings on a campus or even several locations distributed around a metropolitan area. Data centers are confronted with the problem of moving vast amounts of data not only around a single data center building, but also between buildings in distributed data center architecture. Links within a single datacenter building may be shorter than 500 meters, though some will require optics capable of 2 km. Between datacenter buildings, there is an increasing need for high performance interconnects over 10km in reach.

Our modulators are suitable for single-mode fiber optic links. We believe that our single mode modulator solutions will be competitive at 500m to 10km link distance lengths, with inherent advantages for 800Gbps applications.

Telecommunications/Data Communications

The telecommunications industry has evolved from transporting traditional analogue voice data over copper wire into the movement of digital voice and data. Telecommunication companies are faced with the enormous increasing challenges to keep up with the resulting tremendous explosion in demand for bandwidth. The metropolitan network is especially under stress now and into the near future. Telecommunications companies provide services to some data center customers for the inter-data center connections discussed above. 5G mobile upgrade, autonomous driving and IoT are expected to increase the need for data stored and processed close to the end user in edge data centers. This application similarly requires optics capable of very high speeds and greater than 10 km reach.

Industry issues of scaling

The key issues facing the fiber-optic communications industry are the economic progress and scalability of any PIC based technological platform. Our polymer platform is unique in that it is truly scalable and is expected to become a high performance engine for transceiver modules. Scalable means being able to scale up for high-speed data rates, while simultaneously being able to scale down in cost, and lower power consumption. This allows a competitive cost per data rate or cost per Gbps metric to be achieved.

Fiber optic datacenter and high-performance computing customers want to achieve the metric of $1/Gbps @ 800Gbps (this essentially means a single mode fiber optic link that has a total cost of $800 and operates with a data rate of 800Gbps). Equally importantly, the datacenter industry would like to reduce the power consumption of optical ports for 400Gbps, 800Gbps, etc., significantly. As industry tries to match this target, it needs scalable PIC platforms to achieve this goal, of which our polymer platform is uniquely suited.

An article by Dr, Michael Lebby that was recently published in broadband communities (BBC) magazine in early February 2023 discusses the virtues of polymer based technologies as part of an industry technology roadmap. The article is entitled "The internet is the brick wall Nostradamus did not see coming." In this article cost/performance metrics are discussed that show the trend to higher and higher data rates using PIC platforms that include very high speed, low power modulator devices.

The article also shows that electro-optic polymers play an important role in PICs over the next decade as they can reduce or close the gap between customer expectations and technical performance through effective scaling increase of high performance with low cost for short distance transceiver optical links.

Some of the things needed to achieve the scaling performance of polymers in integrated photonics platforms is within sight today:

1. Increased r33 (which leads to very low Vpi in modulator devices) and we are currently optimizing our polymers for this. With Vpi levels of 1V or less will enable direct from associated electronics and potentially save network architects the cost of individual driver ICs.

2. Increase temperature stability so that the polymers can operate at broader temperature ranges effective, where we have made significant progress over the past few years.

3. Low optical loss in waveguides and active/passive devices for improved optical budget metrics which is currently an ongoing development program at our Company.

4. Higher levels of hermeticity for lower cost packaging of optical sub-assemblies within a transceiver module, where our advanced designs are being implemented into polymer-based packages that utilize atomic layer deposition (ALD) that is being developed in-house.

Scalability in terms of cost reduction and high volume manufacturing can be enhanced by:

1. Leverage of commercial silicon photonics manufacturing capacity through the use of silicon-based foundries. Our Polymer Plus™ platform seeks to be additive to standard silicon photonics circuits.

2. Reduction of optical packaging costs by integration at the chip level of multiple modulators and also with other optical devices. Our P2IC™ platform seeks to address device integration.

Business Strategy

Our business strategy anticipates that our revenue stream will be derived from one or some combination of the following: (i) technology licensing for specific product application; (ii) joint venture relationships with significant industry leaders; and (iii) the production and direct sale of our own electro-optic device components. Our objective is to be a leading provider of proprietary technology and know-how in the electro-optic device market. In order to meet this objective, we intend to continue to:

- Further the development of proprietary organic electro-optic polymer material systems

- Develop photonic devices based on our P2ICTM technology
- Develop proprietary intellectual property
- Grow our commercial device development capabilities
- Partner with silicon-based foundries who can scale volume quickly
- Grow our product reliability and quality assurance capabilities
- Grow our optoelectronic packaging and testing capabilities
- Grow our commercial material manufacturing capabilities
- Maintain/develop strategic relationships with major telecommunications and data communications companies to further the awareness and commercialization of our technology platform
- Add high-level personnel with industrial and manufacturing experience in key areas of our materials and device development programs.

Create Organic Polymer-Enabled Electro-Optic Modulators

We intend to utilize our proprietary optical polymer technology to create an initial portfolio of commercial electro-optic polymer product devices with applications for various markets, including telecommunications, data communications and data centers. These product devices will be part of our proprietary photonics integrated circuit (PIC) technology platform.

We expect our initial modulator products will operate at symbol rates at least 112 Gigabaud which is roughly 200Gbps when utilized with PAM4 encoding schemes. Our devices are highly linear, and can also enable the performance required to take advantage of more advance complex encoding schemes if required.

Our Research and Development Process

Our research and development process consist of the following steps:

- We develop novel polymer materials utilizing our patented and patent pending technology to meet certain performance specifications. We then develop methods to synthesize larger quantities of such material.
- We conduct a full battery of tests at the completion of the synthesis of each new polymer material to evaluate its characteristics. We also create development strategies to optimize materials to meet specifications for specific applications. We model and simulate each new polymer material so that we can further understand how to optimize the material for device operation.
- We integrate data from the material characterization and test results to fabricate devices. We analyze device-testing results to refine and improve fabrication processes and methods. In addition, we investigate alternative material and design variations to possibly create more efficient fabrication processes.
- We create an initial device design using simulation software. Following device fabrication, we run a series of optical and electronic tests on the device.
- We are developing PDKs with commercial silicon-based foundries so that our technology can transfer seamlessly to larger silicon wafer fabrication plants, and scale in volume quickly.

We have and expect to continue to make significant operating and capital expenditures for research and development. Our research and development expenses were \$12,805,374, \$12,476,040 and \$4,590,545 for the years ended December 31, 2022, 2021 and 2020, respectively.

Our Proprietary Products in Development

As part of a tactical marketing strategy, our Company is developing several optical devices using our proprietary electro-optical polymer material, which are in various stages of development. These include:

Ridge Waveguide Modulator, Polymer Stack ™

Our ridge electro-optic waveguide modulator was designed and fabricated in our in-house laboratory. The fabrication of our first in-house device is significant to our entire device program and is an important starting point for modulators that are being developed for target markets. We have multiple generations of new materials that we will soon be optimizing for this specific design. In September 2017 we announced that our initial alpha prototype ridge waveguide modulator, enabled by our P^2IC™ polymer system, demonstrated bandwidth performance levels that will enable 112 Gbaud modulation in fiber-optic communications. This device demonstrated true amplitude (intensity) modulation in a Mach-Zehnder modulator structure incorporating our polymer waveguides. This important achievement will allow users to utilize arrays of 4 x 112 Gbaud symbol rate (4x 200 Gbps data rate) polymer modulators using PAM-4 encoding to enable 800 Gbps data rate systems. These ridge waveguide modulators are currently being packaged with our partner into prototype packages.

These prototype packages will enable potential customers to evaluate the performance at 112 Gbaud. Once a potential customer generates technical feedback on our prototype, we expect to be asked to optimize the performance to their specifications. Assuming this is successful, we expect to enter a qualification phase where our prototypes will be evaluated more fully.

In parallel, we are developing modulators for scalability to higher symbol rates above 112 Gbaud. In September 2018, we showed in conference presentations the potential of our polymer modulator platform to operate at over 100 GHz bandwidth. This preliminary result corresponds to 100 Gbps data rates using a simple NRZ data encoding scheme or 200 Gbps with PAM-4 encoding. With 4 channel arrays in our P^2IC™ platform, the Company thus has the potential to address both 400 Gbps and 800 Gbps markets. While customers may start the engagement at 112 Gbaud, we believe potential customers recognize that scalability to higher speeds is an important differentiator of the polymer technology.

We believe the ridge waveguide modulator Polymer Stack™ represents our first commercially viable device and targets the fiber optics communications market. We have completed internal market analysis and are initially targeting interconnect reach distances of less than 1km. In these markets, the system network companies are looking to implement modulator-based transceivers that can handle aggregated data rates 800 Gbps and above. The market opportunity for less than 10km is worth over \$2B over the next decade.

Polymer Plus™

Using our novel waveguide design, we are developing a more compact modulator to be implemented directly with existing integrated photonics platforms such as silicon photonics and Indium Phosphide. As our electro-optic polymers are applied in liquid form, they can be deposited as a thin film coating in a fabrication clean room such as may be found in semiconductor foundries. This approach we call Polymer Plus™. The advantage of this approach is that it allows existing semiconductor integrated photonics platforms such as silicon photonics and indium phosphide to be upgraded with higher speed modulation functionality with the use of polymers in a straight-forward and simple approach. Further, our polymers are unique in that they are stable enough to seamlessly integrate into existing CMOS, Indium Phosphide (InP), Gallium Arsenide (GaAs), and other semiconductor manufacturing lines.

A large majority of commercial silicon photonics platforms utilize large silicon photonics foundries such as those that manufacture IC products for a number of applications such as communications, computing, consumer, etc. In order to seamlessly integrate our polymer materials to upgrade for example, silicon photonics designs, partnering with a silicon foundry is necessary.

Polymer Slot™

As part of supporting further improvement and scalability of our platform, we continue to develop more advanced device structures that include the Polymer Slot™. Our high performance, low power, extremely small footprint polymer photonics slot waveguide modulator utilizes a slot design that is part of PIC platform such as silicon photonics with one of our proprietary electro-optic polymer material systems as the enabling material layer. Initial performance results in 2022 from commercial foundries achieved key design specifications for the slot modulator.

Preliminary testing and initial data on our polymer photonics slot waveguide modulators fabricated at commercial foundries demonstrated extremely high performance suitable for the hyperscaler and fiber optics markets. The tested polymer photonic slot chip had less than 1-millimeter square footprint, enabling the possibility of sophisticated PIC architecture designs on a single silicon substrate. In addition, the waveguide structure was a fraction of the length of a typical inorganic-based silicon photonics modulator waveguide and is suitable to be used as an engine for state-of-the-art pluggable transceiver modules such as the OSFP and the QSFP-DD.

With the combination of our proprietary electro-optic polymer material and the extremely high optical field concentration in the slot waveguide, the test modulators demonstrated very low operating voltage. Initial speeds exceeded 70GHz in the telecom, 1550 nanometer frequency band, and there were devices that exceeded over 100GHz 3dB bandwidth.

We are also continuing our collaborative development of our polymer photonic slot waveguide modulators (Polymer Slot™) with a partner that has advanced device design capabilities using Plasmonic technologies. Some of these devices demonstrated performance levels that exceeded 250GHz in 2022.

Our Long-Term Device Development Goal - Multichannel Polymer Photonic Integrated Circuit (P^2IC™)

Our P^2IC™ platform is positioned to address markets with aggregated data rates of 100 Gbps, 400 Gbps, 800 Gbps and beyond. Our P^2IC™ platform will contain several photonic devices that may include, over and above polymer-based modulators, photonic devices such as lasers, multiplexers, demultiplexers, detectors, fiber couplers.

While our polymer-based ridge waveguide and slot modulators are currently under development to be commercially viable products, our long-term device development goal is to produce a platform for the 400 Gbps, 800 Gbps, 1600Gbps and beyond fiber optic transceiver market. This has been stated in our photonics product roadmap that is publicly available on our website. The roadmap shows a progression in speed from 50 Gbaud based modulators to 100 Gbaud based modulators. The roadmap shows a progression in integration in which the modulators are arrayed to create a flexible, multichannel P^2IC™ platform that spans 100 Gbps, 400 Gbps, 800 Gbps, 1.6Tbps (or 1600Gbps), and a scaling philosophy that will grow to 3.2Tbps line rates.

We showed bandwidths of polymer-based modulator devices at a major international conference (ECOC – European Conference on Optical Communications 2018) with bandwidths that exceeded 100GHz. We noted that to achieve 100Gbaud, the polymer-based modulator only needs to achieve 80GHz bandwidth. During ECOC 2019, we showed environmental stability. We continue to develop our polymer materials and device designs to optimize additional metrics. We are now optimizing the device parameters for very low voltage operation. At the ECOC 2022 conference we demonstrated two different world record performances using polymer slot based modulators.

Other Potential Applications for Our Products

We believe that there are myriad potential applications for our organic polymer materials and devices outside of our initial focus of data communications, telecommunications and data centers. These potential applications encompass areas as diverse as military, space, optical computing, and life sciences. We believe that as viable organic polymer materials gain acceptance, their increased flexibility, functionality and low cost will create new applications that may not yet be technically feasible. Two such future applications with revolutionary potential are:

All-Optical Switches

An all-optical switch is one that enables signals in optical fibers or networks to be selectively switched from one fiber or circuit to another. Many device designs have been developed and commercialized in today's telecom networks to effect optical switching by using mechanical or electrical control elements to accomplish the switching event. Future networks will require all-optical switches that can be more rapidly activated with a low energy and short duration optical (light) control pulse.

Multi-Channel Optical Modem

The availability of low-cost electro-optic modulators will enable low-cost multichannel optical modems that will use many wavelengths in parallel and employ high efficiency modulation techniques such as QAM (quadrature amplitude modulation). Such modems would enable an order of magnitude increase in the Internet capacity of legacy fiber. Our Company is in the early feasibility stage of such a multichannel optical modem.

Our Past Government Program Participation

Our Company has been a participant in several vital government sponsored research and development programs with various government agencies that protect the interests of our country. The following is a list of some of the various divisions of government agencies that have provided us with advisory, financial and/or materials support in the pursuit of high-speed electro-optic materials. We are not currently partnered with, strategically related to, or financially supported by any governmental agency at this time, however, we may explore future opportunities as our Company grows and gains the additional resources and personnel necessary to support these efforts. Our previous relationships included:

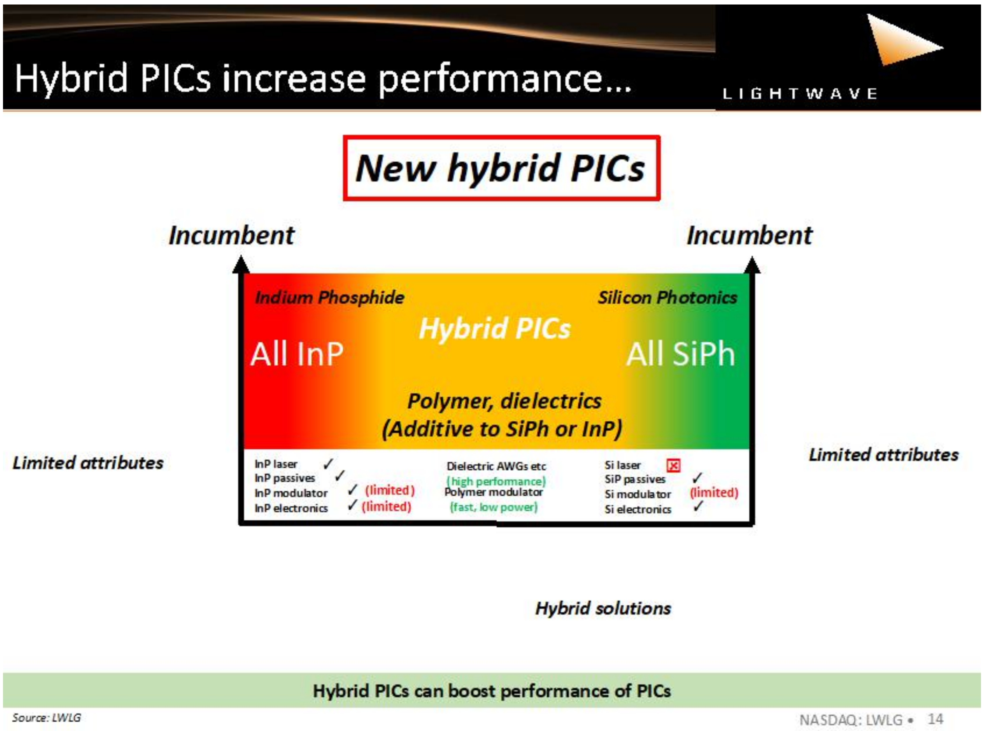
- National Reconnaissance Office (NRO)
- Properties Branch of the Army Research Laboratory on the Aberdeen Proving Grounds in Aberdeen, Maryland.
- Defense Advance Research Project Agency (DARPA)
- Naval Air Warfare Center Weapons Division in China Lake, California
- Air Force Research Laboratory at Wright-Patterson Air Force Base in Dayton, Ohio

Our Competition

Competitive Technologies - PIC Based Technologies

PIC technologies have historically been driven using III-V compound semiconductors, namely InP, although GaAs remains a strong PIC platform, and is expected to strengthen via the VCSEL based 3D sensing applications. Indium Phosphide has been used since the 1980s as the first PIC platform with laser modulator chips where both the laser and modulator were fabricated monolithically. Since the 1980s, there have been InP based transmitters, receivers, and other functional elements that all support the fiber-communications industry. In fact, over the past 3 decades, the fiber communications industry has driven the increased performance, miniaturization and simplicity in packaging for PIC based technologies. Also, back in the 1980s, 'optoelectronics' was the key word to describe having both electronic and photonic functions or devices on a single chip. This was known in early publications as an optoelectronics integrated circuit (OEIC). Today optoelectronics is synonymous with 'photonics', and hence the common-place use of 'photonics integrated circuits' for PICs.

In the below figure that discusses hybrid PICs, it can be seen in red that the incumbent technology for PICs is InP. InP can provide a number of devices and opportunities in both electronics as well as photonics. InP main weakness from a function standpoint is that although it can provide HFETs, JFETs, bipolar electronic devices, it has not been able to successfully penetrate LSI, VLSI, or ULSI etc., with digital IC circuitry. Chips such as ASICs and DSPs are not practically available with the InP platform – mostly due to advancement in electronic transistor design, and also through limited maturity in large format wafer manufacturing. Today the majority of InP fabrication is based on 4" or 100mm wafers, and only in the past two years have folks been seriously looking at 6" or 150mm InP wafer infrastructure. From the photonics standpoint, there are very good reasons why InP is the incumbent technology – it provides world class performance in lasers, modulators, simple electronics such as drivers and TIAs (transimpedance amplifiers), as well as highly performing active and passive devices such as SOAs, waveguides, spot-size converters, and mux/demux blocks such as AWG and Eschelle gratings.



Over the past decade, the rise of silicon-based photonics has accelerated quickly (as can be seen in green in the Figure). Silicon has a huge history in electronics, and it's been said by many that if the existing infrastructure could be utilized effectively, then the cost of producing photonics with similar fabrication, design, testing, and simulation tools, would become competitive with the current incumbent technology: InP. As can be seen by the figure, silicon is capable of handling many photonics devices in addition to all electronic functionality with CMOS and BiCMOS based technologies. The only photonic device that remains impossible (at least for the time being) is the emitter or laser where light is generated. This has spawned a new segment for silicon photonics (SiPh) where engineers and scientists have developed creative ways to implement InP into device, wafer, and epi-designs that are silicon based. These solutions are typically referred to as heterogeneous solutions or Hybrid PICs where both InP and silicon are utilized to create PIC platforms with emitter or laser-based functionality.

While the red area of the Figure represents the incumbent technology InP, the green areas, Silicon Photonics, the middle areas that are shaded yellow represent PIC based technologies that can utilize either III-V compound semiconductor platforms such as InP, GaAs, even GaN, as well as silicon platforms such as silicon wafers, and various combinations of silicon-based materials such as SOI (silicon on insulator), SiGe etc. The yellow areas are represented by both polymers and dielectric materials that can be deposited onto either silicon or III-V material wafers. These combinations of technology allow flexibility in PIC designs where both polymers and dielectrics can provide a multitude of active and passive photonic devices such as: waveguides (W/G), spot size converters (SSC), modulators (such as Mach Zehnder and slot types), multipliers and demultipliers (Mux/Demux variants such as AWGs, MMI, and Echelle gratings). The interesting part of the polymer and dielectric technology is that combinations of active and passive devices can be mixed and matched with either III-V compound devices as well as silicon based, heterogeneous based devices to design more effective and efficient PICs. For polymers, very low voltage can be utilized for low cost, low power consumption, very high-speed modulators that can be deposited onto a semiconductor platform. For dielectric photonics, very low temperature sensitivity mux/demux devices (such as athermal designs) can be deposited onto a semiconductor platform. As can be seen from the Figure, polymer and dielectric technology suffers from that the fact that high density ICs and laser-based emitters are not available but could be integrated with the appropriate designs for the PIC with III-V compound semiconductors and/or silicon-based technology that have both DSP/ASIC type circuits and laser emitters.

PIC technologies have a number various and broad applications as can be seen by the Figure below and highlighted in green. In this Figure applications range from fiber optic communications (green lines), to other market verticals such as: display/ projection display, automotive/LIDAR for self-driving vehicles, optical sensing/3D, bio-photonic sensing, medical, instrumentation etc. .Market TAMs are forecasted over the next decade with estimations for the opportunities for PICs.

Our initial target markets: fiber communications

LIGHTWAVE

Photonics applications	Photonics components market 2030*	Optical Transceivers * TAM (2022)	Optical Transceivers * TAM (2030)	Partner type	Opportunity for Integrated Photonics (PICs) (Polymer, SiPh, InP)
Fiber comms	~$60-80B	$7B	~$40-60B	Foundry, OEM/CM (TxRx)	Existing/very strong growth
HPC/compute/AI	~$10-20B	$1B	~$10-15B	Foundry, OEM/CM (TxRx)	Existing/very strong growth
DCI/datacenter	~$20-30B	$9B	~$20-30B	Foundry, OEM/CM (TxRx)	Existing/strong growth
5G systems/back haul/RF	~$5-10B	~$1-2B	~$4-8B	Foundry, OEM/CM (TxRx)	Existing/strong growth
Display/project	~$10-20B	<$1B	~$5-15B	Foundry, OEM/CM (panel)	High-volume/strong forecast
Automotive (LIDAR)	~$30-50B	~$1-2B	~$20-30B	Foundry, OEM/CM (LIDAR)	High-volume & very strong forecast
Optical sensing/3D	~$4-10B	~$1-2B	~$2-5B	Foundry, OEM/CM (sensor)	High-volume & solid forecast
Bio-photonic sensing	~$2-5B	<$1B	~$2-3B	Foundry, OEM/CM	Strong forecast
Medical	~$5-10B	<$1B	~$5-8B	Foundry, OEM/CM	Strong forecast
Instrumentation	~$2-3B	<$1B	~$1-2B	Foundry, OEM/CM	Strong forecast

Sources: *Lightwave Logic (LWLG) estimates using market research data

NASDAQ: LWLG • 16

PIC technologies are based upon semiconductor wafers (such as III-V compound semiconductors – InP, GaAs etc.) as well as silicon wafers (which can be tailored to become SiGe heterogeneous, SOI, etc.). As these platforms are semiconductor based, the wafers are processed in fabs or fabrication facilities to produce devices. As a general rule, silicon has the largest wafers with 8” (200mm) and 12” (300mm) format discs. GaAs typically is running 3” (75mm), 4” (100mm) and 6” (150mm) wafers in production fabs or fabrication plants around the world. There is an expectation that GaAs will eventually move to 8” (200mm) wafers in the next 5 years. InP is in production today on 2” (50mm), 3” (75mm) and 4” (100mm) wafers with an expectation to move to 6” (150mm) in the next 5 years. Heterogeneous solutions with silicon photonics that utilize materials such as SiGe and InP are typically 8” (200mm) and 12” (300mm) format wafers. Polymer photonics can be deposited on either III-V compound semiconductor wafers as well as silicon wafers which makes it suitable for the next generation of PIC based technological platforms for the fiber communications industry.

The supply chain for the PIC industry starts with the wafer development and continues through epitaxial growth, device fabrication, optical sub-assembly, module or transceiver builds, and sub-systems which are implemented into optical networking applications. Within these supply chain segments, several combinations of technology can be utilized. For example, CMOS IC circuits can be fabricated onto silicon wafers together with silicon photonics, heterogeneous solutions, that could have the advantage of polymer active devices, and dielectric passive devices on board. InP may be combined with polymer photonics to house on-board or on-wafer emitters to source light for the optical signaling with modulators. Included in the wafers can be combinations of electrical and optical circuitry. Electrical circuitry is usually set up as both as single as well as multilevel interconnects. Optical circuitry is usually set up as a waveguide or optical layer as part of the device fabrication design. PICs can interconnect electrical devices with photonic devices, and also increase chip functionality through the use of electrical and optical active and passive device solutions. Polymer technologies can provide active device function through for example Mach Zehnder modulators, as well as providing passive device function with waveguides, multipliers, and demultipliers.

Competitors

The markets we are targeting for our electro-optic polymer technology are intensely competitive. While there are no major multi-national companies that compete directly with us on electro-polymers, there are other companies that do manufacture optical modulators. These companies that have incumbent optical modulators using semiconductors include: Lumentum, Broadcom, Intel, Ciena, Fujitsu, and Coherent. These companies are heavily invested in the production of crystalline-based semiconductor electro-optic modulator technologies, as well as the development of novel manufacturing techniques and modulator designs.

Smaller companies that compete with us on optical modulators using new and novel technologies include: Hyperlite (who are developing thin film lithium niobate (TFLN) and Lumiphase (who are developing Barium Titanate or BTO).

Our Plan to Compete

We believe that as our organic polymer technology gains industry acceptance, we will be poised to obtain a significant portion of the component manufacturing market and have our technology become ubiquitous. Electro-optic polymers demonstrate several advantages over other technologies, such as inorganic-based technologies, due to their reduced manufacturing and processing costs, higher performance, and lower power requirements. Our patented organic polymers and future electro-optic photonic devices have demonstrated significant stability advantages over our known competitor’s materials.

We believe the principal competitive factors in our target markets are:

- The ability to develop and commercialize highly stable optical polymer-based materials and optical devices in commercial quantities.
- The ability to obtain appropriate patent and proprietary rights protection.
- The ability to create commercial silicon-based PDKs for our electro-optic polymers
- Lower cost, high production yield for these products.
- The ability to enable integration and implement advanced technologies.
- Strong sales and marketing, and distribution channels for access to products.

We believe that our current business planning will position our Company to compete adequately with respect to these factors. Our future success is difficult to predict because we are an early stage company with all of our potential products still in development.

Many of our existing and potential competitors have substantially greater research and product development capabilities and financial, scientific, marketing and human resources than we do. As a result, these competitors may:

- Succeed in developing products that are equal to or superior to our potential products or that achieve greater market acceptance than our potential products.
- Devote greater resources to developing, marketing or selling their products.
- Respond quickly to new or emerging technologies or scientific advances and changes in customer requirements, which could render our technologies or potential products obsolete.
- Introduce products that make the continued development of our potential products uneconomical.
- Obtain patents that block or otherwise inhibit our ability to develop and commercialize our potential products.
- Withstand price competition more successfully than we can.
- Establish cooperative relationships among themselves or with third parties that enhance their ability to address the needs of our prospective customers.
- Take advantage of acquisition or other opportunities more readily than we can.

Employees and Human Capital

We currently have 21 full-time employees, and we retain several independent contractors on an as-needed basis. Based on our current development plan we expect to add 9 additional full-time employees in 2023.

People

As a technology and innovation-driven company, we depend on a highly skilled workforce. Attracting, developing, advancing and retaining the best talent is critical for us to execute our strategy and grow our business. Individuals with technical, engineering, chemistry and other science backgrounds, experience, or interests are particularly important for us to succeed. We strive to advance a diverse, equitable and inclusive work environment.

Technical Team

Our team is composed of world-class technologists, including materials scientists, design engineers, device engineers, synthetic organic chemists, test and material engineers and technicians.

Diversity, Inclusion and Equity

We recognize and view equity as key to our success. We work to create a culture of diversity and inclusion so that all of our employees feel they are respected and treated equally, regardless of gender, race, ethnicity, age, disability, sexual orientation, gender identity, cultural background or religious belief. We strive to provide our employees a diverse, equitable, and inclusive work environment.

Compensation and benefits

Our total rewards package includes market-competitive pay, stock option grants and bonuses, healthcare benefits, retirement savings plans, life insurance, disability insurance, paid time off and family leave, and flexible work schedules.

The principal purposes of our equity incentive plan is to attract and retain employees who will contribute to our Company's long range success, to provide incentives that align the interests of our employees with those of our shareholders, and to promote the success of our Company's business.

Health and Safety

We are committed to providing a healthy environment and safe workplace by operating in accordance with established health and safety protocols within our facility and maintaining a strong health and safety compliance program. We prioritize, manage, and carefully track safety performance at our facility and integrate sound safety practices in every aspect of our operations. We regularly conduct self-assessments to examine our safety culture and processes. In response to the COVID-19 pandemic and related mitigation measures, and in conjunction with federal and statewide mandates, we implemented certain changes in an effort to protect our employees from COVID-related exposures. For example, we implemented social distancing in the workplace, extensive cleaning and sanitation processes for both research and development areas and office spaces, and broad work-from-home initiatives for employees in our administrative functions.

Available Information

We maintain a website at www.lightwavelogic.com. We make available on our website under "Investors" – "Financial & Filings," free of charge, our annual reports on Form 10-K, quarterly reports on Form 10-Q, current reports on Form 8-K, and amendments to those reports as soon as reasonably practicable after we electronically file or furnish such material with the SEC. References to our website in this report are provided as a convenience, and the information on our website is not, and shall not be deemed to be a part of this Report on Form 10-K or incorporated into any other filings we make with the SEC. The SEC maintains an Internet site (www.sec.gov) that contains reports, proxy and information statements, and other information regarding issuers that file electronically with the SEC. In addition, we make available on our website under "Investors" – "Corporate Governance", free of charge, our Audit Committee Charter, Compensation Committee Charter, Nominating And Corporate Governance Committee Charter, Operations Committee Charter and Code of Ethics and Business Conduct. In addition, the foregoing information is available in print, without charge, to any stockholder who requests these materials from us.

Item 1A. Risk Factors.

Investing in our common stock is risky. In addition to the other information contained in this Annual Report on Form 10-K, you should consider carefully the following risk factors in evaluating our business and us. If any of the following events actually occur, our business, operating results, prospects or financial condition could be materially and adversely affected. This could cause the trading price of our common stock to decline and you may lose all or part of your investment. The risks described below are not the only ones that we face. Additional risks not presently known to us or that we currently deem immaterial may also significantly impair our business operations and could result in a complete loss of your investment.

We have incurred substantial operating losses since our inception and will continue to incur substantial operating losses for the foreseeable future.

Since our inception, we have been engaged primarily in the research and development of our electro-optic polymer materials technologies and potential products. As a result of these activities, we incurred significant losses and experienced negative cash flow since our inception. We incurred a net loss of $17,230,480 for the year ended December 31, 2022, $18,631,381 for the year ended December 31, 2021 and $6,715,564 for the year ended December 31, 2020. We anticipate that we will continue to incur operating losses through at least 2023.

We may not be able to generate significant revenue either through customer contracts for our potential products or technologies or through development contracts from the U.S. government or government subcontractors. We expect to continue to make significant operating and capital expenditures for research and development and to improve and expand production, sales, marketing and administrative systems and processes. As a result, we will need to generate significant revenue to achieve profitability. We cannot assure you that we will ever achieve profitability.

We are subject to the risks frequently experienced by early stage companies.

The likelihood of our success must be considered in light of the risks frequently encountered by early stage companies, especially those formed to develop and market new technologies. These risks include our potential inability to:

- Establish product sales and marketing capabilities;
- Establish and maintain markets for our potential products;
- Identify, attract, retain and motivate qualified personnel;
- Continue to develop and upgrade our technologies to keep pace with changes in technology and the growth of markets using polymer based materials;
- Develop expanded product production facilities, along with silicon-based foundry and other outside contractor relationships;
- Maintain our reputation and build trust with customers;
- Scale up from small pilot or prototype quantities to large quantities of product on a consistent basis;
- Contract for or develop the internal skills needed to master large volume production of our products; and
- Fund the capital expenditures required to develop volume production due to the limits of our available financial resources.

If we fail to effectively manage our growth, and effectively transition from our focus on research and development activities to commercially successful products, our business could suffer.

Failure to manage growth of operations could harm our business. To date, a large number of our activities and resources have been directed at the research and development of our technologies and development of potential related products including work in association with external partners. The transition from a focus on research and development to being a vendor of products requires effective planning and management. Additionally, growth arising from the expected synergies from future acquisitions will require effective planning and management. Future expansion will be expensive and will likely strain management and other resources.

In order to effectively manage growth, we must:

- Continue to develop an effective planning and management process to implement our business strategy;
- Hire, train and integrate new personnel in all areas of our business;
- Expand our facilities and increase capital investments; and
- Continue to successfully partner with silicon-based foundries.

We cannot assure you that we will be able to accomplish these tasks effectively or otherwise effectively manage our growth.

We will require additional capital to continue to fund our operations and if we do not obtain additional capital, we may be required to substantially limit our operations.

Our business does not presently generate the cash needed to finance our current and anticipated operations. Based on our current operating plan and budgeted cash requirements, we believe that we have sufficient funds to finance our operations through April 2024; however, we will need to obtain additional future financing after that time to finance our operations until such time that we can conduct profitable revenue-generating activities. We expect that we will need to seek additional funding through public or private financings, including equity financings, and through other arrangements, including collaborative arrangements. Poor financial results, unanticipated expenses or unanticipated opportunities could require additional financing sooner than we expect. Other than with respect to (i) the purchase agreement for $33 million we entered into with Lincoln Park Capital Fund, LLC ("**Lincoln Park**") on October 4, 2021 (the "**2021 Purchase Agreement**"); (ii) the purchase agreement for up to $30 million we entered into with Lincoln Park on February 28, 2023 (the "**2023 Purchase Agreement**"); and (iii) the sales agreement for up to $35 million we entered into with Roth Capital Partners, LLC ("**Roth Capital**") on December 9, 2022 (the "**Roth Sales Agreement**"); we have no plans or arrangements with respect to the possible acquisition of additional financing, and such financing may be unavailable when we need it or may not be available on acceptable terms. We currently have a remaining amount of $2,126,557 million that is available to our Company pursuant to the 2021 Purchase Agreement with Lincoln Park, $30 million that is available to our Company pursuant to the 2023 Purchase Agreement with Lincoln Park, and $35 million that is available to our Company pursuant to the Roth Sales Agreement with Roth Capital.

Our forecast of the period of time through which our financial resources will be adequate to support our operations is a forward-looking statement and involves risks and uncertainties, and actual results could vary as a result of a number of factors, including the factors discussed elsewhere in this Annual Report on Form 10-K. We have based this estimate on assumptions that may prove to be wrong, and we could use our available capital resources sooner than we currently expect.

Additional financing may not be available to us, due to, among other things, our Company not having a sufficient credit history, income stream, profit level, asset base eligible to be collateralized, or market for its securities. If we raise additional funds by issuing equity or convertible debt securities, the percentage ownership of our existing shareholders may be reduced, and these securities may have rights superior to those of our common stock. If adequate funds are not available to satisfy our long-term capital requirements, or if planned revenues are not generated, we may be required to substantially limit our operations.

We are entering new markets, and if we fail to accurately predict growth in these new markets, we may suffer substantial losses.

We are devoting significant resources to develop next generation proprietary photonic devices that are based on our advanced electro-optical polymer material systems for future applications in data communications and telecommunications markets and we are exploring other applications that include automotive/LIDAR, sensing, displays etc. We expect to continue to develop products for these markets and to seek to identify new markets. These markets change rapidly, and we cannot assure you that they will grow or that we will be able to accurately forecast market demand, or lack thereof, in time to respond appropriately. Our investment of resources to develop products for these markets may either be insufficient to meet actual demand or result in expenses that are excessive in light of actual sales volumes. Failure to predict growth and demand accurately in new markets may cause us to suffer substantial losses. In addition, as we enter new markets, there is a significant risk that:

- The market may not accept the price and/or performance of our products;
- There may be issued patents we are not aware of that could block our entry into the market or could result in excessive litigation; and
- The time required for us to achieve market acceptance of our products may exceed our capital resources that would require additional investment.

Our plan to develop relationships with strategic partners may not be successful.

Part of our business strategy is to maintain and develop strategic relationships with private firms, such as packaging companies and silicone based foundries, and to a lesser extent, government agencies and academic institutions, to conduct research and development and testing of our products and technologies. For these efforts to be successful, we must identify partners whose competencies complement ours. We must also successfully enter into agreements with them on terms attractive to us, and integrate and coordinate their resources and capabilities with our own. We may be unsuccessful in entering into agreements with acceptable partners or negotiating favorable terms in these agreements. Also, we may be unsuccessful in integrating the resources or capabilities of these partners. In addition, our strategic partners may prove difficult to work with or less skilled than we originally expected. If we are unsuccessful in our collaborative efforts, our ability to develop and market products could be severely limited.

The failure to establish and maintain collaborative relationships may have a materially adverse affect on our business.

We are initially targeting applications in data communications and telecommunications markets and are exploring other applications that include automotive/LIDAR, sensing, displays etc. Our ability to generate revenues depends significantly on the extent to which potential customers and other potential industry partners develop, promote and sell systems that incorporate our products, which, of course, we cannot control. Any failure by potential customers and other potential industry partners to successfully develop and market systems that incorporate our products could adversely affect our sales. The extent to which potential customers and other industry partners develop, promote and sell systems incorporating our products is based on a number of factors that are largely beyond our ability to control.

We may participate in joint ventures that expose us to operational and financial risk.

We may participate in one or more joint ventures for the purpose of assisting us in carrying out our business expansion, especially with respect to new product and/or market development. We may experience with our joint venture partner(s) issues relating to disparate communication, culture, strategy, and resources. Further, our joint venture partner(s) may have economic or business interests or goals that are inconsistent with ours, exercise their rights in a way that prohibits us from acting in a manner which we would like, or they may be unable or unwilling to fulfill their obligations under the joint venture or other agreements. We cannot assure you that the actions or decisions of our joint venture partners will not affect our operations in a way that hinders our corporate objectives or reduces any anticipated cost savings or revenue enhancement resulting from these ventures.

If we fail to develop and introduce new or enhanced products on a timely basis, our ability to attract and retain customers could be impaired and our competitive position could be harmed.

We plan to operate in a dynamic environment characterized by rapidly changing technologies and industry standards and technological obsolescence. To compete successfully, we must design, develop, market and sell products that provide increasingly higher levels of performance and reliability and meet the cost expectations of our customers. The introduction of new products by our competitors, the market acceptance of products based on new or alternative technologies, or the emergence of new industry standards could render our anticipated products obsolete. Our failure to anticipate or timely develop products or technologies in response to technological shifts could adversely affect our operations. In particular, we may experience difficulties with product design, manufacturing, marketing or certification that could delay or prevent our development, introduction or marketing of products. If we fail to introduce products that meet the needs of our customers or penetrate new markets in a timely fashion our Company will be adversely affected.

Our future growth will suffer if we do not achieve sufficient market acceptance of our organic nonlinear optical material products or our proprietary photonic devices.

We expect our patented and patent-pending optical materials along with trade secrets and licensed materials, to be the core of and the enabling technology for future generations of optical devices, modules, sub-systems and systems that we will develop or potentially out-license to electro-optic device manufacturers. All of our potential products are still in the development stage, and we do not know when a market for these products will develop, if at all. Our success depends, in part, upon our ability to gain market acceptance of our products. To be accepted, our products must meet the technical and performance requirements of our potential customers. OEMs, suppliers or government agencies may not accept polymer-based products. In addition, even if we achieve some degree of market acceptance for our potential products in one industry, we may not achieve market acceptance in other industries for which we are developing products.

Achieving market acceptance for our products will require marketing efforts and the expenditure of financial and other resources to create product awareness and demand by customers. We may be unable to offer products that compete effectively due to our limited resources and operating history. Also, certain large corporations may be predisposed against doing business with a company of our limited size and operating history. Failure to achieve broad acceptance of our products by customers and to compete effectively would harm our operating results.

Our potential customers require our products to undergo a lengthy and expensive qualification process, which does not assure product sales.

Prior to purchasing our products, our potential customers will require that our products undergo extensive qualification processes. These qualification processes may continue for several months or more. However, qualification of a product by a customer does not assure any sales of the product to that customer. Even after successful qualification and sales of a product to a customer, a subsequent revision to the product, changes in our customer's manufacturing process or our selection of a new supplier may require a new qualification process, which may result in additional delays. Also, once one of our products is qualified, it could take several additional months or more before a customer commences volume production of components or devices that incorporate our products. Despite these uncertainties, we are devoting substantial resources, including design, engineering, sales, marketing and management efforts, to qualifying our products with customers in anticipation of sales. If we are unsuccessful or delayed in qualifying any of our products with a customer, sales of our products to a customer may be precluded or delayed, which may impede our growth and cause our business to suffer.

Obtaining a sales contract with a potential customer does not guarantee that a potential customer will not decide to cancel or change its product plans, which could cause us to generate no revenue from a product and adversely affect our results of operations.

Even after we secure a sales contract with a potential customer, we may experience delays in generating revenue from our products as a result of a lengthy development cycle that may be required. Potential customers will likely take a considerable amount of time to evaluate our products; it could take 12 to 24 months from early engagement by our sales team to actual product sales. The delays inherent in these lengthy sales cycles increase the risk that a customer will decide to cancel, curtail, reduce or delay its product plans, causing us to lose anticipated sales. In addition, any delay or cancellation of a customer's plans could materially and adversely affect our financial results, as we may have incurred significant expense and generated no revenue. Finally, our customers' failure to successfully market and sell their products could reduce demand for our products and materially and adversely affect our business, financial condition and results of operations. If we were unable to generate revenue after incurring substantial expenses to develop any of our products, our business would suffer.

Many of our products will have long sales cycles, which may cause us to expend resources without an acceptable financial return and which makes it difficult to plan our expenses and forecast our revenue.

Many of our products will have long sales cycles that involve numerous steps, including initial customer contacts, specification writing, engineering design, prototype fabrication, pilot testing, regulatory approvals (if needed), sales and marketing and commercial manufacture. During this time, we may expend substantial financial resources and management time and effort without any assurance that product sales will result. The anticipated long sales cycle for some of our products makes it difficult to predict the quarter in which sales may occur. Delays in sales may cause us to expend resources without an acceptable financial return and make it difficult to plan expenses and forecast revenues.

Successful commercialization of our current and future products will require us to maintain a high level of technical expertise.

Technology in our target markets is undergoing rapid change. To succeed in our target markets, we will have to establish and maintain a leadership position in the technology supporting those markets. Accordingly, our success will depend on our ability to:

- Accurately predict the needs of our target customers and develop, in a timely manner, the technology required to support those needs;
- Provide products that are not only technologically sophisticated but are also available at a price acceptable to customers and competitive with comparable products;
- Establish and effectively defend our intellectual property; and
- Enter into relationships with other companies that have developed complementary technology into which our products may be integrated.

We cannot assure you that we will be able to achieve any of these objectives.

One of our significant target markets is the telecommunications market, which historically has not accepted polymer modulators.

One of our significant target markets is the telecommunications market, which demands high reliability optical components. Historically, polymer modulators have not been accepted into this market even though polymer modulators have achieved Telcordia™ based specifications. It is clear that the telecommunications market is demanding higher and higher data rates for its optical components, and may again decide that polymer based modulators are not suitable even if higher data rates, high reliability, and low power consumption are demonstrated.

Another of our significant target markets is the data communications (datacenter and/or high performance computing) market, which may be subject to heavy competition from other PIC based technologies such as silicon photonics and Indium Phosphide.

Another of our significant target markets is the data communications (datacenter and/or high performance computing) market, which may be subject to heavy competition from other PIC based technologies such as silicon photonics and Indium Phosphide. As the demands for high performance, low cost ($/Gbps) is implemented into next generation architectures, polymer modulators and polymer based PIC products may be subject to significant competition. Furthermore, there is a potential that technologies such as silicon photonics and Indium Phosphide might reach the metric of $1/Gbps at 400Gbps before ours. Customers may then be less willing to purchase new technology such as ours or invest in new technology development such as ours for next generation systems.

Our inability to successfully acquire and integrate other businesses, assets, products or technologies could harm our business and cause us to fail at achieving our anticipated growth.

We may grow our business through strategic acquisitions and investments, and we are actively evaluating acquisitions and strategic investments in businesses, products or technologies that we believe could complement or expand our product offering, create and/or expand a client base, enhance our technical capabilities or otherwise offer growth or cost-saving opportunities. From time to time, we may enter into letters of intent with companies with which we are negotiating potential acquisitions or investments or as to which we are conducting due diligence. Although we are currently not a party to any binding material definitive agreement with respect to potential investments in, or acquisitions of, complementary businesses, products or technologies, we may enter into these types of arrangements in the future, which could materially decrease the amount of our available cash or require us to seek additional equity or debt financing. We have limited experience in successfully acquiring and integrating businesses, products and technologies. We may not be successful in negotiating the terms of any potential acquisition, conducting thorough due diligence, financing the acquisition or effectively integrating the acquired business, product or technology into our existing business and operations. Our due diligence may fail to identify all of the problems, liabilities or other shortcomings or challenges of an acquired business, product or technology, including issues related to intellectual property, product quality or product architecture, regulatory compliance practices, revenue recognition or other accounting practices, or employee or customer issues.

Additionally, in connection with any acquisitions we complete, we may not achieve the synergies or other benefits we expected to achieve, and we may incur write-downs, impairment charges or unforeseen liabilities that could negatively affect our operating results or financial position or could otherwise harm our business. If we finance acquisitions using existing cash, the reduction of our available cash could cause us to face liquidity issues or cause other unanticipated problems in the future. If we finance acquisitions by issuing convertible debt or equity securities, the ownership interest of our existing stockholders may be diluted, which could adversely affect the market price of our stock. Further, contemplating or completing an acquisition and integrating an acquired business, product or technology could divert management and employee time and resources from other matters, which could harm our business, financial condition and operating results.

Our operations and financial results could be adversely impacted by the COVID-19 pandemic, which has at times negatively impacted our stock price and could curtail our ability to raise necessary funds in the near-term on terms that are acceptable to us, and may negatively impact our business, results of operations, particularly with respect to our research and development, and financial position.

The COVID-19 pandemic continues to have a significant impact around the world, prompting governments and businesses to take certain measures in response, such as the imposition of travel restrictions, temporary closures of businesses, quarantine and shelter-in-place orders, and adoption of remote working. While the extent of the impact of the COVID-19 pandemic on our business and financial results remains uncertain, a continued and prolonged public health crisis such as the COVID-19 pandemic would have a negative impact on our business, results of operations, particularly with respect to our research and development, and financial condition. The COVID-19 pandemic has resulted in significant volatility and substantial declines in the stock markets, which has negatively impacted our stock price at times which in turn has negatively impacted our ability to raise significant funds in during those times on terms that are acceptable to us. It is unknown the potential impact in the long-term in the event of a prolonged disruption or recession. In addition, the COVID-19 pandemic could impact the conduct of our research and development due to the slowdown or stoppage of modulator and materials development at our laboratory facility. Given the dynamic nature of these circumstances, the duration of any business disruption or potential impact of the COVID-19 pandemic to our business is difficult to predict.

The extent to which the COVID-19 pandemic will adversely impact our business, financial condition and results of operations is highly uncertain and cannot be predicted.

The COVID-19 pandemic has created significant worldwide uncertainty, volatility and economic disruption. The extent to which COVID-19 will adversely impact our business, financial condition and results of operations is dependent upon numerous factors, many of which are highly uncertain, rapidly changing and uncontrollable. These factors include, but are not limited to: (i) the duration and scope of the pandemic; (ii) governmental, business and individual actions that have been and continue to be taken in response to the pandemic, including travel restrictions, quarantines, social distancing, work-from-home and shelter-in-place orders and shut-downs; (iii) the impact on U.S. and global economies and the timing and rate of economic recovery; (iv) potential adverse effects on the financial markets and access to capital; (v) potential goodwill or other impairment charges; (vi) increased cybersecurity risks as a result of pervasive remote working conditions; (vii) our ability to effectively carry out our operations due to any adverse impacts on the health and safety of our employees and their families; and (viii) the ability of our collaborative partners to timely satisfy their collaborative obligations to us.

We may incur debt in the future that might be secured with our intellectual property as collateral, which could subject our Company to the risk of loss of all of our intellectual property.

We currently have no debt to service. If we incur debt in the future, we may be required to secure the debt with our intellectual property, including all of our patents and patents pending. In the event we default on the debt, we could incur the loss of all of our intellectual property, which would materially and adversely affect our Company and cause you to lose your entire investment in our Company.

Our failure to compete successfully could harm our business.

The markets that we are targeting for our proprietary electro-optic polymer systems and photonic devices are intensely competitive. Most of our present and potential competitors have or may have substantially greater research and product development capabilities, financial, scientific, marketing, manufacturing and human resources, name recognition and experience than we have. As a result, these competitors may:

- succeed in developing products that are equal to or superior to our potential products or that will achieve greater market acceptance than our potential products;
- devote greater resources to developing, marketing or selling their products;
- respond more quickly to new or emerging technologies or scientific advances and changes in customer requirements, which could render our technologies or potential products obsolete;
- introduce products that make the continued development of our potential products uneconomical;
- obtain patents that block or otherwise inhibit our ability to develop and commercialize our potential products;
- withstand price competition more successfully than we can;
- establish cooperative relationships among themselves or with third parties that enhance their ability to address the needs of our prospective customers.

Our failure to compete successfully against these existing or future competitors could harm our business.

We may be unable to obtain effective intellectual property protection for our potential products and technology.

Our intellectual property, or any intellectual property that we have or may acquire, license or develop in the future, may not provide meaningful competitive advantages. Our patents and patent applications, including those we license, may be challenged by competitors, and the rights granted under such patents or patent applications may not provide meaningful proprietary protection. For example, numerous patents held by third parties relate to polymer materials and electro-optic devices. These patents could be used as a basis to challenge the validity or limit the scope of our patents or patent applications. A successful challenge to the validity or limitation of the scope of our patents or patent applications could limit our ability to commercialize our polymer materials technology and, consequently, reduce our revenues.

Moreover, competitors may infringe our patents or those that we license, or successfully avoid these patents through design innovation. To combat infringement or unauthorized use, we may need to resort to litigation, which can be expensive and time-consuming and may not succeed in protecting our proprietary rights. In addition, in an infringement proceeding a court may decide that our patents or other intellectual property rights are not valid or are unenforceable, or may refuse to stop the other party from using the intellectual property at issue on the ground that it is non-infringing. Policing unauthorized use of our intellectual property is difficult and expensive, and we may not be able to, or have the resources to, prevent misappropriation of our proprietary rights, particularly in countries where the laws may not protect these rights as fully as the laws of the United States.

We also rely on the law of trade secrets to protect unpatented technology and know-how. We try to protect this technology and know-how by limiting access to those employees, contractors and strategic partners with a need to know this information and by entering into confidentiality agreements with these parties. Any of these parties could breach the agreements and disclose our trade secrets or confidential information to our competitors, or these competitors might learn of the information in other ways. Disclosure of any trade secret not protected by a patent could materially harm our business.

We may be subject to patent infringement claims, which could result in substantial costs and liability and prevent us from commercializing our potential products.

Third parties may claim that our potential products or related technologies infringe their patents. Any patent infringement claims brought against us may cause us to incur significant expenses, divert the attention of our management and key personnel from other business concerns and, if successfully asserted against us, require us to pay substantial damages. In addition, as a result of a patent infringement suit, we may be forced to stop or delay developing, manufacturing or selling potential products that are claimed to infringe a patent covering a third party's intellectual property unless that party grants us rights to use its intellectual property. We may be unable to obtain these rights on terms acceptable to us, if at all. Even if we are able to obtain rights to a third party's patented intellectual property, these rights may be non-exclusive, and therefore our competitors may obtain access to the same intellectual property. Ultimately, we may be unable to commercialize our potential products or may have to cease some of our business operations as a result of patent infringement claims, which could severely harm our business.

If our potential products infringe the intellectual property rights of others, we may be required to indemnify customers for any damages they suffer. Third parties may assert infringement claims against our current or potential customers. These claims may require us to initiate or defend protracted and costly litigation on behalf of customers, regardless of the merits of these claims. If any of these claims succeed, we may be forced to pay damages on behalf of these customers or may be required to obtain licenses for the products they use. If we cannot obtain all necessary licenses on commercially reasonable terms, we may be unable to continue selling such products.

Our technology may be subject to government rights.

We may have obligations to government agencies in connection with the technology that we have developed, including the right to require that a compulsory license be granted to one or more third parties selected by certain government agencies. It may be difficult to monitor whether these third parties will limit their use of our technology to these licensed uses, and we could incur substantial expenses to enforce our rights to our licensed technology in the event of misuse.

The loss of certain of our key personnel, or any inability to attract and retain additional personnel, could impair our ability to attain our business objectives.

Our future success depends to a significant extent on the continued service of our key management personnel, particularly Dr. Michael Lebby, our Chief Executive Officer and James S. Marcelli our President, Chief Operating Officer, Secretary and Principal Financial Officer. Accordingly, the loss of the services of either of these persons would adversely affect our business and our ability to timely commercialize our products, and impede the attainment of our business objectives.

Our future success will also depend on our ability to attract, retain and motivate highly skilled personnel to assist us with product development and commercialization. Competition for highly educated qualified personnel in the polymer industry is intense. If we fail to hire and retain a sufficient number of qualified management, engineering, sales and technical personnel, we will not be able to attain our business objectives.

If we fail to develop and maintain the quality of our manufacturing processes, our operating results would be harmed.

The manufacture of our potential products is a multi-stage process that requires the use of high-quality materials and advanced manufacturing technologies. Also, polymer-related device development and manufacturing must occur in a highly controlled, clean environment to minimize particles and other yield and quality-limiting contaminants. In spite of stringent quality controls, weaknesses in process control or minute impurities in materials may cause a substantial percentage of a product in a lot to be defective. If we are not able to develop and continue to improve on our manufacturing processes or to maintain stringent quality controls, or if contamination problems arise, our operating results would be harmed.

The complexity of our anticipated products may lead to errors, defects and bugs, which could result in the necessity to redesign products and could negatively, impact our reputation with customers.

Products as complex as those we intend to market might contain errors, defects and bugs when first introduced or as new versions are released. Delivery of products with production defects or reliability, quality or compatibility problems could significantly delay or hinder market acceptance of our products or result in a costly recall and could damage our reputation and adversely affect our ability to sell our products. If our products experience defects, we may need to undertake a redesign of the product, a process that may result in significant additional expenses.

We may also be required to make significant expenditures of capital and resources to resolve such problems. There is no assurance that problems will not be found in new products after commencement of commercial production, despite testing by our suppliers, our customers and us.

If we decide to make commercial quantities of products at our facilities, we will be required to make significant capital expenditures to increase capacity.

We lack the internal ability to manufacture products at a level beyond the stage of early commercial introduction. To the extent we do not have an outside vendor to manufacture our products, we will have to increase our internal production capacity and we will be required to expand our existing facilities or to lease new facilities or to acquire entities with additional production capacities. These activities would require us to make significant capital investments and may require us to seek additional equity or debt financing. We cannot assure you that such financing would be available to us when needed on acceptable terms, or at all. Further, we cannot assure you that any increased demand for our potential products would continue for a sufficient period of time to recoup our capital investments associated with increasing our internal production capacity.

In addition, we do not have experience manufacturing our potential products in large quantities. In the event of significant demand for our potential products, large-scale production might prove more difficult or costly than we anticipate and lead to quality control issues and production delays.

We may not be able to manufacture products at competitive prices.

To date, we have produced limited quantities of products for research, development, demonstration and prototype purposes. The cost per unit for these products currently exceeds the price at which we could expect to profitably sell them. If we cannot substantially lower our cost of production as we move into sales of products in commercial quantities, our financial results will be harmed.

We may be unable to export our potential products or technology to other countries, convey information about our technology to citizens of other countries or sell certain products commercially, if the products or technology are subject to United States export or other regulations.

We are developing certain polymer-based products that we believe the United States government and other governments may be interested in using for military and information gathering or antiterrorism activities. United States government export regulations may restrict us from selling or exporting these potential products into other countries, exporting our technology to those countries, conveying information about our technology to citizens of other countries or selling these potential products to commercial customers. We may be unable to obtain export licenses for products or technology, if they become necessary. We currently cannot assess whether national security concerns would affect our potential products and, if so, what procedures and policies we would have to adopt to comply with applicable existing or future regulations.

We are subject to regulatory compliance related to our operations.

We are subject to various U.S. governmental regulations related to occupational safety and health, labor and business practices. Failure to comply with current or future regulations could result in the imposition of substantial fines, suspension of production, alterations of our production processes, cessation of operations, or other actions, which could harm our business.

We may incur liability arising from the use of hazardous materials.

Our business and our facilities are subject to a number of federal, state and local laws and regulations relating to the generation, handling, treatment, storage and disposal of certain toxic or hazardous materials and waste products that we use or generate in our operations. Many of these environmental laws and regulations subject current or previous owners or occupiers of land to liability for the costs of investigation, removal or remediation of hazardous materials. In addition, these laws and regulations typically impose liability regardless of whether the owner or occupier knew of, or was responsible for, the presence of any hazardous materials and regardless of whether the actions that led to the presence were taken in compliance with the law. In our business, we use hazardous materials that are stored on site. We use various chemicals in our manufacturing process that may be toxic and covered by various environmental controls. An unaffiliated waste hauler transports the waste created by use of these materials off-site. Many environmental laws and regulations require generators of waste to take remedial actions at an off-site disposal location even if the disposal was conducted lawfully. The requirements of these laws and regulations are complex, change frequently and could become more stringent in the future. Failure to comply with current or future environmental laws and regulations could result in the imposition of substantial fines, suspension of production, alteration of our production processes, cessation of operations or other actions, which could severely harm our business.

Our data and information systems and network infrastructure may be subject to hacking or other cyber security threats. If our security measures are breached and an unauthorized party obtains access to our proprietary business information, our information systems may be perceived as being unsecure, which could harm our business and reputation, and our proprietary business information could be misappropriated which could have an adverse effect on our business and results of operations.

Our Company stores and transmits its proprietary information on its computer systems. Despite our security measures, our information systems and network infrastructure may be vulnerable to cyber-attacks or could be breached due to an employee error or other disruption that could result in unauthorized disclosure of sensitive information that has the potential to significantly interfere with our business operations. Breaches of our security measures could expose us to a risk of loss or misuse of this information, litigation and potential liability. Since techniques used to obtain unauthorized access or to sabotage information systems change frequently and generally are not recognized until launched against a target, we may be unable to anticipate these techniques or to implement adequate preventive measures in advance of such an attack on our systems. In addition, we use third party vendors to store our proprietary information who use cyber or "Cloud" storage of information as part of their service or product offerings, and despite our attempts to validate the security of such services, our proprietary information may be misappropriated by other parties. In the event of an actual or perceived breach of our security, or the security of one of our vendors, the market perception of the effectiveness of our security measures could be harmed and we could suffer damage to our reputation or our business. Additionally, misappropriation of our proprietary business information could prove competitively harmful to our business.

We conduct significantly all of our research and development activities at our Englewood, CO facility, and circumstances beyond our control may result in considerable business interruptions.

We conduct significantly all of our research and development activities at our Englewood, CO facility. Our operations are vulnerable to interruption by fire, earthquake, floods or other natural disaster, quarantines or other disruptions associated with infectious diseases, national catastrophe, terrorist activities, war, disruptions in our computing and communications infrastructure due to power loss, telecommunications failure, human error, physical or electronic security breaches and computer viruses, and other events beyond our control. We do not have a detailed disaster recovery plan. Additionally, presently, the novel strain of coronavirus known as COVID-19 has the potential to interrupt some, if not all, of our research and development activities.

We could be negatively affected as a result of a proxy contest and the actions of activist stockholders.

A proxy contest with respect to election of our directors, or other activist stockholder activities, could adversely affect our business because: (1) responding to a proxy contest and other actions by activist stockholders can be costly and time-consuming, disruptive to our operations and divert the attention of management and our employees; (2) perceived uncertainties as to our future direction caused by activist activities may result in the loss of potential business opportunities, and may make it more difficult to attract and retain qualified personnel and business partners; and (3) if individuals are elected to our Board of Directors with a specific agenda, it may adversely affect our ability to effectively and timely implement our strategic plans.

The requirements of being a public company are a strain on our systems and resources, are a diversion to management's attention and are costly.

As a public company, we are subject to the reporting requirements of the Securities Exchange Act of 1934 ("**Exchange Act**") the Sarbanes-Oxley Act of 2002 ("**Sarbanes-Oxley Act**"), the Dodd-Frank Wall Street Reform and Consumer Protection Act ("**Dodd-Frank Act**"), and the rules and regulations of The NASDAQ Stock Market. The requirements of these rules and regulations increase our legal, accounting and financial compliance costs, make some activities more difficult, time-consuming and costly and may also place undue strain on our personnel, systems and resources.

The Exchange Act requires, among other things, that we file annual, quarterly and current reports with respect to our business and operating results. The Sarbanes-Oxley Act requires, among other things, that we maintain effective disclosure controls and procedures and internal control over financial reporting. We are continuing the costly process of implementing and testing our systems to report our results as a public company, to continue to manage our growth and to implement internal controls. We are and will continue to be required to implement and maintain various other control and business systems related to our equity, finance, treasury, information technology, other recordkeeping systems and other operations. As a result of this implementation and maintenance, management's attention may be diverted from other business concerns, which could adversely affect our business. Furthermore, we rely on third-party software and system providers for ensuring our reporting obligations and effective internal controls, and to the extent these third parties fail to provide adequate service including as a result of any inability to scale to handle our growth and the imposition of these increased reporting and internal controls and procedures, we could incur material costs for upgrading or switching systems and our business could be materially affected.

In addition, changing laws, regulations and standards relating to corporate governance and public disclosure are creating uncertainty for public companies, increasing legal and financial compliance costs and making some activities more time consuming. These laws, regulations and standards are subject to varying interpretations, in many cases due to their lack of specificity, and, as a result, their application in practice may evolve over time as new guidance is provided by regulatory and governing bodies. This could result in continuing uncertainty regarding compliance matters and higher costs necessitated by ongoing revisions to disclosure and governance practices. We intend to invest resources to comply with evolving laws, regulations and standards, and this investment may result in increased general and administrative expenses and a diversion of management's time and attention from revenue-generating activities to compliance activities. If our efforts to comply with new laws, regulations and standards differ from the activities intended by regulatory or governing bodies due to ambiguities related to their application and practice, regulatory authorities may initiate legal proceedings against us and our business may be adversely affected.

In addition, we expect these laws, rules and regulations to make it more difficult and more expensive for us to obtain director and officer liability insurance, and we may be required to incur substantial costs to maintain appropriate levels of coverage. These factors could also make it more difficult for us to attract and retain qualified members of our board of directors, particularly to serve on our audit committee, and qualified executive officers.

As a result of being a public company, our business and financial condition are more visible, which we believe may result in threatened or actual litigation, including by competitors and other third parties. If such claims are successful, our business and operating results could be adversely affected, and even if the claims do not result in litigation or are resolved in our favor, these claims, and the time and resources necessary to resolve them, could divert the time and resources of our management and adversely affect our business and operating results.

If we fail to maintain an effective system of disclosure controls and internal control over financial reporting, our ability to produce timely and accurate financial statements or comply with applicable regulations could be impaired.

As a public company, we are subject to the reporting requirements of the Securities Exchange Act of 1934 (Exchange Act) the Sarbanes-Oxley Act of 2002 (Sarbanes-Oxley Act), the Dodd-Frank Wall Street Reform and Consumer Protection Act (Dodd-Frank Act), and the rules and regulations of The NASDAQ Stock Market. We expect that compliance with these rules and regulations will continue to increase our legal, accounting and financial compliance costs, make some activities more difficult, time consuming and costly, and place significant strain on our personnel, systems and resources.

The Sarbanes-Oxley Act requires, among other things, that we assess the effectiveness of our internal control over financial reporting annually and the effectiveness of our disclosure controls and procedures quarterly. In particular, Section 404 of the Sarbanes-Oxley Act, (Section 404), requires us to perform system and process evaluation and testing of our internal control over financial reporting to allow management to report on, and our independent registered public accounting firm to attest to, the effectiveness of our internal control over financial reporting. Our compliance with applicable provisions of Section 404 requires that we incur substantial accounting expense and expend significant management time on compliance-related issues as we implement additional corporate governance practices and comply with reporting requirements. Moreover, if we are not able to comply with the requirements of Section 404 applicable to us in a timely manner, or if we or our independent registered public accounting firm identifies deficiencies in our internal control over financial reporting that are deemed to be material weaknesses, the market price of our stock could decline and we could be subject to sanctions or investigations by the SEC or other regulatory authorities, stockholder or other third-party litigation, all of which would require additional financial and management resources.

Furthermore, investor perceptions of our Company may suffer if deficiencies are found, and this could cause a decline in the market price of our stock or hinder our ability to raise capital. Irrespective of compliance with Section 404, any failure of our internal control over financial reporting could have a material adverse effect on our stated operating results and harm our reputation. If we are unable to continue to implement and maintain these requirements effectively or efficiently, it could harm our operations, financial reporting, or financial results and could result in an adverse opinion on our internal controls from our independent registered public accounting firm.

The exercise of options and warrants and other issuances of shares of common stock or securities convertible into common stock will dilute your interest.

Our Board may determine from time to time that it needs to raise additional capital by issuing additional shares of our common stock or other securities and we are not restricted from issuing additional common stock, including securities that are convertible into or exchangeable for, or that represent the right to receive, shares of our common stock. Because our decision to issue securities in any future offering will depend on market conditions and other factors beyond our control, we cannot predict or estimate the amount, timing, or nature of any future offerings, or the prices at which such offerings may be affected. Additional equity offerings may dilute the holdings of existing stockholders or reduce the market price of our common stock.

As of December 31, 2022, we have outstanding options and warrants to purchase an aggregate of 8,073,173 shares of our common stock at exercise prices ranging from $0.51 - $16.81 per share with a weighted average exercise price of $1.91 per share. The exercise of options and warrants at prices below the market price of our common stock could adversely affect the price of shares of our common stock. Additional dilution may result from the issuance of shares of our capital stock in connection with any collaboration (although none are contemplated at this time) or in connection with other financing efforts, including pursuant to the 2021 Purchase Agreement with Lincoln Park, the 2023 Purchase Agreement with Lincoln Park, and the Roth Sales Agreement with Roth Capital. Any issuance of our common stock that is not made solely to then-existing stockholders proportionate to their interests, such as in the case of a stock dividend or stock split, will result in dilution to each stockholder by reducing his, her or its percentage ownership of the total outstanding shares. Moreover, if we issue options or warrants to purchase our common stock in the future and those options or warrants are exercised or we issue restricted stock, stockholders may experience further dilution. Holders of shares of our common stock have no preemptive rights that entitle them to purchase their pro rata share of any offering of shares of any class or series.

The trading price of our common stock has been, and may continue to be, volatile, and the value of our common stock may decline. This volatility, as well as general market conditions, may cause our stock price to fluctuate greatly and even potentially expose us to litigation.

Our common stock may be subject to continued volatility. During the past 52 weeks, the share price for our common stock ranged from a low of $3.91 to high of $13.59. We cannot assure you that the market price for our common stock will be less volatile or will remain at its current level. A decrease in the market price for our shares could result in substantial losses for investors. The market price of our common stock may be significantly affected by one or more of the following factors, many of which are beyond our control, including:

- our Company's ability to execute on its business plan;

- the status of particular development programs and the timing of performance under specific development agreements;
- actual or anticipated demand for our potential products and technologies;
- amount and timing of our costs related to our development and marketing efforts or other initiatives and expansion of our operations;
- changes in anticipated commercial deployment of our products and financial results;
- our ability to enter into, renegotiate or renew key agreements or strategic relationships,
- our ability to develop expanded product production facilities, along with silicon-based foundry and other outside contractor relationships;
- issuance of new or updated research or reports by securities analysts;
- the use by investors or analysts of third-party data regarding our business that may not reflect our operations;
- fluctuations in the valuation of companies perceived by investors to be comparable to us;
- share price and volume fluctuations attributable to inconsistent trading volume levels of our shares;
- large trades, block trades or short selling of our common stock,
- actual or anticipated changes in our competitive position relative to our industry competitors;
- announcements or implementation by our competitors of technological innovations or new products;
- changes in laws or regulations applicable to our products or industry;
- additions or departures of key personnel;
- capital-raising activities or commitments;
- product shortages requiring suppliers to allocate minimum quantities;
- the commencement or conclusion of legal proceedings that involve us;
- costs related to possible future acquisitions of technologies or businesses;
- economic conditions specific to our industry, as well as general economic and market conditions; or
- other events or factors, including those resulting from civil unrest, war, foreign invasions, terrorism, or public health crises (e.g. Covid-19), or responses to such events.

Furthermore, the stock markets frequently experience extreme price and volume fluctuations that affect the market prices of equity securities of many companies. These fluctuations often have been unrelated or disproportionate to the operating performance of those companies. These broad market and industry fluctuations, as well as general economic, political, and market conditions such as recessions, elections, interest rate changes, or international currency fluctuations, may negatively impact the market price of our common stock. As a result of such fluctuations, you may not realize any return on your investment in us and may lose some or all of your investment. In the past, companies that have experienced volatility in the market price of their stock have been subject to securities class action litigation or derivative litigation.

A sale of a substantial number of shares of our common stock may cause the price of our common stock to decline and may impair our ability to raise capital in the future.

Our common stock is traded on The NASDAQ Capital Market and, despite certain increases of trading volume from time to time, there have been periods when the market for our common stock could be considered "thinly-traded," meaning that the number of persons interested in purchasing our common stock at or near bid prices at any given time may be relatively small. Finance transactions or option/warrant exercises resulting in a large amount of newly issued shares that become readily tradable, or other events that cause current stockholders to sell shares, could place downward pressure on the trading price of our stock the trading price of our stock could decline. Additionally, we believe a significant portion of our shares are held by shareholders that accumulated their shares during a time when our shares prices were significantly less than our current share prices. If these shareholders, some of which hold a substantial number of shares of our common stock, decide to sell some or all of their shares at once without regard to the impact of their sales on the market price of our stock, the trading price of our stock could decline. In addition, the lack of a robust resale market may require a stockholder who desires to sell a large number of shares of common stock to sell the shares in increments over time to mitigate any adverse impact of the sales on the market price of our stock.

If our existing stockholders sell, or the market perceives that our stockholders intend to sell, substantial amounts of our common stock in the public market, including shares issued upon the exercise of outstanding options or warrants or pursuant to the 2021 Purchase Agreement with Lincoln Park, the 2023 Purchase Agreement with Lincoln Park, and the Roth Sales Agreement with Roth Capital, the market price of our common stock could decline. Sales of a substantial number of shares of our common stock may make it more difficult for us to sell equity or equity-related securities in the future at a time and price that we deem reasonable or appropriate. We may become involved in securities class action litigation that could divert management's attention and harm our business.

Our common stock will be subject to potential delisting if we do not maintain the listing requirements of the Nasdaq Capital Market.

Our common stock commenced trading on The NASDAQ Capital Market on September 1, 2021. We cannot assure you that that an active trading market for our common stock will continue to be sustained. Nasdaq has rules for continued listing, including, without limitation, minimum market capitalization and other requirements. Failure to maintain our listing, or de-listing from Nasdaq, would make it more difficult for stockholders to dispose of our securities and more difficult to obtain accurate price quotations on our securities. This could have an adverse effect on the price of our common stock. Our ability to issue additional securities for financing or other purposes, or otherwise to arrange for any financing we may need in the future, may also be materially and adversely affected if our common stock and/or other securities are not traded on a national securities exchange.

If securities or industry analysts do not publish research or reports about our business, or if they change their recommendations regarding our stock adversely, our stock price and trading volume could decline.

The trading market for most listed companies' securities depends in part on the research and reports that securities or industry analysts publish about them or their business. We currently have no independent research analysts that cover our stock and we may not obtain research coverage by securities and industry analysts until our products are commercialized and we obtain revenues, and there is no assurances that we will ever obtain independent research analysts coverage. If no securities or industry analysts commence coverage of us, the trading price for our common stock could be negatively affected. In the event any analyst who covers us downgrades our securities, the price of our securities would likely decline. If one or more of these analysts ceases to cover us or fails to publish regular reports on us, interest in the purchase of our securities could decrease, which could cause the price of our common stock and its trading volume to decline.

Our board of directors has the authority, without stockholder approval, to issue preferred stock with terms that may not be beneficial to existing common stockholders and with the ability to affect adversely stockholder voting power and perpetuate their control over us.

Our articles of incorporation, as amended, allow us to issue shares of preferred stock without any vote or further action by our stockholders. Our board of directors has the authority to fix and determine the relative rights and preferences of preferred stock. Our board of directors also has the authority to issue preferred stock without further stockholder approval, including large blocks of preferred stock. As a result, our board of directors could authorize the issuance of a series of preferred stock that would grant to holders thereof the preferred right to our assets upon liquidation, the right to receive dividend payments before dividends are distributed to the holders of common stock or other preferred stockholders and the right to the redemption of the shares, together with a premium, prior to the redemption of our common stock or existing preferred stock, if any.

Preferred stock could be used to dilute a potential hostile acquirer. Accordingly, any future issuance of preferred stock or any rights to purchase preferred stock may have the effect of making it more difficult for a third party to acquire control of us. This may delay, defer or prevent a change of control or an unsolicited acquisition proposal. The issuance of preferred stock also could decrease the amount of earnings attributable to, and assets available for distribution to, the holders of our common stock and could adversely affect the rights and powers, including voting rights, of the holders of our common stock and preferred stock.

Our articles of incorporation and bylaws, and certain provisions of Nevada corporate law, as well as certain of our contracts, contain provisions that could delay or prevent a change in control even

if the change in control would be beneficial to our stockholders.

Nevada law, as well as our articles of incorporation, as amended, and bylaws, contain anti-takeover provisions that could delay or prevent a change in control of our Company, even if the change in control would be beneficial to our stockholders. These provisions could lower the price that future investors might be willing to pay for shares of our common stock. These anti-takeover provisions:

- authorize our board of directors to create and issue, without stockholder approval, preferred stock, thereby increasing the number of outstanding shares, which can deter or prevent a takeover attempt;
- prohibit cumulative voting in the election of directors, which would otherwise allow less than a majority of stockholders to elect director candidates;
- empower our board of directors to fill any vacancy on our board of directors, whether such vacancy occurs as a result of an increase in the number of directors or otherwise;
- provide that our board of directors be divided into three classes, with approximately one-third of the directors to be elected each year;
- provide that our board of directors is expressly authorized to adopt, amend or repeal our bylaws; and
- provide that our directors will be elected by a plurality of the votes cast in the election of directors.

Nevada Revised Statutes, the terms of our employee stock option agreements and other contractual provisions may also discourage, delay or prevent a change in control of our Company. Nevada Revised Statutes sections 78.378 to 78.3793 provide state regulation over the acquisition of a controlling interest in certain Nevada corporations unless the articles of incorporation or bylaws of the corporation provide that the provisions of these sections do not apply. Our articles of incorporation, as amended, and bylaws do not state that these provisions do not apply. The statute creates a number of restrictions on the ability of a person or entity to acquire control of a Nevada company by setting down certain rules of conduct and voting restrictions in any acquisition attempt, among other things. The statute contains certain limitations and it may not apply to our Company. Our 2016 Equity Incentive Plan includes change-in-control provisions that allow us to grant options that may become vested immediately upon a change in control. Our board of directors also has the power to adopt a stockholder rights plan that could delay or prevent a change in control of our Company even if the change in control is generally beneficial to our stockholders. These plans, sometimes called "poison pills," are oftentimes criticized by institutional investors or their advisors and could affect our rating by such investors or advisors. If our board of directors adopts such a plan, it might have the effect of reducing the price that new investors are willing to pay for shares of our common stock.

Together, these charter, statutory and contractual provisions could make the removal of our management and directors more difficult and may discourage transactions that otherwise could involve payment of a premium over prevailing market prices for our common stock. Furthermore, the existence of the foregoing provisions, as well as the significant common stock beneficially owned by our founders, executive officers, and members of our board of directors, could limit the price that investors might be willing to pay in the future for shares of our common stock. They could also deter potential acquirers of our Company, thereby reducing the likelihood that you could receive a premium for your common stock in an acquisition.

Item 1B. Unresolved Staff Comments.

None.

Item 2. Properties.

Our principal executive offices and research and development facility is located at 369 Inverness Parkway, Suite 350, Englewood, Colorado. The 13,420 square feet facility includes fully functional 1,000 square feet of class 1,000 cleanroom, 500 square feet of class 10,000 cleanroom, chemistry laboratories, and analytic laboratories, and serves as our office, laboratory and research and development space. On November 22, 2022, our Company entered into an amendment to our lease to obtain an additional 9,684 square feet of office and warehouse space with an expected commencement date of August 1, 2023. Our total annual base rent during 2023 is expected to be approximately $278,510.

Item 3. Legal Proceedings.

We are not a party to any litigation of a material nature, nor are we aware of any threatened litigation of a material nature.

Item 4. Mine Safety Disclosures.

Not Applicable.

PART II

Item 5. Market For Registrant's Common Equity, Related Stockholder Matters and Issuer Purchases Of Equity Securities.

Market Information

Our common stock trades on the Nasdaq Capital Market under the symbol LWLG.

Holders of Common Stock

On February 28, 2022, we had approximately 80 holders of our common stock, not including persons who hold our common stock in nominee or "street name" accounts through brokers or banks.

Dividend Policy

Our Company has never paid a cash dividend and has no present plans to pay cash dividends.

Securities Authorized for Issuance under Equity Compensation Plans

Equity Compensation Plans as of December 31, 2022.

Equity Compensation Plan Information			
Plan category	Number of securities to be issued upon exercise of outstanding options, warrants and rights (a)	Weighted-average exercise price of outstanding options, warrants and rights (b)	Number of securities remaining available for future issuance under equity compensation plans (excluding securities reflected in column (a)) (c)
Equity compensation plans approved by security holders(1)	7,285,173	$2.03	2,317,680
Equity compensation plans not approved by security holders(2)	788,000	$0.72	0
Total	8,073,173	$1.91	2,317,680

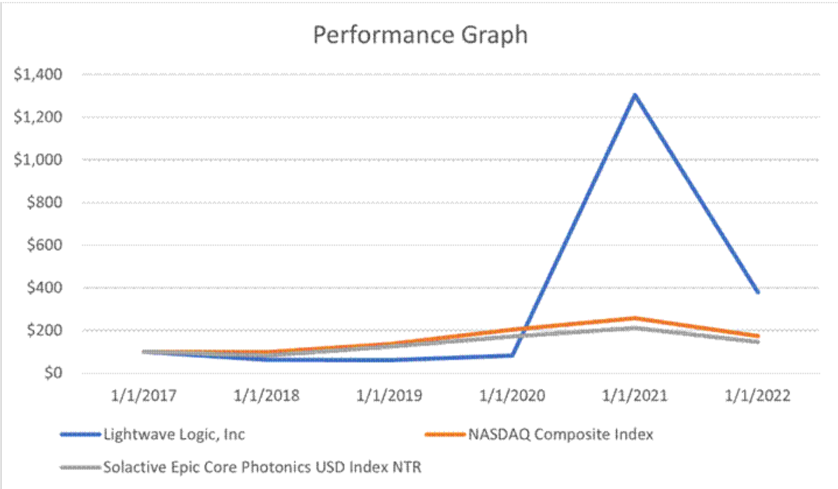
1. Reflects shares of common stock to be issued pursuant to our 2016 Equity Incentive Plan and our 2007 Employee Stock Plan, both of which are for the benefit of our directors, officers, employees and consultants. We have reserved 8,000,000 shares of common stock for such persons pursuant to our 2016 Equity Incentive Plan. We terminated our 2007 Employee Stock Plan in June 2016 and no additional awards are made under that plan.

2. Comprised of common stock purchase warrants we issued for services.

Stock Performance Graph

The graph set forth below compares the cumulative total stockholder return on our common stock between December 31, 2017 and December 31, 2022, with the cumulative total return of (a) the NASDAQ Composite Index and (b) Solactive EPIC Core Photonics USD Index NTR, over the same period. This graph assumes the investment of $100 on December 31, 2017 in our common stock, the NASDAQ Composite Index and the Solactive EPIC Core Photonics USD Index NTR and assumes the reinvestment of dividends, if any. The graph assumes our closing sales price on December 31, 2017 of $1.14 per share as the initial value of our common stock.

The comparisons shown in the graph below are based upon historical data. The stock price performance shown in the graph below is not necessarily indicative of, nor is it intended to forecast, the potential future performance of our common stock. Information used in the graph was obtained from the NASDAQ Stock Market LLC and Solactive AG, financial data providers and sources believed to be reliable.



The above graph and related information shall not be deemed "soliciting material" or to be "filed" with the Securities and Exchange Commission, nor shall such information be incorporated by reference into any future filing under the Securities Act or the Exchange Act except to the extent we specifically incorporate it by reference into such filing. Our stock price performance shown in the graph below is not indicative of future stock price performance.

Recent Sales of Unregistered Securities

During the period covered by this report, our Company has sold the following securities without registering the securities under the Securities Act:

Date	Security
April 6, 2022	Common Stock — 150,000 shares of common stock at $1.48 per share pursuant to a warrant exercise.
June 3, 2022	Common Stock — 25,000 shares of common stock at $.75 per share pursuant to a warrant exercise.
Oct 7, 2022	Common Stock — 25,000 shares of common stock at $.64 per share pursuant to a warrant exercise.
Oct 7, 2022	Common Stock — 25,000 shares of common stock at $.67 per share pursuant to a warrant exercise.
Dec 2, 2022	Common Stock — 125,000 shares of common stock at $.98 per share pursuant to a warrant exercise.

No underwriters were utilized, and no commissions or fees were paid with respect to any of the above transactions. These persons were the only offerees in connection with these transactions. We relied on Section 4(a)(2) and Rule 506 of Regulation D of the Securities Act since the transaction does not involve any public offering.

Purchases of Equity Securities by the Issuer or Affiliated Purchasers

None.

Item 6. RESERVED.

Item 7. MANAGEMENT'S DISCUSSION AND ANALYSIS OF FINANCIAL CONDITION AND RESULTS OF OPERATIONS.

The following management's discussion and analysis of financial condition and results of operations provides information that management believes is relevant to an assessment and understanding of our plans and financial condition. The following selected financial information is derived from our historical financial statements and should be read in conjunction with such financial statements and notes thereto set forth elsewhere within this Annual Report on Form 10-K and the "Forward-Looking Statements" explanation included elsewhere herein.

Overview

Lightwave Logic, Inc. is a development stage company moving toward commercialization of next generation electro-optic photonic devices made on its P^2IC™ technology platform which we have detailed as: 1) Polymer Stack™, 2) Polymer Plus™, and 3) Polymer Slot™. Our unique polymer technology platform uses in-house proprietary high-activity and high-stability organic polymers. Electro-optical devices called modulators convert data from electric signals into optical signals for multiple applications.

Our differentiation at the modulator device level is in higher speed, lower power consumption, simplicity of manufacturing, small footprint (size), and reliability. We have demonstrated higher speed and lower power consumption in packaged devices, and during 2022, we continued to make advances in techniques to translate material properties to efficient, reliable modulator devices with commercial foundries. We are currently focused on testing and demonstrating the simplicity of manufacturability and reliability of our devices, including in conjunction with the silicon photonics manufacturing ecosystem. In 2022 we discussed the addition of several silicon-based foundry partners to help scale in volume our polymer modulator devices. Silicon-based foundries are large semiconductor fabrication plants developed for the electronics IC business, that are now engaging with silicon photonics to increase their wafer throughput. Partnering with silicon-based foundries not only demonstrates that our polymer technology can be transferred into standard production lines using standard equipment, it also allows us to efficiently utilize our capital. The foundry partnerships will allow us to scale our high-performance polymer optical engines quickly and efficiently.

Our extremely strong and broad patent portfolio allows us to optimize our business model in three areas: 1) Traditional focus on product development, 2) Patent licensing and 3) Technology transfer to foundries. We are continually looking to strengthen our patent portfolio both by internal inventions and acquisition of intellectual property.

We are initially targeting applications in fiber optic data communications and telecommunications markets and are exploring other applications that include automotive/LIDAR, sensing, displays etc., for our polymer technology platform. Our goal is to have our unique polymer technology platform become ubiquitous.

Our business strategy anticipates that our revenue stream will be derived from one or some combination of the following: (i) technology licensing for specific product application; (ii) joint venture relationships with significant industry leaders; and (iii) the production and direct sale of our own electro-optic device components. Our objective is to be a leading provider of proprietary technology and know-how in the electro-optic device market. In order to meet this objective, we intend to continue to:

- Further the development of proprietary organic electro-optic polymer material systems
- Develop photonic devices based on our P2IC™ technology
- Develop proprietary intellectual property
- Grow our commercial device development capabilities

- Partner with silicon-based foundries who can scale volume quickly
- Grow our product reliability and quality assurance capabilities
- Grow our optoelectronic packaging and testing capabilities
- Grow our commercial material manufacturing capabilities
- Maintain/develop strategic relationships with major telecommunications and data communications companies to further the awareness and commercialization of our technology platform
- Add high-level personnel with industrial and manufacturing experience in key areas of our materials and device development programs.

Create Organic Polymer-Enabled Electro-Optic Modulators

We intend to utilize our proprietary optical polymer technology to create an initial portfolio of commercial electro-optic polymer product devices with applications for various markets, including telecommunications, data communications and data centers. These product devices will be part of our proprietary photonics integrated circuit (PIC) technology platform.

We expect our initial modulator products will operate at symbol rates at least 112 Gigabaud which is roughly 200Gbps when utilized with PAM4 encoding schemes. Our devices are highly linear, and can also enable the performance required to take advantage of more advance complex encoding schemes if required.

Capital Requirements

As a development stage company, we do not generate revenues. We have incurred substantial net losses since inception. We have satisfied our capital requirements since inception primarily through the issuance and sale of our common stock.

Results of Operations

Comparison of year ended December 31, 2022 to year ended December 31, 2021 and year ended December 31, 2021 to year ended December 31, 2020

Revenues

As a development stage company, we had no revenues during the years ended December 31, 2022, December 31, 2021 and December 31, 2020. The Company is in various stages of photonic device and materials development and evaluation with potential customers and strategic partners. The Company expects to obtain a revenue stream from technology licensing agreements, technology transfer agreements and the production and direct sale of its own electro-optic device components.

Operating Expenses

	For the Year Ending December 31, 2022	For the Year Ending December 31, 2021	Change from Prior Year	Percent Change from Prior Year
Research and development	$ 12,805,374	$ 12,476,040	$ 329,334	3%
General and administrative	4,334,290	4,520,403	(186,113)	-4%
	$ 17,139,664	$ 16,996,443	$ 143,221	1%

	For the Year Ending December 31, 2021	For the Year Ending December 31, 2020	Change from Prior Year	Percent Change from Prior Year
Research and development	$ 12,476,040	$ 4,590,545	$ 7,885,495	172%
General and administrative	4,520,403	2,009,429	2,510,974	125%
	$ 16,996,443	$ 6,599,974	$ 10,396,469	158%

Research and development expenses increased for the year ended December 31, 2022, as compared to the year ended December 31, 2021, primarily due to increases in research and development non-cash stock option amortization, prototype device development expenses, research and development salary expenses, laboratory and wafer fabrication materials and supplies, research and development consulting expenses, depreciation and research and development travel expenses offset by a decrease in expense for cashless option exercises and research and development bonus expenses.

Research and development non-cash stock option amortization expenses increased by $3,732,646 in the year ended December 31, 2022, compared to the same period in 2021. Prototype device development expenses increased by $1,460,419 in the year ended December 31, 2022, compared to the same period in 2021. Research and development salary expenses increased by $617,627 in the year ended December 31, 2022, compared to the same period in 2021. Laboratory and wafer fabrication materials and supplies increased by $242,737 in the year ended December 31, 2022, compared to the same period in 2021. Research and development consulting expenses increased by $224,435 in the year ended December 31, 2022, compared to the same period in 2021. Depreciation expenses increased by $173,206 in the year ended December 31, 2022, compared to the same period in 2021. Research and development travel expenses increased by $147,136 in the year ended December 31, 2022, compared to the same period in 2021. The expense for research and development cashless option exercises decreased by $3,382,582 in the year ended December 31, 2022, compared to the same period in 2021. Research and development bonus expenses decreased by $3,003,169 in the year ended December 31, 2022, compared to the same period in 2021.

Research and development expenses increased for the year ended December 31, 2021, as compared to the year ended December 31, 2020, primarily due to the research and development expense for cashless option exercises and increases in research and development bonus and salary expenses, prototype device development expenses, non-cash stock option and warrant amortization, laboratory and wafer fabrication materials and supplies, operations committee fees, depreciation and research and development travel expenses.

The research and development expense for cashless option exercises for the year ended December 31, 2021 were $3,490,324. There was no expense for cashless option exercises for the year ended December 31, 2020. Research and development bonus and salary expenses increased by $3,300,257 in the year ended December 31, 2021, compared to the same period in 2020 primarily for bonus expenses. Prototype device development expenses increased by $368,483 in the year ended December 31, 2021, compared to the same period in 2020. Non-cash stock option and warrant amortization expenses increased by $349,059 in the year ended December 31, 2021, compared to the same period in 2020. Laboratory and wafer fabrication materials and supplies increased by $128,481 in the year ended December 31, 2021, compared to the same period in 2020. Depreciation expenses increased by $92,404 in the year ended December 31, 2021, compared to the same period in 2020. Research and development travel expenses increased by $41,741 in the year ended December 31, 2021, compared to the same period in 2020.

We expect to continue to incur substantial research and development expense developing and commercializing our photonic devices, and electro-optic materials platform. These expenses will increase as a result of accelerated development effort to support commercialization of our non-linear optical polymer materials technology; to build photonic device prototypes; working with semiconductor foundries; hiring additional technical and support personnel; engaging senior technical advisors; pursuing other potential business opportunities and collaborations; customer testing and evaluation; and incurring related operating expenses.

General and administrative expenses decreased for the year ended December 31, 2022, as compared to the year ended December 31, 2021, primarily due to decreases in general and administrative bonus and salary expenses and general and administrative expense for cashless option exercises offset by increases general and administrative non-cash stock option amortization, legal expenses, director fees, insurance and general and administrative travel expenses.

General and administrative bonus and salary expenses decreased by $2,054,916 in the year ended December 31, 2022, compared to the same period in 2021 primarily for bonus expenses in the year ended December 31, 2021. The expense for general and administrative cashless option exercises decreased by $170,137 in the year ended December 31, 2022, compared to the same period in 2021. General and administrative non-cash stock option amortization increased by $1,138,708 in the year ended December 31, 2022, compared to the same period in 2021. Legal expenses increased by $417,624 in the year ended December 31, 2022, compared to the same period in 2021. Director fees increased by $149,750 in the year ended December 31, 2022, compared to the same period in 2021. Insurance expenses increased by $136,771 in the year ended December 31, 2022, compared to the same period in 2021. General and administrative travel expenses increased by $75,652 in the year ended December 31, 2022, compared to the same period in 2021.

General and administrative expenses increased for the year ended December 31, 2021, as compared to the year ended December 31, 2020, primarily due to general and administrative bonus expenses, general and administrative expense for cashless option exercises and increases in investor expenses, general and administrative consulting fees, non-cash stock option amortization, legal fees, general and administrative travel expenses and director and officer insurance.

General and administrative bonus and salary expenses increased by $2,015,959 in the year ended December 31, 2021, compared to the same period in 2020 primarily for bonus expenses. The general and administrative expense for cashless option exercises for the year ended December 31, 2021 were $182,501. There was no expense for cashless option exercises for the year ended December 31, 2020. Investor expenses increased by $108,341 in the year ended December 31, 2021, compared to the same period in 2020 primarily for the expenses to uplist the Company to the Nasdaq Capital Market. Compensation consulting expenses increased by $53,500 in the year ended December 31, 2021, compared to the same period in 2020. Non-cash stock option amortization expenses increased by $49,739 in the year ended December 31, 2021, compared to the same period in 2020. Legal expenses increased by $44,718 in the year ended December 31, 2021, compared to the same period in 2020 primarily for the expenses to uplist the Company to the Nasdaq Capital Market. General and administrative travel expenses increased by $33,260 in the year ended December 31, 2021, compared to the same period in 2020. Director and officer insurance increased by $32,390 in the year ended December 31, 2021, compared to the same period in 2020.

Other Income (Expense)

	For the Year Ending December 31, 2022	For the Year Ending December 31, 2021	Change from Prior Year	Percent Change from Prior Year
Other Income/(Expense)	$ (90,816)	$ (1,634,938)	$ 1,544,122	-94%

	For the Year Ending December 31, 2021	For the Year Ending December 31, 2020	Change from Prior Year	Percent Change from Prior Year
Other Income/(Expense)	$ (1,634,938)	$ (115,590)	$ (1,519,348)	1314%

Other income (expenses) decreased for the year ended December 31, 2022, as compared to the year ended December 31, 2021, primarily due to a decrease in commitment fee associated with the purchase of shares by an institutional investor for sale under a stock purchase agreement in the amount of $1,849,755 offset by the forgiveness by the Small Business Administration during 2021 of a loan funding from the Paycheck Protection Programn the amount of $410,700.

Other income (expenses) increased for the year ended December 31, 2021, as compared to the year ended December 31, 2020, primarily due to an increase in commitment fee in the amount of $1,943,098 associated with the purchase of shares by an institutional investor for sale under a stock purchase agreement offset by the Paycheck Protection Program loan forgiveness January 22, 2021 in the amount of $410,700.

Net Loss

	For the Year Ending December 31, 2022	For the Year Ending December 31, 2021	Change from Prior Year	Percent Change from Prior Year
Net Loss	$ 17,230,480	$ 18,631,381	$ (1,400,901)	-8%

	For the Year Ending December 31, 2021	For the Year Ending December 31, 2020	Change from Prior Year	Percent Change from Prior Year
Net Loss	$ 18,631,381	$ 6,715,564	$ 11,915,817	177%

Net loss was $17,230,480 and $18,631,381 for the year ended December 31, 2022 and 2021, respectively, for a decrease of $1,400,901 due primarily to decreases in expense for cashless option exercises, bonus expenses and commitment fee associated with the purchase of shares by an institutional investor for sale under a stock purchase agreement offset by increases in non-cash stock option amortization, prototype device development expenses, research and development salary expenses, legal expenses, the forgiveness by the Small Business Administration during 2021 of a loan funding from the Paycheck Protection Program, laboratory and wafer fabrication materials and supplies, research and development consulting fees, travel expenses, depreciation, director fees and insurance expenses.

Net loss was $18,631,381 and $6,715,564 for the year ended December 31, 2021 and 2020, respectively, for an increase of $11,915,817, due primarily to bonus and salary expenses, the expense for cashless option exercises and increases in commitment fee, non-cash stock option and warrant amortization, prototype device development expenses, laboratory and wafer fabrication materials and supplies, investor expenses, operations committee fees, depreciation, compensation consulting fees, travel expenses, legal expenses and director and officer insurance.

Significant Accounting Policies

Our Company's accounting policies are more fully described in Note 1 of Notes to Financial Statements. As disclosed in Note 1 of Notes to Financial Statements, the preparation of financial statements in conformity with accounting principles generally accepted in the United States requires management to make estimates and assumptions that affect the amounts reported in the financial statements and accompanying disclosures. Although these estimates are based on our management's best knowledge of current events and actions our Company may undertake in the future, actual results could differ from the estimates.

Liquidity and Capital Resources

Our primary source of operating cash inflows was proceeds from the sale of common stock to Lincoln Park, an institutional investor, pursuant to purchase agreements with Lincoln Park (the institutional investor) as described in Note 10 to the Financial Statements and proceeds received pursuant to the exercise of options and warrants.

All of the registered shares under the January 21, 2019 purchase agreement with Lincoln Park have been issued as of June 30, 2021. On July 2, 2021, the Company filed a $100 million universal shelf registration statement which became effective on July 9, 2021. On October 4, 2021, our Company entered into the 2021 Purchase Agreement to sell up to $33 million of common stock over a 36-month period, with $2,126,557 remaining on the 2021 Purchase Agreement as of the date of this filing. On February 28, 2023, our Company entered into the 2023 Purchase Agreement to sell up to $30 million of common stock over a 36-month period, with $30 remaining on the 2023 Purchase Agreement as of the date of this filing, and on December 9, 2022, our Company entered into the Roth Sales Agreement with Roth Capital, as sales agent, whereby pursuant to the Roth Sales Agreement, our Company may offer and sell up to $35,000,000 in shares of our common stock, from time to time through Roth Capital. As of the date of this filing $35 million remains available to our Company pursuant to the Roth Sales Agreement.

During the year ended December 31, 2022, the Company received $12,775,268 in proceeds pursuant to the 2021 purchase agreement with the institutional investor and $653,895 in proceeds pursuant to the exercise of options and warrants. During the year ended December 31, 2021, the Company received $30,350,674 in proceeds pursuant to the purchase agreements with the institutional investor and $2,379,225 in proceeds pursuant to the exercise of options and warrants. During the year ended December 31, 2020, we received $5,173,300 in proceeds pursuant to the January 2019 purchase agreement with the institutional investor and $1,658,442 in proceeds from exercise of warrants. Additionally, on April 24, 2020, we received $410,700 in loan funding from the Paycheck Protection Program, as described in Note 8 to the Financial Statements. The loan was forgiven by the Small Business Administration in its entirety on January 22, 2021.

During the year ended December 31, 2022, our primary sources of cash outflows from operations included payroll, rent, utilities, payments to vendors including prototypes development and foundries expenses, third-party service providers and payroll taxes related to cashless option exercise. During the year ended December 31, 2021, our primary sources of cash outflows from operations included payroll and bonus, payroll taxes related to cashless option exercise, rent, utilities, payments to vendors including prototypes development and foundries expenses and third-party service providers. During the year ended December 31, 2020, our primary sources of cash outflows from operations included payroll, rent, utilities, payments to vendors and third-party service providers.

Sources and Uses of Cash

Our future expenditures and capital requirements will depend on numerous factors, including: the progress of our research and development efforts; the rate at which we can, directly or through arrangements with original equipment manufacturers, introduce and sell products incorporating our polymer materials technology; the costs of filing, prosecuting, defending and enforcing any patent claims and other intellectual property rights; market acceptance of our products and competing technological developments; and our ability to establish cooperative development, joint venture and licensing arrangements. We expect that we will incur approximately $1,604,000 of expenditures per month over the next 12 months.

We expect the 2021 Purchase Agreement, the 2023 Purchase Agreement and the Roth Sales Agreement (all as more fully described below) to provide us with sufficient funds to maintain our operations over that period of time. Our current cash position enables us to finance our operations through April 2024 before we will be required to replenish our cash reserves pursuant to our 2021 Purchase Agreement, the 2022 Purchase Agreement or the Roth Sales Agreement. Our cash requirements are expected to increase at a rate consistent with our Company's path to revenue growth as we expand our activities and operations with the objective of commercializing our electro-optic polymer technology. We currently have no debt to service.

We expect that our cash used in operations will continue to increase during 2023 and beyond as a result of the following planned activities:

- The addition of management, sales, marketing, technical and other staff to our workforce;
- Increased spending for the expansion of our research and development efforts, including purchases of additional laboratory and production equipment;
- Increased spending in marketing as our products are introduced into the marketplace;
- Partnering with commercial foundries to implement our electro-optic polymers into accepted PDKs by the foundries;
- Developing and maintaining collaborative relationships with strategic partners;
- Developing and improving our manufacturing processes and quality controls; and
- Increases in our general and administrative activities related to our operations as a reporting public company and related corporate compliance requirements.

2021 and 2023 Purchase Agreements - Lincoln Park

On October 4, 2021, our Company entered into the 2021 Purchase Agreement with Lincoln Park, pursuant to which Lincoln Park agreed to purchase from us up to $33 million of our common stock (subject to certain limitations) from time to time over a 36-month period. On February 28, 2023, our Company entered into the 2023 Purchase Agreement with Lincoln Park, pursuant to which Lincoln Park agreed to purchase from us up to $30 million of our common stock (subject to certain limitations) from time to time over a 36-month period. Pursuant to each of the 2021 Purchase Agreement, and the 2023 Purchase Agreement, Lincoln Park is obligated to make purchases as the Company directs in accordance with each of the applicable purchase agreements, which may be terminated by the Company at any time, without cost or penalty. Sales of shares will be made in specified amounts and at prices that are based upon the market prices of our common stock immediately preceding the sales to Lincoln Park. We expect this financing to provide us with sufficient funds to maintain our operations for the foreseeable future. With the additional capital, we expect to achieve a level of revenues attractive enough to fulfill our development activities and adequate enough to support our business model for the foreseeable future.

There are no trading volume requirements or restrictions under either of the 2021 Purchase Agreement or the 2023 Purchase Agreement, and we will control the timing and amount of any sales of our common stock to Lincoln Park. Lincoln Park has no right to require any sales by us, but is obligated to make purchases from us as we direct in accordance with each of the applicable purchase agreements. We can also accelerate the amount of common stock to be purchased under certain circumstances. There are no limitations on the use of proceeds, financial or business covenants, restrictions on future financings (other than restrictions on the Company's ability to enter into a similar type of agreement or equity line of credit during the term, excluding an at-the-market transaction with a registered broker-dealer), rights of first refusal, participation rights, penalties or liquidated damages in either of the purchase agreements.

Roth Sales Agreement – Roth Capital

On December 9, 2022, we entered into the Roth Sales Agreement with Roth Capital, as sales agent. Pursuant to the Roth Sales Agreement, our Company may offer and sell up to $35,000,000 in shares of our common stock, from time to time through Roth Capital. Upon delivery of a placement notice based on our Company's instructions and subject to the terms and conditions of the Roth Sales Agreement, Roth Capital may sell the shares by methods deemed to be an "at the market offering" as defined in Rule 415(a)(4) promulgated under the Securities Act, including sales made directly on or through The Nasdaq Capital Market, on any other existing trading market for the Company's common stock, in negotiated transactions at market prices prevailing at the time of sale or at prices related to such prevailing market prices, or by any other method permitted by law, including negotiated transactions, subject to the prior written consent of our Company. We are not obligated to make any sales of shares under the Roth Sales Agreement. The Company or Roth Capital may suspend or terminate the offering of shares upon notice to the other party, subject to certain conditions. Roth Capital will act as sales agent on a commercially reasonable efforts basis consistent with its normal trading and sales practices and applicable state and federal law, rules and regulations and the rules of Nasdaq. We have agreed to pay Roth Capital commissions for its services of acting as agent of 3.0% of the gross proceeds from the sale of the shares pursuant to the Roth Sales Agreement.

The amount of proceeds we receive from the Roth Sales Agreement, if any, will depend upon the number of shares of our common stock sold and the market price at which they are sold. There can be no assurance that we will be able to sell any shares under or fully utilize the Roth Sales Agreement. Roth Capital is not required to sell any specific number of shares of our common stock under the Roth Sales Agreement. We intend to use net proceeds from the Roth Sales Agreement for general corporate purposes, including, without limitation, sales and marketing activities, product development, making acquisitions of assets, businesses, companies or securities, capital expenditures, and for working capital needs.

We cannot assure you that we will meet the conditions of either of the purchase agreements with Lincoln Park in order to obligate Lincoln Park to purchase our shares of common stock, and we cannot assure you that we will be able to sell any shares under or fully utilize the Roth Sales Agreement. In the event we fail to do so, and other adequate funds are not available to satisfy long-term capital requirements, or if planned revenues are not generated, we may be required to substantially limit our operations. This limitation of operations may include reductions in capital expenditures and reductions in staff and discretionary costs.

Analysis of Cash Flows

For the year ended December 31, 2022

Net cash used in operating activities was $10,465,880 for the year ended December 31, 2022, primarily attributable to the net loss of $17,230,480 adjusted by $5,813,628 in options issued for services, $91,713 amortization of deferred compensation, $209,709 in common stock issued for services, $1,045,208 in depreciation expenses and patent amortization expenses, ($379,037) in prepaid expenses, ($135,661) in accounts payable, accrued bonuses and accrued expenses and $119,040 in cashless option exercise expense. Net cash used in operating activities consisted of payments for research and development, legal, professional and consulting expenses, rent and other expenditures necessary to develop our business infrastructure.

Net cash used by investing activities was $2,209,722 for the year ended December 31, 2022, consisting of $260,415 in cost for intangibles, $1,307,187 in asset additions for the Colorado headquarter facility and labs and $642,120 in a loan issuance.

Net cash provided by financing activities was $13,345,141 for the year ended December 31, 2022 and consisted of $653,895 in proceeds from exercise of options and warrants, $12,775,268 in proceeds from resale of common stock to an institutional investor offset by $84,022 in cashless option exercise tax payments.

On December 31, 2022, our cash and cash equivalents totaled $24,102,151, our assets totaled $29,263,472, our liabilities totaled $1,710,449 and we had stockholders' equity of $27,553,023.

For the year ended December 31, 2021

Net cash used in operating activities was $10,038,626 for the year ended December 31, 2021, primarily attributable to the net loss of $18,631,381 adjusted by $11,001 in warrants issued for services, $1,022,985 in options issued for services, $2,059,464 in common stock issued for services, $878,520 in depreciation expenses and patent amortization expenses, ($410,700) in Paycheck Protection Program loan forgiveness, $334,877 in prepaid expenses, $1,023,785 in accounts payable, accrued bonuses and accrued expenses and $3,672,823 in cashless option exercise expense. Net cash used in operating activities consisted of payments for research and development, legal, professional and consulting expenses, rent and other expenditures necessary to develop our business infrastructure.

Net cash used by investing activities was $1,116,179 for the year ended December 31, 2021, consisting of $18,649 in cost for intangibles and $1,097,530 in asset additions primarily for the Colorado headquarter facility and labs.

Net cash provided by financing activities was $31,280,827 for the year ended December 31, 2021 and consisted of $2,379,225 in proceeds from exercise of options and warrants, $30, 350,674 in proceeds from resale of common stock to an institutional investor offset by $1,435,965 in cashless option exercise tax payments and $13,107 repayment of equipment purchased.

On December 31, 2021, our cash and cash equivalents totaled $23,432,612, our assets totaled $27,228,575, our liabilities totaled $2,024,303 and we had stockholders' equity of $25,204,272.

For the year ended December 31, 2020

Net cash used in operating activities was $4,873,863 for the year ended December 31, 2020, primarily attributable to the net loss of $6,715,564 adjusted by $95,774 in warrants issued for services, $539,414 in options issued for services, $116,366 in common stock issued for services, $784,419 in depreciation expenses and patent amortization expenses, ($194,636) in prepaid expenses, $89,664 in accounts payable and accrued expenses and $410,700 in proceeds from Paycheck Protection Plan refundable advance. Net cash used in operating activities consisted of payments for research and development, legal, professional and consulting expenses, rent and other expenditures necessary to develop our business infrastructure.

Net cash used by investing activities was $217,984 for the year ended December 31, 2020, consisting of $59,923 in cost for intangibles and $158,061 in asset additions primarily for the new Colorado headquarter facility and labs.

Net cash provided by financing activities was $6,162,093 for the year ended December 31, 2020 and consisted of $1,658,442 in proceeds from exercise of warrants, $5,173,300 in proceeds from resale of common stock to an institutional investor offset by $669,649 repayment of equipment purchased.

On December 31, 2020, our cash and cash equivalents totaled $3,306,590, our assets totaled $7,366,778, our liabilities totaled $1,591,332 and we had stockholders' equity of $5,775,446.

Contractual Obligations

See "Note 7–Commitments" of the notes to the financial statements contained elsewhere within this Annual Report on Form 10-K for a discussion of our operating lease for office and laboratory space.

Item 7A. Quantitative and Qualitative Disclosures About Market Risk

At December 31, 2022, we had $24,102,151 million in cash and cash equivalents. For the purposes of this Item 7A. we consider all highly liquid instruments with maturities of three months or less at the time of purchase to be cash equivalents. The fair value of all of our cash equivalents is determined based on "Level 1" inputs, which are based upon quoted prices for identical or similar instruments in markets that are active. We do not use any market risk sensitive instruments to hedge any risks, and we hold no market risk sensitive instruments for trading or speculative purposes. We place our cash investments in instruments that meet credit quality standards. At December 31, 2022, we had deposits with a financial institution that exceeded the Federal Depository Insurance coverage.

Market Interest Rate Risk

We are exposed to market risk related to changes in interest rates. Our primary exposure to market risk is interest rate sensitivity, which is affected by changes in the general level of U.S. interest rates. If a 10% change in interest rates had occurred on December 31, 2022, this change would not have had a material effect on the fair value of our investment portfolio as of that date.

Due to the short holding period of our investments and the nature of our investments, we have concluded that we do not have a material financial market risk exposure.

Item 8. Financial Statements and Supplementary Data

Our Financial Statements of are attached as Appendix A (following Exhibits) and included as part of this Form 10-K Report. A list of our Financial Statements is provided in response to Item 15 of this Form 10-K Report.

Item 9. Changes In And Disagreements With Accountants On Accounting and Financial Disclosure

None.

Item 9A. Controls and Procedures.

Evaluation of Disclosure Controls and Procedures

As of December 31, 2022, our Company evaluated the effectiveness and design and operation of its disclosure controls and procedures. Our Company's disclosure controls and procedures are the controls and other procedures that we designed to ensure that our Company records, processes, summarizes, and reports in a timely manner the information that it must disclose in reports that our Company files with or submits to the Securities and Exchange Commission. Our principal executive officer and principal financial officer reviewed and participated in this evaluation. Based on this evaluation, our Company made the determination that its disclosure controls and procedures were effective.

Management's Annual Report on Internal Control Over Financial Reporting

Our management is responsible for establishing and maintaining adequate internal control over financial reporting, as such term is defined in Exchange Act Rules 13a-15(f) and 15d-15(f). Under the supervision and with the participation of management, including our principal executive officer and principal financial officer, we conducted an evaluation of the effectiveness of our internal controls over financial reporting based on the framework in Internal Control-Integrated Framework issued by the Committee of Sponsoring Organizations of the Treadway Commission ("COSO"). Based on this evaluation, management has concluded that our internal control over financial reporting was effective as of December 31, 2022.

The Company's internal control over financial reporting includes policies and procedures that (1) pertain to maintenance of records that, in reasonable detail, accurately and fairly reflect transactions and dispositions of the assets of the Company; (2) provide reasonable assurance that transactions are recorded as necessary to permit preparation of financial statements in accordance with generally accepted accounting principles, and that receipts and expenditures of the Company are being made only in accordance with authorizations of management and directors of the Company; and (3) provide reasonable assurance regarding prevention or timely detection of unauthorized acquisition, use, or disposition of the Company's assets that could have a material effect on the financial statements.

Our management, including our principal executive officer and principal financial officer, does not expect that our disclosure controls or our internal control over financial reporting will prevent or detect all errors and all fraud. A control system, no matter how well designed and operated, can provide only reasonable, not absolute, assurance that the control system's objectives will be met. Internal control over financial reporting is a process that involves human diligence and compliance and is subject to lapses in judgment and breakdowns resulting from human failures. In addition, the design of any system of controls is based in part on certain assumptions about the likelihood of future events, and controls may become inadequate if conditions change. There can be no assurance that any design will succeed in achieving its stated goals under all potential future conditions.

Audit Report on Internal Controls Over Financial Reporting of the Registered Public Accounting Firm

Morison Cogen LLP, the Company's independent registered public accounting firm has audited the financial statements included in this Annual Report on Form 10-K and, as part of their audit, has issued their report, included herein, on the effectiveness of the Company's internal control over financial reporting as of December 31, 2022.

Changes in Internal Control Over Financial Reporting

No change in our Company's internal control over financial reporting occurred during our fourth fiscal quarter that has materially affected, or is reasonably likely to materially affect, our internal control over financial reporting.

Item 9B. Other Information

None.

Item 9C. Disclosure Regarding Foreign Jurisdictions that Prevent Inspections.

None.

PART III

Item 10. Directors, Executive Officers and Corporate Governance

Information required under this Item will be contained in our definitive proxy statement, which will be filed within 120 days of December 31, 2022, our most recent fiscal year end, and is incorporated herein by reference.

Item 11. Executive Compensation.

Information required under this Item will be contained in our definitive proxy statement, which will be filed within 120 days of December 31, 2022, our most recent fiscal year end, and is incorporated herein by reference.

Item 12. Security Ownership of Certain Beneficial Owners and Management and Related Stockholder Matters.

Information required under this Item will be contained in our definitive proxy statement, which will be filed within 120 days of December 31, 2022, our most recent fiscal year end, and is incorporated herein by reference.

Item 13. Certain Relationships and Related Transactions, and Director Independence.

Information required under this Item will be contained in our definitive proxy statement, which will be filed within 120 days of December 31, 2022, our most recent fiscal year end, and is incorporated herein by reference.

Item 14. Principal Accountant Fees and Services.

Information required under this Item will be contained in our definitive proxy statement, which will be filed within 120 days of December 31, 2022, our most recent fiscal year end, and is incorporated herein by reference.

PART IV

Item 15. Exhibits, Financial Statement Schedules

(a) The following Audited Financial Statements are filed as part of this Form 10-K Report:

Report of Independent Registered Public Accounting Firm
Balance Sheets
Statements of Comprehensive Loss
Statement of Stockholders' Equity
Statements of Cash Flows
Notes to Financial Statements

(b) The following exhibits are filed as part of this report.

Exhibit No.	Description of Exhibit	Location
3.1	Articles of Incorporation	Incorporated by reference to Company's Form 10-SB as filed with the SEC on April 13, 2007
3.2	Certificate of Amendment to Articles of Incorporation	Incorporated by reference to Company's Definitive Schedule 14C Information Statement as filed with the SEC on February 19, 2008
3.3	Certificate of Amendment to Articles of Incorporation	Incorporated by reference to Company's Form S-1 Registration Statement as filed with the SEC on August 3, 2015
3.4	Restated Bylaws	Incorporated by reference to the Company's Form 10-K as filed with the SEC on March 16, 2018
4.1	Description of Registrant's Securities	Filed herewith
10.1	Employee Agreement – Michael Lebby	Incorporated by reference to the Company's Current Report on Form 8-K as filed with the SEC on March 22, 2017
10.2	Employee Agreement Amendment - Michael Lebby	Incorporated by reference to the Company's Current Report on Form 8-K as filed with the SEC on April 20, 2021
10.3	Employee Agreement Amendment - Michael Lebby	Incorporated by reference to the Company's Current Report on Form 8-K as filed with the SEC on January 21, 2022
10.4	Employee Agreement - James Marcelli	Incorporated by reference to Company's Form 10-Q as filed with the SEC on August 12, 2015
10.5	Employee Agreement Amendment - James Marcelli	Incorporated by reference to the Company's Current Report on Form 8-K as filed with the SEC on April 20, 2021
10.6	Employee Agreement Amendment - James Marcelli	Incorporated by reference to the Company's Current Report on Form 8-K as filed with the SEC on January 21, 2022
10.7	Form of Executive Paid Time Off Waiver Agreement	Incorporated by reference to the Company's Form 10-K as filed with the SEC on March 16, 2018
10.8	Form of Director Agreement	Incorporated by reference to the Company's Form 10-K as filed with the SEC on March 16, 2018
10.9	Form of Director and Officer Indemnification Agreement	Incorporated by reference to the Company's Current Report on Form 8-K as filed with the SEC on January 21, 2022
10.10	Form of Director's Non-Disclosure Agreement	Incorporated by reference to the Company's Form 10-K as filed with the SEC on March 16, 2018
10.11	Operations Committee Charter	Incorporated by reference to the Company's Form 10-Q as filed with the SEC on August 15, 2016
10.12	Statement of Operations Committee Work - Frederick J. Leonberger	Incorporated by reference to the Company's Current Report on Form 8-K as filed with the SEC on April 3, 2017
10.13	Statement of Operations Committee Work - Siraj Nour El-Ahmadi	Incorporated by reference to the Company's Form 10-K as filed with the SEC on March 31, 2021

10.14	2007 Employee Stock Plan	Incorporated by reference to Company's Definitive Schedule 14C Information Statement as filed with the SEC on February 19, 2008
10.15	2007 Employee Stock Plan Amendment	Incorporated by reference to Company's Definitive Schedule 14A Proxy Statement as filed with the SEC on July 22, 2014
10.16	2016 Equity Incentive Plan	Incorporated by reference to Appendix A to the Company's Definitive Schedule 14A filed with the SEC on April 20, 2016
10.17	2016 Equity Incentive Plan Amendment	Incorporated by reference to Appendix A to the Company's Definitive Schedule 14A filed with the SEC on April 12, 2019
10.18	Form of Non-qualified Stock Option Award Agreement - Employees	Incorporated by reference to the Company's Annual Report on Form 10-K as filed with the SEC on March 17, 2017
10.19	Form of Non-qualified Stock Option Award Agreement - Executive Officers	Incorporated by reference to the Company's Annual Report on Form 10-K as filed with the SEC on March 17, 2017
10.20	Form of Non-qualified Stock Option Award Agreement - Non Employee Directors	Incorporated by reference to the Company's Annual Report on Form 10-K as filed with the SEC on March 17, 2017
10.21	Form of Restricted Stock Award Agreement -Non Employee Directors	Incorporated by reference to the Company's Annual Report on Form 10-K as filed with the SEC on March 1, 2022
10.22	Lease Agreement dated October 26, 2017	Incorporated by reference to the Company's Current Report on Form 8-K as filed with the SEC on November 2, 2017
10.23	First Amendment to the October 26, 2017 Lease Agreement dated November 22, 2022	Filed herewith
10.24	Purchase Agreement, dated October 4, 2021, by and between the Company and Lincoln Park	Incorporated by reference to the Company's Current Report on Form 8-K as filed with the SEC on October 5, 2021
10.25	Registration Rights Agreement, dated October 4, 2021, by and between the Company and Lincoln Park	Incorporated by reference to the Company's Current Report on Form 8-K as filed with the SEC on October 5, 2021
10.26	Purchase Agreement, dated February 28, 2023, by and between the Company and Lincoln Park	Filed herewith
10.27	Registration Rights Agreement, dated February 28, 2023, by and between the Company and Lincoln Park	Filed herewith
14.1	Code of Ethics and Business Conduct	Incorporated by reference to the Company's Form 10-K as filed with the SEC on March 16, 2018
21.1	Subsidiaries of the Registrant	Filed herewith

23.1	Consent of Independent Registered Public Accounting Firm - Morison Cogen LLP	Filed herewith
31.1	Certification pursuant to Rule 13a-14(a) of the Securities Exchange Act of 1934, as amended, executed by the Principal Executive Officer of the Company.	Filed herewith
31.2	Certification pursuant to Rule 13a-14(a) of the Securities Exchange Act of 1934, as amended, executed by the Principal Financial Officer of the Company.	Filed herewith
32.1	Certification pursuant to 18 U.S.C. Section 1350, as adopted pursuant to Section 906 of the Sarbanes-Oxley Act of 2002, executed by the Principal Executive Officer of the Company.	Filed herewith
32.2	Certification pursuant to 18 U.S.C. Section 1350, as adopted pursuant to Section 906 of the Sarbanes-Oxley Act of 2002, executed by the Principal Financial Officer of the Company.	Filed herewith
101.INS	Inline XBRL Instance Document (the instance document does not appear in the Interactive Data File because its XBRL tags are embedded within the Inline XBRL document)	
101.SCH	Inline XBRL Taxonomy Extension Schema Document	
101.CAL	Inline XBRL Taxonomy Extension Calculation Linkbase Document	

101.DEF	Inline XBRL Taxonomy Extension Definition Linkbase Document	
101.LAB	Inline XBRL Taxonomy Extension Label Linkbase Document	
101.PRE	Inline XBRL Taxonomy Extension Presentation Linkbase Document	
104	Cover Page Interactive Data File (formatted as Inline XBRL and contained in Exhibit 101)	

Item 16. Form 10-K Summary

None

SIGNATURES

Pursuant to the requirements of Section 13 or 15(d) of the Securities Exchange Act of 1934, the registrant has duly caused this report to be signed on its behalf by the undersigned, thereunto duly authorized.

LIGHTWAVE LOGIC, INC.
Registrant

By: /s/ Michael Lebby
Michael Lebby,
Chief Executive Officer
(Principal Executive Officer)

Date: March 1, 2023

Pursuant to the requirements of the Securities Exchange Act of 1934, this report has been signed below by the following persons on behalf of the registrant and in the capacities and on the dates indicated.

Signature	Title	Date
/s/ Michael Lebby Michael Lebby	Chief Executive Officer, Principal Executive Officer, Chair of the Board of Directors	March 1, 2023
/s/ James S. Marcelli James S. Marcelli	President, Chief Operating Officer, Principal Financial Officer, Secretary, Director	March 1, 2023
/s/ Ronald A. Bucchi Ronald A. Bucchi	Director	March 1, 2023
/s/ Siraj Nour El-Ahmadi Siraj Nour El-Ahmadi	Director	March 1, 2023
/s/ Frederick J. Leonberger Frederick J. Leonberger	Director	March 1, 2023
/s/ Craig Ciesla Craig Ciesla	Director	March 1, 2023

LIGHTWAVE LOGIC, INC.

FINANCIAL STATEMENTS

DECEMBER 31, 2022, 2021 AND 2020

CONTENTS

REPORT OF INDEPENDENT REGISTERED PUBLIC ACCOUNTING FIRM

To the Board of Directors and
Stockholders of Lightwave Logic, Inc.

Opinions on the Financial Statements and Internal Control over Financial Reporting

We have audited the accompanying balance sheets of Lightwave Logic, Inc. (the Company) as of December 31, 2022 and 2021, and the related statements of comprehensive loss, stockholders' equity, and cash flows for each of the three years in the period ended December 31, 2022, and the related notes (collectively referred to as the financial statements). We also have audited the Company's internal control over financial reporting as of December 31, 2022, based on criteria established in *Internal Control – Integrated Framework (2013)* issued by the Committee of Sponsoring Organizations of the Treadway Commission (COSO).

In our opinion, the financial statements referred to above present fairly, in all material respects, the financial position of the Company as of December 31, 2022 and 2021, and the results of its operations and its cash flows for each of the three years in the period ended December 31, 2022, in conformity with accounting principles generally accepted in the United States of America. Also, in our opinion, the Company maintained, in all material respects, effective internal control over financial reporting as of December 31, 2022, based on criteria established in *Internal Control – Integrated Framework (2013)* issued by COSO.

Basis for Opinion

The Company's management is responsible for these financial statements, for maintaining effective internal control over financial reporting, and for its assessment of the effectiveness of internal control over financial reporting included in the accompanying Management's Report on Internal Control over Financial Reporting. Our responsibility is to express an opinion on the Company's financial statements and an opinion on the Company's internal control over financial reporting based on our audits. We are a public accounting firm registered with the Public Company Accounting Oversight Board (United States) (PCAOB) and are required to be independent with respect to the Company in accordance with the U.S. federal securities laws and the applicable rules and regulations of the Securities and Exchange Commission and the PCAOB.

We conducted our audits in accordance with the standards of the PCAOB. Those standards require that we plan and perform the audits to obtain reasonable assurance about whether the financial statements are free of material misstatement, whether due to error or fraud, and whether effective internal control over financial reporting was maintained in all material respects.

Our audits of the financial statements included performing procedures to assess the risks of material misstatement of the financial statements, whether due to error or fraud, and performing procedures that respond to those risks. Such procedures included examining, on a test basis, evidence regarding the amounts and disclosures in the financial statements. Our audits also included evaluating the accounting principles used and significant estimates made by management, as well as evaluating the overall presentation of the financial statements. Our audit of internal control over financial reporting included obtaining an understanding of internal control over financial reporting, assessing the risk that a material weakness exists, and testing and evaluating the design and operating effectiveness of internal control based on the assessed risk. Our audits also included performing such other procedures as we considered necessary in the circumstances. We believe that our audits provide a reasonable basis for our opinions.

Definition and Limitations of Internal Control over Financial Reporting

A company's internal control over financial reporting is a process designed to provide reasonable assurance regarding the reliability of financial reporting and the preparation of financial statements for external purposes in accordance with generally accepted accounting principles. A company's internal control over financial reporting includes those policies and procedures that (1) pertain to the maintenance of records that, in reasonable detail, accurately and fairly reflect the transactions and dispositions of the assets of the company; (2) provide reasonable assurance that transactions are recorded as necessary to permit preparation of financial statements in accordance with generally accepted accounting principles, and that receipts and expenditures of the company are being made only in accordance with authorizations of management and directors of the company; and (3) provide reasonable assurance regarding prevention or timely detection of unauthorized acquisition, use, or disposition of the company's assets that could have a material effect on the financial statements.

Because of its inherent limitations, internal control over financial reporting may not prevent or detect misstatements. Also, projections of any evaluation of effectiveness to future periods are subject to the risk that controls may become inadequate because of changes in conditions, or that the degree of compliance with the policies or procedures may deteriorate.

Critical Audit Matters

Critical audit matters are matters arising from the current period audit of the financial statements that were communicated or required to be communicated to the audit committee and that: (1) relate to accounts or disclosures that are material to the financial statements and (2) involved our especially challenging, subjective, or complex judgments. We determined that there are no critical audit matters.

/s/ Morison Cogen LLP

We have served as the Company's auditor since 2005.
PCAOB ID Number 00536

Blue Bell, Pennsylvania
March 1, 2023

LIGHTWAVE LOGIC, INC.
BALANCE SHEETS

		December 31, 2022		December 31, 2021
ASSETS				
CURRENT ASSETS				
Cash and cash equivalents	$	24,102,151	$	23,432,612
Prepaid expenses and other current assets		611,345		232,308
Loan receivable		642,120		—
		25,355,616		23,664,920
PROPERTY AND EQUIPMENT - NET		2,519,267		2,179,075
OTHER ASSETS				
Intangible assets - net		1,030,335		848,133
Operating Lease - Right of Use - Building		358,254		536,447
		1,388,589		1,384,580
TOTAL ASSETS	$	29,263,472	$	27,228,575
LIABILITIES AND STOCKHOLDERS' EQUITY				
CURRENT LIABILITIES				
Accounts payable	$	791,671	$	215,734
Accrued bonuses and accrued expenses		380,280		1,118,080
Accounts payable and accrued expenses - related parties		100,169		32,189
Deferred lease liability		41,778		41,778
Operating lease liability		190,125		178,192
		1,504,023		1,585,973
LONG TERM LIABILITIES				
Deferred lease liability		38,297		80,075
Operating lease liability		168,129		358,255
		206,426		438,330
TOTAL LIABILITIES		1,710,449		2,024,303
STOCKHOLDERS' EQUITY				
Preferred stock, $0.001 par value, 1,000,000 authorized, no shares issued or outstanding		—		—
Common stock $0.001 par value, 250,000,000 authorized, 112,882,793 and 110,555,459 issued and outstanding at December 31, 2022 and December 31, 2021		112,883		110,556
Additional paid-in-capital		134,406,825		114,696,597
Deferred compensation		(133,324)		—
Accumulated deficit		(106,833,361)		(89,602,881)
TOTAL STOCKHOLDERS' EQUITY		27,553,023		25,204,272
TOTAL LIABILITIES AND STOCKHOLDERS' EQUITY	$	29,263,472	$	27,228,575

The accompanying notes are an integral part of these financial statements.

LIGHTWAVE LOGIC, INC.
STATEMENTS OF COMPREHENSIVE LOSS
FOR THE YEARS ENDING DECEMBER 31, 2022, 2021 AND 2020

	For the Year Ending December 31, 2022	For the Year Ending December 31, 2021	For the Year Ending December 31, 2020
NET SALES	$ —	$ —	$ —
COST AND EXPENSE			
Research and development	12,805,374	12,476,040	4,590,545
General and administrative	4,334,290	4,520,403	2,009,429
	17,139,664	16,996,443	6,599,974
LOSS FROM OPERATIONS	(17,139,664)	(16,996,443)	(6,599,974)
OTHER INCOME (EXPENSE)			
Paycheck Protection Program loan forgiveness	—	410,700	—
Interest income	91,659	13,826	776
Commitment fee	(209,709)	(2,059,464)	(116,366)
Other Income	27,234	—	—
NET LOSS	$ (17,230,480)	$ (18,631,381)	$ (6,715,564)
LOSS PER SHARE			
Basic	$ (0.15)	$ (0.18)	$ (0.07)
Diluted	$ (0.15)	$ (0.18)	$ (0.07)
WEIGHTED AVERAGE NUMBER OF SHARES			
Basic	111,814,926	105,223,959	91,859,025
Diluted	111,814,926	105,223,959	91,859,025

The accompanying notes are an integral part of these financial statements.

LIGHTWAVE LOGIC, INC.
STATEMENT OF STOCKHOLDERS' EQUITY
FOR THE YEARS ENDING DECEMBER 31, 2022, 2021 AND 2020

	Number of Shares	Common Stock	Additional Paid-in Capital	Deferred Compensation	Accumulated Deficit	Total
BALANCE AT DECEMBER 31, 2021	110,555,459	$ 110,556	$ 114,696,597	$ —	$ (89,602,881)	$ 25,204,272
Common stock issued to institutional investor	1,625,000	1,625	12,773,643	—	—	12,775,268
Common stock issued for commitment shares	23,468	22	209,687	—	—	209,709
Exercise of options	302,950	303	257,592	—	—	257,895
Cashless exercise of 4,375 options	2,596	3	35,015	—	—	35,018
Exercise of warrants	350,000	350	395,650	—	—	396,000
Options issued for services	—	—	5,813,628	—	—	5,813,628
Restricted stock awards issued for future services	28,500	29	274,995	(275,024)	—	—
Forfeiture restricted stock awards issued for future services	(5,180)	(5)	(49,982)	49,987	—	—
Deferred compensation	—	—	—	91,713	—	91,713
Net loss for the year ending December 31, 2022	—	—	—		(17,230,480)	(17,230,480)
BALANCE AT DECEMBER 31, 2022	112,882,793	$ 112,883	$ 134,406,825	$ (133,324)	$ (106,833,361)	$ 27,553,023

	Number of Shares	Common Stock	Additional Paid-in Capital	Deferred Compensation	Accumulated Deficit	Total
BALANCE AT DECEMBER 31, 2020	97,775,789	$ 97,776	$ 76,649,170	$ —	$ (70,971,500)	$ 5,775,446
Common stock issued to institutional investor	9,290,011	9,291	30,341,383	—	—	30,350,674
Common stock issued for commitment shares	514,536	514	2,058,950	—	—	2,059,464
Exercise of options	2,046,250	2,046	1,948,829	—	—	1,950,875
Cashless exercise of 445,252 options	251,873	252	2,236,606	—	—	2,236,858
Exercise of warrants	677,000	677	427,673	—	—	428,350
Options issued for services	—	—	1,022,985	—	—	1,022,985
Warrants issued for services	—	—	11,001	—	—	11,001
Net loss for the year ending December						

31, 2021	—	—	—	—	(18,631,381)	(18,631,381)
BALANCE AT DECEMBER 31, 2021	110,555,459	$ 110,556	$ 114,696,597	$ —	$ (89,602,881)	$ 25,204,272

	Number of Shares	Common Stock	Additional Paid-in Capital	Deferred Compensation	Accumulated Deficit	Total
BALANCE AT DECEMBER 31, 2019	87,409,600	$ 87,410	$ 69,076,240	$ —	$ (64,255,936)	$ 4,907,714
Common stock issued to institutional investor	8,125,000	8,125	5,165,175	—	—	5,173,300
Common stock issued for commitment shares	168,137	168	116,198	—	—	116,366
Exercise of warrants	2,073,052	2,073	1,656,369	—	—	1,658,442
Options issued for services	—	—	539,414	—	—	539,414
Warrants issued for services	—	—	95,774	—	—	95,774
Net loss for the year ending December 31, 2020	—	—	—	—	(6,715,564)	(6,715,564)
BALANCE AT DECEMBER 31, 2020	97,775,789	$ 97,776	$ 76,649,170	$ —	$ (70,971,500)	$ 5,775,446

The accompanying notes are an integral part of these financial statements.

LIGHTWAVE LOGIC, INC.
STATEMENTS OF CASH FLOWS
FOR THE YEARS ENDING DECEMBER 31, 2022, 2021 AND 2020

	For the Year Ending December 31, 2022	For the Year Ending December 31, 2021	For the Year Ending December 31, 2020
CASH FLOWS FROM OPERATING ACTIVITIES			
Net loss	$ (17,230,480)	$ (18,631,381)	$ (6,715,564)
Adjustments to reconcile net loss to net cash used in operating activities			
Warrants issued for services	—	11,001	95,774
Stock options issued for services	5,813,628	1,022,985	539,414
Amortization of deferred compensation	91,713	—	—
Cashless option exercise	119,040	3,672,823	—
Common stock issued for services and fees	209,709	2,059,464	116,366
Depreciation and amortization of patents	1,045,208	878,520	784,419
Paycheck Protection Program loan forgiveness	—	(410,700)	—
Decrease (increase) in assets			
Prepaid expenses and other current assets	(379,037)	334,877	(194,636)
Increase (decrease) in liabilities			
Accounts payable	575,937	46,487	80,824
Accrued bonuses and accrued expenses	(737,800)	1,036,684	15,627
Accounts payable and accrued expenses-related parties	67,980	(17,608)	34,992
Deferred lease liability	(41,778)	(41,778)	(41,779)
Paycheck Protection Program advance	—	—	410,700
Net cash used in operating activities	(10,465,880)	(10,038,626)	(4,873,863)
CASH FLOWS FROM INVESTING ACTIVITIES			
Cost of intangibles	(260,415)	(18,649)	(59,923)
Purchase of property and equipment	(1,307,187)	(1,097,530)	(158,061)
Issuance of loan	(642,120)	—	—
Net cash used in investing activities	(2,209,722)	(1,116,179)	(217,984)
CASH FLOWS FROM FINANCING ACTIVITIES			
Exercise of options and warrants	653,895	2,379,225	1,658,442
Cashless option exercise tax payments	(84,022)	(1,435,965)	—
Issuance of common stock, institutional investor	12,775,268	30,350,674	5,173,300
Repayment of equipment purchase payable	—	(13,107)	(669,649)
Net cash provided by financing activities	13,345,141	31,280,827	6,162,093
NET INCREASE IN CASH AND CASH EQUIVALENTS	669,539	20,126,022	1,070,246
CASH AND CASH EQUIVALENTS - BEGINNING OF YEAR	23,432,612	3,306,590	2,236,344
CASH AND CASH EQUIVALENTS - END OF YEAR	$ 24,102,151	$ 23,432,612	$ 3,306,590

The accompanying notes are an integral part of these financial statements.

NOTE 1 – SUMMARY OF SIGNIFICANT ACCOUNTING POLICIES

History and Nature of Business
Lightwave Logic, Inc. is a technology company focused on the development of next generation photonic devices and non-linear optical polymer materials systems for applications in high speed fiber-optic data communications and optical computing markets. Currently the Company is in various stages of photonic device and materials development and evaluation with potential customers and strategic partners. The Company expects to obtain a revenue stream from technology licensing agreements, technology transfer agreements and the production and direct sale of its own electro-optic device components.

The Company's current development activities are subject to significant risks and uncertainties, including failing to secure additional funding to operationalize the Company's technology now under development.

Lightwave Logic, Inc. (the "Company") was organized under the laws of the State of Nevada in 1997, and the Company commenced with its current business plan in 2004.

Basis of Presentation
The accompanying financial statements are presented in accordance with accounting principles generally accepted in the United States of America.

Estimates
The preparation of financial statements in conformity with accounting principles generally accepted in the United States requires management to make estimates and assumptions that affect the amounts reported in the financial statements and accompanying disclosures. Although these estimates are based on management's best knowledge of current events and actions the Company may undertake in the future, actual results could differ from the estimates.

Cash Equivalents
For the purposes of the statement of cash flows, the Company considers all highly liquid instruments with maturities of three months or less at the time of purchase to be cash equivalents.

Concentration of Credit Risk
Certain financial instruments potentially subject the Company to concentrations of credit risk. These financial instruments consist primarily of cash. At December 31, 2022, the Company did have deposits with a financial institution that exceed the Federal Depository Insurance coverage.

Property and Equipment
Equipment is stated at cost. Depreciation is principally provided by use of straight-line methods for financial and tax reporting purposes over the estimated useful lives of the assets, generally 5 years. When property is retired or otherwise disposed of, the cost and accumulated depreciation are removed from the accounts and any resulting gain or loss is included in operations.

NOTE 1 – SUMMARY OF SIGNIFICANT ACCOUNTING POLICIES (CONTINUED)

Intangible Assets
Definite-lived intangible assets are stated at cost. Patents are amortized over their estimated useful lives, commencing from the date of grant for the remaining legal lives of the patents. The patents generally have a term of up to 20 years from the date of filing of the earliest related patent application. When certain patent applications are abandoned by the Company for claims that are covered by patents already granted to the Company, the cost of patent applications are removed from the accounts and the resulting expense is reflected in the statement of comprehensive loss.

Fair Value of Financial Instruments
The carrying value of the Company's short-term financial instruments such as cash, accounts payable and accrued expenses approximate their fair values because of their short maturities.

Revenue Recognition
In accordance with FASB ASC 606, *Revenue from Contracts with Customers*, the Company will recognize revenue upon transfer of promised goods or services in an amount that reflects the consideration expected to be received in exchange for those goods or services. To determine revenue recognition for arrangements within the scope of FASB ASC 606, the Company performs the following five steps:

1. Identify the contract with the customer.
2. Identify the performance obligations in the contract.
3. Determine the transaction price.
4. Allocate the transaction price to the performance obligations in the contract.
5. Recognize revenue as (or when) the performance obligations are satisfied.

For product sales, revenue will be recognized at a point in time when the product is shipped or is delivered to the customer's location. For services performed, revenue will be recognized at a point in time when the service is performed. However, for certain contracts, revenue will be recognized over time as the customer simultaneously receives and consumes the benefits of performance as the Company performs the service. For license agreements, each contract will be reviewed to determine the portion of the revenue recognition at the point in time that the license is transferred to the customer and the portion of the revenue recognition to be recognized over time.

Income Taxes
The Company follows Financial Accounting Standards Board ("FASB") Accounting Standards Codification ("ASC") 740, "Income Taxes," which requires an asset and liability approach to financial accounting and reporting for income taxes. Deferred income tax assets and liabilities are computed annually for temporary differences between the financial statement and tax bases of assets and liabilities that will result in taxable or deductible amounts in the future based on enacted tax laws and rates applicable to the periods in which the differences are expected to affect taxable income. Valuation allowances are established when necessary to reduce deferred tax assets to the amount expected to be realized. Income tax expense is the tax payable or refundable for the period plus or minus the change during the period in deferred tax assets and liabilities.

NOTE 1 – SUMMARY OF SIGNIFICANT ACCOUNTING POLICIES (CONTINUED)

Stock-based Payments
The Company accounts for stock-based compensation under the provisions of Financial Accounting Standards Board (FASB) Accounting Standards Codification (ASC) 718, "Compensation - Stock Compensation", which requires the measurement and recognition of compensation expense for all stock-based awards made to employees and directors based on estimated fair values on the grant date. The fair value of restricted stock awards is estimated by the market price of the Company's common stock at the date of grant. Restricted stock awards are being amortized to expense over the vesting period. The Company estimates the fair value of option and warrant awards on the date of grant using the Black-Scholes model. The value of the portion of the award that is ultimately expected to vest is recognized as expense over the requisite service periods using the straight-line method. In June 2018, the FASB issued ASU No. 2018-07, *Compensation – Stock*

Compensation (Topic 718), Improvements to Nonemployee Share-Based Payment Accounting (the "2018 Update). The amendments in the 2018 Update expand the scope of Topic 718 to include share-based payment transactions for acquiring goods and services from nonemployees. Prior to the 2018 Update, Topic 718 applied only to share- based transactions to employees. Consistent with the accounting requirement for employee share-based payment awards, nonemployee share-based payment awards within the scope of Topic 718 are measured at grant-date fair value of the equity instruments that an entity is obligated to issue when the good has been delivered or the service has been rendered and any other conditions necessary to earn the right to benefit from the instruments have been satisfied.

The Company has elected to account for forfeiture of stock-based awards as they occur.

Loss Per Share

The Company follows FASB ASC 260, "Earnings per Share", resulting in the presentation of basic and diluted earnings per share. Because the Company reported a net loss in 2022, 2021 and 2020, common stock equivalents, including stock options and warrants were anti-dilutive; therefore, the amounts reported for basic and dilutive loss per share were the same.

Recoverability of Long-Lived Assets

The Company follows FASB ASC 360, "Property, Plant, and Equipment". Long-lived assets to be held and used are reviewed for impairment whenever events or changes in circumstances indicate that the related carrying amount may not be recoverable. When required, impairment losses on assets to be held and used are recognized based on the excess of the asset's carrying amount.

Comprehensive Income (Loss)

The Company follows FASB ASC 220.10, "Reporting Comprehensive Income (Loss)." Comprehensive income (loss) is a more inclusive financial reporting methodology that includes disclosure of certain financial information that historically has not been recognized in the calculation of net income (loss). Since the Company has no items of other comprehensive income (loss), comprehensive income (loss) is equal to net income (loss).

Recently Adopted Accounting Pronouncements

As of December 31, 2022 and for the period then ended, there are no recently adopted accounting standards that have a material effect on the Company's financial statements.

Recently Issued Accounting Pronouncements Not Yet Adopted

As of December 31, 2022, there are no recently issued accounting standards not yet adopted which would have a material effect on the Company's financial statements.

NOTE 2 – MANAGEMENT'S PLANS

Our future expenditures and capital requirements will depend on numerous factors, including: the progress of our research and development efforts; the rate at which we can, directly or through arrangements with original equipment manufacturers, introduce and sell products incorporating our polymer materials technology; the costs of filing, prosecuting, defending and enforcing any patent claims and other intellectual property rights; market acceptance of our products and competing technological developments; and our ability to establish cooperative development, joint venture and licensing arrangements. We expect that we will incur approximately $1,604,000 of expenditures per month over the next 12 months. Our current cash position enables us to finance our operations through April 2024. On July 2, 2021, the Company filed a $100,000,000 universal shelf registration statement with the U.S. Securities and Exchange Commission which became effective on July 9, 2021. On October 4, 2021, the Company entered into a purchase agreement with the institutional investor to sell up to $33,000,000 of common stock over a 36-month period (described in Note 10). Pursuant to the purchase agreement, the Company received $1,720,750 in January and February 2023 and a remaining available amount of $2,126,557 is available to the Company per the agreement. On December 9, 2022, the Company entered into a sales agreement with an investment banking company whereby the Company may offer and sell shares of its common stock having an aggregate offering price of up to $35,000,000 from time to time through or to the investment banking company, as sales agent or principal (described in Note 10). Our cash requirements are expected to increase at a rate consistent with the Company's path to revenue as we expand our activities and operations with the objective of commercializing our electro-optic polymer technology. We currently have no debt to service.

NOTE 3 – PREPAID EXPENSES AND OTHER CURRENT ASSETS

Prepaid expenses and other current assets consist of the following:

	December 31, 2022	December 31, 2021
Insurance	$ 218,767	$ 123,877
License	94,195	38,865
Legal	83,941	—
Deposit for equipment	59,850	—
Other	45,675	33,041
Prototype devices	40,473	—
Rent	36,525	36,525
Investor relations	18,250	—
Loan interest receivable	13,669	—
	$ 611,345	$ 232,308

NOTE 4 – LOAN RECEIVABLE

On September 7, 2022, the Company entered into a convertible loan agreement (the "Loan") with an entity and issued a loan on September 12, 2022 in the amount of EUR 600,000 bearing interest at 7% per annum with a maturity date of March 31, 2023. The Company recorded $13,375 of interest income for the year ended December 31, 2022. The exchange rates used for the conversion of the EUR denominated loan are the December 31, 2022 reporting period end date exchange rate for the loan principal resulting in a balance of $642,120 and interest receivable resulting in a balance of $13,669 and the average exchange rate for the period ending December 31, 2022 for interest income.

NOTE 5 – PROPERTY AND EQUIPMENT

Property and equipment consist of the following:

	December 31, 2022	December 31, 2021
Office equipment	$ 119,404	$ 95,516
Lab equipment	6,234,777	4,952,933

Furniture		33,128		33,128
Leasehold improvements		184,843		254,350
		6,572,152		5,335,927
Less: Accumulated depreciation		4,052,885		3,156,852
	$	2,519,267	$	2,179,075

Depreciation expense for the years ending December 31, 2022, 2021 and 2020 was $966,995, $792,004 and $701,015. During the year ending December 31, 2022, the Company retired $70,963 of leasehold improvements. During the years ended December 31, 2021 and 2020, the Company did not sell or retire property and equipment.

NOTE 6 – INTANGIBLE ASSETS

This represents legal fees and patent fees associated with the prosecution of patent applications. The Company has recorded amortization expense on patents granted, which are amortized over the remaining legal life. Maintenance patent fees are paid to a government patent authority to maintain a granted patent in force. Some countries require the payment of maintenance fees for pending patent applications. Maintenance fees paid after a patent is granted are expensed, as these are considered ongoing costs to "maintain a patent". Maintenance fees paid prior to a patent grant date are capitalized to patent costs, as these are considered "patent application costs". No amortization expense has been recorded on the remaining patent applications since patents on these applications have yet to be granted.

Intangible assets consist of the following:

		December 31, 2022		December 31, 2021
Patents	$	1,606,064	$	1,345,649
Less: Accumulated amortization		575,729		497,516
	$	1,030,335	$	848,133

Amortization expense for the years ending December 31, 2022, 2021 and 2020 was $78,213, $86,516 and $83,404. There were no patent costs written off for the years ended December 31, 2022, 2021 and 2020.

NOTE 7 – COMMITMENTS

On October 30, 2017, the Company entered into a lease agreement (the "Lease") to lease approximately 13,420 square feet of office, laboratory and research and development space located in Colorado for the Company's principal executive offices and research and development facility. The term of the lease is sixty- one (61) months, beginning on November 1, 2017 and ending on November 30, 2022. During January 2022, the term was extended for an additional twenty-four (24) months. This extension did not require a lease modification as the additional option period was included in the original computation as of January 1, 2019. Base rent for the first year of the lease term is approximately $168,824, with an increase in annual base rent of approximately 3% in each subsequent year of the lease term. As specified in the lease, the Company paid the landlord (i) all base rent for the period November 1, 2017 and ending on October 31, 2019, in the sum of $347,045; and (ii) the estimated amount of tenant's proportionate share of operating expenses for the same period in the sum of $186,293. Commencing on November 1, 2019, monthly installments of base rent and one-twelfth of landlord's estimate of tenant's proportionate share of annual operating expenses shall be due on the first day of each calendar month. The lease also provides that (i) on November 1, 2019 landlord shall pay the Company for the cost of the cosmetic improvements in the amount of $3.00 per rentable square foot of the premises, and (ii) on or prior to November 1, 2019, the Company shall deposit with Landlord the sum of $36,524 as a security deposit which shall be held by landlord to secure the Company's obligations under the lease. On October 30, 2017, the Company entered into an agreement with the tenant leasing the premise from the landlord ("Original Lessee") whereby the Original Lessee agreed to pay the Company the sum of $260,000 in consideration of the Company entering into the lease and landlord agreeing to the early termination of the Original Lessee's lease agreement with landlord. The consideration of $260,000 was received on November 1, 2017.

Due to the adoption of the new lease standard, the Company has capitalized the present value of the minimum lease payments commencing November 1, 2019, including the additional option period using an estimated incremental borrowing rate of 6.5%. The minimum lease payments do not include common area annual expenses which are considered to be nonlease components.

As of January 1, 2019 the operating lease right-of-use asset and operating lease liability amounted to $885,094 with no cumulative-effect adjustment to the opening balance of retained earnings/accumulated deficit.

On November 22, 2022, the Company entered into an amendment to the Lease ("the Amended Lease") to lease an additional approximately 9,684 square feet of adjacent office and warehouse space. The Amended Lease is contingent upon the landlord entering into a written agreement with the existing tenant occupying the expanded premise ("the Existing Tenant Lease Termination") to terminate its lease prior to the expiration date thereof, and to surrender the expansion premises to the landlord. The term of the Amended Lease is one hundred twenty (120) months, with an effective date estimated to be August 1, 2023 or earlier if the existing tenant terminates its lease prior to that date. Base rent through October 31, 2023 of the Amended Lease term is approximately $30,517 per month. The base rent for the next full year of the Amended Lease term is approximately $377,288, with an increase in annual base rent of approximately 3% in each subsequent year of the lease term. Commencing on the effective date, monthly installments of base rent and one-twelfth of landlord's estimate of tenant's proportionate share of annual operating expenses shall be due on the first day of each calendar month. The Amended Lease also provides an allowance of up to $38,736 to be used solely for the cost of renovations to the additional lease premises. As of December, 31, 2022, the landlord did not enter into the Existing Tenant Lease Termination. As a result, the Company did not capitalize the present value of the minimum lease payments under the Amended Lease.

The Company has elected not to recognize right-of-use assets and lease liabilities arising from short-term leases. There are no other material operating leases.

NOTE 7 – COMMITMENTS (CONTINUED)

The Company is obligated under an operating lease for office and laboratory space. The aggregate minimum future lease payments under the operating lease, including the extended term are as follows:

YEARS ENDING DECEMBER 31,		AMOUNT
2023	$	213,781
2024		182,624

		396,405
Less discounted interest		(38,151)
TOTAL	$	358,254

Rent expense totaling $138,394 and $46,132 is included in research and development and general and administrative expenses for the year ended December 31, 2022. Rent expense totaling $134,243 and $44,747 is included in research and development and general and administrative expenses for the year ended December 31, 2021. Rent expense totaling $129,806 and $43,269 is included in research and development and general and administrative expenses for the year ended December 31, 2020.

NOTE 8 – PAYCHECK PROTECTION PROGRAM ADVANCE

On April 24, 2020, the Company received $410,700 in loan funding from the Paycheck Protection Program, established pursuant to the Coronavirus Aid, Relief, and Economic Security Act enacted on March 27, 2020 and administered by the U.S. Small Business Administration. The unsecured loan is evidenced by a promissory note of the Company dated April 23, 2020 in the principal amount of $410,700, to Community Banks of Colorado, a division of NBH Bank, the lender. The loan proceeds have been used to cover payroll costs, rent and utility costs. The loan was eligible for forgiveness as part of the CARES Act if certain requirements were met. The loan was forgiven by the Small Business Administration in its entirety on January 22, 2021.

NOTE 9 – INCOME TAXES

As discussed in Note 1, the Company utilizes the asset and liability method of accounting for income taxes in accordance with FASB ASC 740.

The income tax (benefit) provision consists of the following:

	2022	2021	2020
Current	$ —	$ —	$ —
Deferred	(5,071,000)	(3,692,000)	(1,972,000)
Change in valuation allowance	5,071,000	3,692,000	1,972,000
	$ —	$ —	$ —

NOTE 9 – INCOME TAXES (CONTINUED)

The reconciliation of the statutory federal rate to the Company's effective income tax rate is as follows:

	2022		2021		2020	
	Amount	%	Amount	%	Amount	%
Income tax benefit at U.S. federal income tax rate	$ (3,618,000)	(21)	$ (3,913,000)	(21)	$ (1,544,000)	(21)
State tax benefit, net of federal tax effect	(784,000)	(4)	(838,000)	(4)	(441,000)	(6)
Federal deduction net of tax	35,000	—	38,000	—	—	—
Tax exempt income	—	—	(111,000)	(1)	—	—
Non-deductible share-based compensation	1,430,000	8	899,000	5	13,000	—
Exercised share based compensation	(2,981,000)	(17)	—	—	—	—
Other	847,000	5	233,000	1		
Change in valuation allowance	5,071,000	29	3,692,000	20	1,972,000	27
	$ —	—	$ —	—	$ —	—

The components of deferred tax assets as of December 31, 2022, 2021 and 2020 are as follows:

	2022	2021	2020
Deferred tax asset for NOL carryforwards	$ 23,930,000	$ 19,966,000	$ 15,338,000
Share-based compensation	2,451,000	1,242,000	2,178,000
Other	(102,000)	—	—
Valuation allowance	(26,279,000)	(21,208,000)	(17,516,000)
	$ —	$ —	$ —

The valuation allowance for deferred tax assets as of December 31, 2022, 2021 and 2020 was $26,279,000, $21,208,000 and $17,516,000, respectively. The change in the total valuation for the year ended December 31, 2022 was an increase of $5,071,000, for the year ended December 31, 2021 was an increase of $3,692,000 and for the year ended December 31, 2020 was an increase of $1,972,000. In assessing the realization of deferred tax assets, management considers whether it is more likely than not that some portion or all of the deferred tax assets will not be realized. The ultimate realization of deferred tax assets is dependent upon the generation of future taxable income during the periods in which the net operating losses and temporary differences become deductible. Management considered projected future taxable income and tax planning strategies in making this assessment. The value of the deferred tax assets was offset by a valuation allowance, due to the current uncertainty of the future realization of the deferred tax assets.

As of December 31, 2022, the Company had net operating loss carry forwards of approximately $97,297,000 and is comprised of net operating losses in the amount of approximately $38,275,000 recorded in tax years beginning prior to January 1, 2018 expiring through the year ending December 31, 2038 and net operating losses recorded in tax years beginning January 1, 2018 and after in the amount of approximately $59,022,000 which are allowed for an indefinite carryforward period but may be subject to limitations. This amount can be used to offset future taxable income of the Company.

The timing and manner in which the Company can utilize operating loss carryforwards in any year may be limited by provisions of the Internal Revenue Code regarding changes in ownership of corporations. Such limitation may have an impact on the ultimate realization of its carryforwards and future tax deductions.

NOTE 9 – INCOME TAXES (CONTINUED)

The Company follows FASB ASC 740.10, which provides guidance for the recognition and measurement of certain tax positions in an enterprise's financial statements. Recognition involves a determination of whether it is more likely than not that a tax position will be sustained upon examination with the presumption that the tax position will be examined by the appropriate taxing authority having full knowledge of all relevant information. The adoption of FASB ASC 740.10 did not require an adjustment to the Company's financial statements.

The Company's policy is to record interest and penalties associated with unrecognized tax benefits as additional income taxes in the statement of operations. As of January 1, 2022, the Company had no unrecognized tax benefits and no charge during 2022, and accordingly, the Company did not recognize any interest or penalties during 2022 related to unrecognized tax benefits. There is no accrual for uncertain tax positions as of December 31, 2022.

The Company files U.S. income tax returns and a state income tax return. With few exceptions, the U.S. and state income tax returns filed for the tax years ending on December 31, 2019 and thereafter are subject to examination by the relevant taxing authorities.

NOTE 10 – STOCKHOLDERS' EQUITY

Preferred Stock

Pursuant to the Company's Articles of Incorporation, the Company's board of directors is empowered, without stockholder approval, to issue series of preferred stock with any designations, rights and preferences as they may from time to time determine. The rights and preferences of this preferred stock may be superior to the rights and preferences of the Company's common stock; consequently, preferred stock, if issued could have dividend, liquidation, conversion, voting or other rights that could adversely affect the voting power or other rights of the common stock. Additionally, preferred stock, if issued, could be utilized, under special circumstances, as a method of discouraging, delaying or preventing a change in control of the Company's business or a takeover from a third party.

Common Stock Options and Warrants

In January 2019, the Company signed a purchase agreement with the institutional investor to sell up to $25,000,000 of common stock. The Company registered 9,500,000 shares pursuant to a registration statement filed on January 30, 2019 which became effective February 13, 2019. The Company issued 350,000 shares of common stock to the institutional investor as an initial commitment fee valued at $258,125, fair value, and 812,500 shares of common stock are reserved for additional commitment fees to the institutional investor in accordance with the terms of the purchase agreement. The Company registered an additional 6,000,000 shares pursuant to a registration statement filed on January 24, 2020 which became effective February 4, 2020. The Company registered an additional 8,000,000 shares pursuant to a registration statement filed on November 20, 2020 which became effective November 20, 2020. During the period January 2019 through December 30, 2022, the institutional investor purchased 22,337,500 shares of common stock for proceeds of $23,773,924 and the Company issued 772,666 shares of common stock as additional commitment fee, valued at $1,575,509, fair value, leaving 39,834 in reserve for additional commitment fees. During the year ending December 30, 2022, the institutional investor did not purchase any shares of common stock. All the registered shares under the purchase agreement have been issued as of December 31, 2022.

NOTE 10 – STOCKHOLDERS' EQUITY (CONTINUED

Common Stock Options and Warrants (Continued)

On July 2, 2021, the Company filed a $100,000,000 universal shelf registration statement with the U.S. Securities and Exchange Commission which became effective on July 9, 2021. On October 4, 2021, the Company entered into a purchase agreement with the institutional investor to sell up to $33,000,000 of common stock over a 36-month period. Concurrently with entering into the purchase agreement, the Company also entered into a registration rights agreement which provides the institutional investor with certain registration rights related to the shares issued under the purchase agreement. Pursuant to the purchase agreement, the Company issued 30,312 shares of common stock to the institutional investor as an initial commitment fee valued at $279,174, fair value, and 60,623 shares of common stock are reserved for additional commitment fees to the institutional investor in accordance with the terms of the purchase agreement. During the period October 4, 2021 through December 31, 2022, the institutional investor purchased 2,852,511 shares of common stock for proceeds of $29,152,692 and the Company issued 53,554 shares of common stock as additional commitment fee, valued at $656,372, fair value, leaving 7,069 in reserve for additional commitment fees. During the year ending December 31, 2022, pursuant to the purchase agreement, the institutional investor purchased 1,625,000 shares of common stock for proceeds of $12,775,268 and the Company issued 23,468 shares of common stock as additional commitment fee, valued at $209,709, fair value. During January and February 2023, pursuant to the purchase agreement, the institutional investor purchased 300,000 shares of common stock for proceeds of $1,720,750 and the Company issued 3,161 shares of common stock as additional commitment fee, valued at $19,377, fair value, leaving 3,908 in reserve for additional commitment fees.

On December 9, 2022, the Company entered into a sales agreement with an investment banking company. In accordance with the terms of this sales agreement, the Company may offer and sell shares of its common stock having an aggregate offering price of up to $35,000,000 from time to time through or to the investment banking company, as sales agent or principal. Sales of shares of the Company's common stock, if any, may be made by any method deemed to be an "at the market offering". The sales agent will be entitled to compensation under the terms of the sales agreement at a commission rate equal to 3% of the gross proceeds of the sales price of common stock that they sell.

NOTE 11 – STOCK BASED COMPENSATION

During 2007, the Board of Directors of the Company adopted the 2007 Employee Stock Plan ("2007 Plan") that was approved by the shareholders. Under the 2007 Plan, the Company is authorized to grant options to purchase up to 10,000,000 shares of common stock to directors, officers, employees and consultants who provide services to the Company. The 2007 Plan is intended to permit stock options granted to employees under the 2007 Plan to qualify as incentive stock options under Section 422 of the Internal Revenue Code of 1986, as amended ("Incentive Stock Options"). All options granted under the 2007 Plan, which are not intended to qualify as Incentive Stock Options are deemed to be non-qualified options ("Non-Statutory Stock Options"). Effective June 24, 2016, the 2007 Plan was terminated. As of December 31, 2022, options to purchase 2,895,000 shares of common stock have been issued and are outstanding.

NOTE 11 – STOCK BASED COMPENSATION (CONTINUED)

During 2016, the Board of Directors of the Company adopted the 2016 Plan that was approved by the shareholders at the 2016 annual meeting of shareholders on May 20, 2016. Under the 2016 Plan, the Company is authorized to grant awards of incentive and non-qualified stock options and restricted stock to purchase up to 3,000,000 shares of common stock to employees, directors and consultants. Effective May 16, 2019, the number of shares of the Company's common stock available for issuance under the 2016 Plan was increased from 3,000,000 to 8,000,000 shares. As of December 31, 2022, options to purchase 4,390,173 shares of common stock have been issued and are outstanding and 28,500 restricted shares of common stock have been granted, 5,180 have been forfeited and 13,816 are non-vested. As of December 31, 2022, 2,317,680 shares of common stock remain available for grants under the 2016 Plan.

Both plans are administered by the Company's Board of Directors or its compensation committee which determines the persons to whom awards will be granted, the number of awards to be granted, and the specific terms of each grant. Subject to the provisions regarding Ten Percent Shareholders, (as defined in the 2016 Plan), the exercise price per share of each option cannot be less than 100% of the fair market value of a share of common stock on the date of grant. Options granted under the 2016 Plan are generally exercisable for a period of 10 years from the date of grant and may vest on the grant date, another specified date or over a period of time.

The Company uses the Black-Scholes option pricing model to calculate the grant-date fair value of an award, with the following assumptions for 2022: no dividend yield in all years, expected volatility, based on the Company's historical volatility, 74.7% to 76.4%, risk-free interest rate between 1.87% to 3.84% and expected option life of 10 years. Prior to May 2018, the expected life is based on the estimated average of the life of options using the "simplified" method, as prescribed in FASB ASC 718, due to insufficient historical exercise activity during recent years. Starting in May 2018, the expected life is based on the legal contractual life of options. The Black-Scholes option pricing model assumptions for 2021 are as follows: no dividend yield in all years, expected volatility, based on the Company's historical volatility, 70.4% to 77.1%, risk-free interest rate between 1.15% to 1.73% and expected option life of 10 years. The Black-Scholes option pricing model assumptions for 2020 are as follows: no dividend yield in all years, expected volatility, based on the Company's historical volatility, 64% to 78%, risk-free interest rate between 0.30% to 1.82% and expected option life of 4.6 to 10 years.

As of December 31, 2022, there was $1,623,565 of unrecognized compensation expense related to non-vested market-based share awards that is expected to be recognized through December 2024.

Share-based compensation was recognized as follows:

	2022	2021	2020
2007 Employee Stock Option Plan	$ —	$ —	$ —
2016 Equity Incentive Plan	5,813,628	1,022,985	539,414
2016 Equity Incentive Plan restricted stock awards	91,713	—	—
Warrants	—	11,001	95,774
Total share-based compensation	$ 5,905,341	$ 1,033,986	$ 635,188

NOTE 11 – STOCK BASED COMPENSATION (CONTINUED)

The following tables summarize all stock option and warrant activity of the Company during the years ended December 31, 2022, 2021 and 2020:

	Non-Qualified Stock Options and Warrants Outstanding and Exercisable		
	Number of Shares	Exercise Price	Weighted Average Exercise Price
Outstanding, December 31, 2019	16,302,517	$0.57 - $1.69	$ 0.85
Granted	647,500	$0.51 - $0.86	$ 0.76
Expired	(4,845,715)	$0.80 - $1.02	$ 0.86
Forfeited	(8,750)	$1.10	$ 1.10
Exercised	(2,073,052)	$0.80	$ 0.80
Outstanding, December 31, 2020	10,022,500	$0.51 - $1.69	$ 0.85
Granted	1,061,000	$1.27 - $16.81	$ 2.32
Forfeited	(28,750)	$0.64 - $0.86	$ 0.82
Exercised	(3,168,502)	$0.60 - $1.50	$ 0.88
Outstanding, December 31, 2021	7,886,248	$0.51 - $16.81	$ 1.02
Granted	884,500	$5.81 - $10.86	$ 9.18
Expired	(25,000)	$1.69	$ 1.69
Forfeited	(15,250)	$1.46 - $7.53	$ 5.71
Exercised	(657,325)	$0.64 - $5.81	$ 1.00
Outstanding, December 31, 2022	8,073,173	$0.51 - $16.81	$ 1.91
Exercisable, December 31, 2022	7,743,176	$0.51 - $16.81	$ 1.69

The aggregate intrinsic value of options and warrants outstanding and exercisable as of December 31, 2022 was $24,110,353. The aggregate intrinsic value is calculated as the difference between the exercise price of the underlying options and warrants and the closing stock price of $4.31 for the Company's common stock on December 31, 2022. During the year ending December 31, 2022, 302,950 options were exercised for proceeds of $257,895 and 4,375 options were exercised via cashless method. During the year ending December 31, 2022, 350,000 warrants were exercised for proceeds of $396,000. During the year ending December 31, 2021, 2,046,250 options were exercised for proceeds of $1,950,875. During the year ending December 31, 2021, 677,000 warrants were exercised for proceeds of $428,350 and 445,252 options were exercised via cashless method. No options were exercised during 2020. During the year ending December 31, 2020, 2,073,052 warrants were exercised for proceeds of $1,658,442.

Non-Qualified Stock Options and Warrants Outstanding			
Range of Exercise Prices	Number Outstanding Currently Exercisable at December 31, 2022	Weighted Average Remaining Contractual Life	Weighted Average Exercise Price of Options and Warrants Currently Exercisable
$0.51 - $16.81	77,43,176	4.8 Years	$1.69

The fair value of restricted stock awards is estimated by the market price of the Company's common stock at the date of grant. Restricted stock activity during the year ending December 31, 2022, 2021 and 2020 are as follows:

NOTE 11 – STOCK BASED COMPENSATION (CONTINUED)

	Restricted Stock Awards Year ended					
	December 31, 2022		December 31, 2021		December 31, 2020	
	Number of Shares	Weighted Average Grant Date Fair Value per Share	Number of Shares	Weighted Average Grant Date Fair Value per Share	Number of Shares	Weighted Average Grant Date Fair Value per Share
Non-vested, beginning of period	—	$ —	—	$ —	—	$ —
Granted	28,500	9.65	—	—	—	—
Vested	(9,504)	9.65	—	—	—	—
Cancelled and forfeited	(5,180)	9.65	—	—	—	—
Non-vested, end of period	13,816	$ 9.65	—	$ —	—	$ —

NOTE 12 – RELATED PARTY

At December 31, 2022 the Company had a legal accrual to a related party of $60,577, fees and consulting expense accruals of advisory board members in the amount of $18,000, fees to directors in the amount of $13,500, travel and office expense accruals of officers in the amount of $4,859 and accounting service fee accrual and expense reimbursement to related parties of $3,233. At December 31, 2021 the Company had office expense accruals of officers in the amount of $24,000, a legal accrual to related party of $6,130 and accounting service fee accrual and expense reimbursements to related parties of $2,059.

NOTE 13 – RETIREMENT PLAN

The Company established a 401(k) retirement plan covering all eligible employees beginning November 15, 2013. A contribution of $57,126 was charged to expense and accrued for the year ending December 31, 2022 to all eligible non-executive participants. A contribution of $53,035 was charged to expense and accrued for the year ending December 31, 2021 to all eligible non-executive participants. A contribution of $53,832 was charged to expense and accrued for the year ending December 31, 2020 to all eligible non-executive participants.

NOTE 14 – SUBSEQUENT EVENTS

On February 28, 2023, the Company entered into a purchase agreement with an institutional investor to sell up to $30,000,000 of common stock over a 36-month period. Concurrently with entering into the purchase agreement, the Company also entered into a registration rights agreement which provides the institutional investor with certain registration rights related to the shares issued under the purchase agreement. Pursuant to the purchase agreement, the institutional investor has agreed to purchase $3,000,000 of shares upon commencement.

**DESCRIPTION OF THE REGISTRANT'S SECURITIES
REGISTERED PURSUANT TO SECTION 12 OF THE
SECURITIES EXCHANGE ACT OF 1934**

Lightwave Logic, Inc. (the "Company" or "we" or "our") has one class of securities registered under Section 12 of the Securities Exchange Act of 1934, our commo stock, par value $0.001 per share (the "common stock").

Description of Common Stock

The following description of our common stock is a summary and does not purport to be complete. It is subject to and qualified in its entirety by reference to our Articles of Incorporation, as amended (the "articles of incorporation") and our Restated Bylaws (the "bylaws"), each of which are incorporated by reference as an exhibit to the Annual Report on Form 10-K of which this exhibit is a part. We encourage you to read our articles of incorporation, our bylaws and the applicable provisions of the Nevada Revised Statutes for additional information.

Authorized Share Capital. The Company's authorized capital stock consists of 250,000,000 shares of common stock, par value $0.001 per share and 1,000,000 shares of preferred stock, par value $0.001 per share.

Voting. Each outstanding share of common stock is entitled to one vote on all matters to be submitted to a vote of the shareholders. Holders do not have preemptive rights, so we may issue additional shares that may reduce each holder's voting and financial interest in our Company. Cumulative voting does not apply to the election of directors, so holders of more than 50% of the shares voted for the election of directors can elect all of the directors. All elections for directors shall be decided by a plurality vote; all other questions shall be decided by majority vote except as otherwise provided by Nevada Revised Statutes. Our bylaws permit the holders of the same percentage of all shareholders entitled to vote at a meeting to take action by written consent without a meeting.

Dividend Rights. Holders of common stock are entitled to receive dividends when, as and if declared by the board of directors out of funds legally available therefor.

Liquidation Preferences. In the event of liquidation, dissolution or winding up of our Company, holders of common stock are entitled to share ratably in all assets remaining available for distribution to them after payment of liabilities and after provision has been made for each class of stock, if any, having preference over the common stock.

Other Terms. Holders of common stock do not have any conversion, redemption provisions or other subscription rights. All of the outstanding shares of common stock are fully paid and non-assessable.

Anti-Takeover Provisions

Certain of our charter, statutory and contractual provisions could make the removal of our management and directors more difficult and may discourage transactions that otherwise could involve payment of a premium over prevailing market prices for our common stock. Furthermore, the existence of the foregoing provisions could lower the price that investors might be willing to pay in the future for shares of our common stock. They could also deter potential acquirers of our Company, thereby reducing the likelihood that you could receive a premium for your common stock in an acquisition.

Charter and Bylaw Provisions

Our articles of incorporation and bylaws contain the following provisions that may have the effect of discouraging unsolicited acquisition proposals:

- authorize our board of directors to create and issue, without shareholder approval, preferred stock, thereby increasing the number of outstanding shares, which can deter or prevent a takeover attempt;
- prohibit cumulative voting in the election of directors, which would otherwise allow less than a majority of shareholders to elect director candidates;
- empower our board of directors to fill any vacancy on our board of directors, whether such vacancy occurs as a result of an increase in the number of directors or otherwise;
- provide that our board of directors be divided into three classes, with approximately one-third of the directors to be elected each year;
- provide that our board of directors is expressly authorized to adopt, amend or repeal our bylaws; and
- provide that our directors will be elected by a plurality of the votes cast in the election of directors.

These provisions could lower the price that future investors might be willing to pay for shares of our common stock.

Nevada Law

Nevada Revised Statutes sections 78.378 to 78.3793 provide state regulation over the acquisition of a controlling interest in certain Nevada corporations unless the articles of incorporation or bylaws of the corporation provide that the provisions of these sections do not apply. Our articles of incorporation and bylaws do not state that these provisions do not apply. The statute creates a number of restrictions on the ability of a person or entity to acquire control of a Nevada company by setting down certain rules of conduct and voting restrictions in any acquisition attempt, among other things. The statute contains certain limitations and it may not apply to our Company. These provisions may have the effect of deterring hostile takeovers or delaying changes in control, which could depress the market price of our common stock and deprive shareholders of opportunities to realize a premium on shares of common stock held by them.

Contractual Provisions

Our employee stock option agreements include change-in-control provisions that allow us to grant options or stock purchase rights that may become vested immediately upon a change in control. The terms of change of control provisions contained in certain of our senior executive employee agreements may also discourage a change in control of our Company.

Our board of directors also has the power to adopt a shareholder rights plan that could delay or prevent a change in control of our Company even if the change in control is generally beneficial to our shareholders. These plans, sometimes called “poison pills,” are oftentimes criticized by institutional investors or their advisors and could affect our rating by such investors or advisors. If our board of directors adopts such a plan, it might have the effect of reducing the price that new investors are willing to pay for shares of our common stock.

Together, these charter, statutory and contractual provisions could make the removal of our management and directors more difficult and may discourage transactions that otherwise could involve payment of a premium over prevailing market prices for our common stock. Furthermore, the existence of the foregoing provisions, could limit the price that investors might be willing to pay in the future for shares of our common stock. They could also deter potential acquirers of our Company, thereby reducing the likelihood that you could receive a premium for your common stock in an acquisition.

Listing

Our common stock is listed on the NASDAQ Capital Market under the symbol "LWLG."

Transfer Agent and Registrar

The transfer agent and registrar for our common stock is Broadridge.

Preferred Stock

Our common stock is subject to the express terms of the Company’s preferred stock and any series thereof. The board of directors may issue preferred stock with voting, dividend, liquidation and other rights that could adversely affect the relative rights of the holders of the common stock.

FIRST AMENDMENT TO LEASE

THIS FIRST AMENDMENT TO LEASE (the "Amendment") is made and entered into this 22nd day of November, 2022, by and between **DEPAUL INVERNESS, LLC, a Colorado limited liability company, ROSEBEN IP, LLC, a Colorado limited liability company and WINDY RIVER RETAIL 8, LLC, a Colorado limited liability company,** collectively as Landlord, and **LIGHTWAVE LOGIC, INC., a Nevada corporation,** as Tenant.

RECITALS

WHEREAS, Landlord, through their predecessor in interest, and Tenant are parties to that certain Lease Agreement dated October 26, 2017 (the "Lease"), for the premises consisting of approximately 13,420 square feet of Net Rentable Area known as Suite 350 (the "Premises") located in Building 369, Inverness Parkway, Englewood, Colorado 80112, as a part of the project known as Inverness Parkway Center; and

WHEREAS, pursuant to the written notice from Tenant dated December 6, 2021, the Term of the Lease was extended for an additional twenty-four (24) months from December 1, 2022 through November 30, 2024 (the "Extension Term"); and

WHEREAS, Landlord and Tenant now desire to amend the Lease to, among other things, redefine the Premises, at the time and in the manner set forth below, to include an additional approximately 9,684 rentable square feet of space consisting of Suite 375 and a portion of the now existing Suite 300 (collectively the "Expansion Premises"), to further extend and redefine the Extension Term, and to modify the rent payable thereunder.

AGREEMENT

NOW THEREFORE, for and in consideration of the mutual covenants and agreements herein contained and other good and valuable consideration, the receipt and sufficiency of which is hereby mutually acknowledged, Landlord and Tenant agree that the Lease is hereby amended as follows:

1. Premises. Expressly subject to the contingency provided for in paragraph 6 below, upon the date of Substantial Completion, as hereinafter defined, of the Tenant Improvements required to be constructed by Landlord described in paragraph 2 below, estimated to be March 1, 2023 (the "Effective Date"), the term "Premises" as the same is used in the Lease shall be redefined for all purposes, including the calculation of Tenant's Proportionate Share, to include the Expansion Premises as depicted on the attached Exhibit A. From and after the Effective Date, the Premises shall then contain a total Net Rentable Area of approximately 23,104 square feet. "Substantial Completion" shall occur on the date that Landlord provides Tenant with written notice that the Tenant Improvements are substantially completed and that the Expansion Premises is then ready for occupancy, excepting only such punch list items to be completed by Landlord within a reasonable period of time thereafter. Following the Effective Date, Landlord and Tenant shall execute a Commencement Date Memorandum setting forth the exact date of the commencement

and termination of the New Term (as defined in paragraph 3 below). Base Rent for the redefined Premises shall be pursuant to paragraph 4 below.

2. Tenant Improvements. Landlord shall, at Landlord's expense and with Building Standard finishes and materials, complete the following improvements to the Expansion Premises: (i) construct demising wall to separate the Expansion Premises from the remainder of Suite 300; (ii) install new overhead door and new concrete driveway to serve the warehouse area; and (iii) deliver in broom-clean condition, with all mechanical and electrical systems in good working order (collectively the "Tenant Improvements"). Landlord shall complete the Tenant Improvements and deliver possession of the Expansion Premises to Tenant on the Effective Date, and at such time Tenant shall begin paying Base Rent and Operating Expenses therefor pursuant to the provisions set forth below. Except as expressly set forth herein with respect to the Tenant Improvements to be completed by Landlord, Tenant shall not be entitled to any other alterations, additions, or improvements, and Tenant shall otherwise accept the redefined Premises, as of the Effective Date, in its AS-IS condition, which condition Tenant hereby acknowledges to be satisfactory for the operation of its business.

In addition to the Tenant Improvements, Landlord shall provide to Tenant an allowance in the amount of up to $38,736 (the "Allowance") to be used solely for the costs of renovations in the Expansion Premises (the "Tenant Work"). Prior to commencement of Tenant Work, Tenant will submit to Landlord plans and specifications in reasonable detail. Within five (5) days of receipt of the plans, Landlord shall provide written approval, or the basis for Landlord's denial. The Allowance shall be paid to Tenant upon: (i) completion of the Tenant Work, in a good and workmanlike manner, consistent with the plans approved by Landlord, and using finishes and materials of no less than building-standard; and (ii) submission to Landlord of applicable invoices and final lien waivers. Any portion of the Allowance not utilized by Tenant in accordance with the foregoing requirements, and prior to November 1, 2026 shall be forfeited by Tenant.

3. Lease Term. Commencing on the Effective Date, the Extension Term of the Lease shall be redefined and extended to mean a period of one hundred twenty (120) full calendar months (the "New Term"); provided, however, if the Effective Date occurs on a day other than the first day of the month, the New Term shall be measured from the first day of the month next following the occurrence of the Effective Date.

4. Base Rent. During the New Term, in addition to all other amounts due under the Lease, including Operating Expenses, Tenant agrees to pay Landlord the following Base Rent for the redefined Premises:

Time Period	Monthly Base Rent	Annual Base Rent per Sq. Ft.
03/01/23-10/31/23*	$30,516.53	$15.85
11/01/23-10/31/24	$31,440.69	$16.33
11/01/24-10/31/25**	$32,384.11	$16.82
11/01/25-10/31/26	$33,346.77	$17.32
11/01/26-10/31/27	$34,347.95	$17.84
11/01/27-10/31/28	$35,387.63	$18.38
11/01/28-10/31/29	$36,446.56	$18.93
11/01/29-10/31/30	$37,544.00	$19.50

11/01/30-10/31/31	$38,660.69	$20.08
11/01/31-10/31/32	$39,835.15	$20.69
11/01/32-02/28/33	$41,028.85	$21.31

*In the event the Effective Date is a day other than March 1, 2023, then the Commencement Date Memorandum to be executed by Landlord and Tenant shall modify the foregoing Base Rent Schedule accordingly. In addition, in the event the Effective Date commences on a day other than the first day of a month, Tenant shall pay a proportionate amount of Base Rent for the redefined Premises for such partial month.

**Beginning on November 1, 2024, the annual increases in Base Rent shall be the greater of the three percent (3%) increases reflected in the Base Rent Schedule set forth above, or the corresponding increase in the annual percentage increase in the "Consumer Price Index for Denver-Aurora-Lakewood (CPI-U) All Items (1982-1984=100)", published by the U.S. Department of Labor, Bureau of Labor Statistics.

5. Operating Expenses. All provisions of Lease relating to Tenant's payment of Additional Rent and Operating Expenses shall continue to apply to the redefined Premises during the New Term, except that Tenant's Proportionate Share shall then be 19.9% of the Project and 39.5% of the Building.

6. Contingency. This Amendment, and the rights and obligations of the parties hereunder, is expressly subject to and conditioned upon Landlord entering into a written agreement with the existing tenant occupying the Expansion Premises to terminate its lease prior to the expiration date thereof, and to surrender the Expansion Premises to Landlord. In the event Landlord is unable to do so, then, upon written notice to Tenant, this Amendment shall become null and void and of no further force or effect. The Effective Date set forth in paragraph 1 above, and Landlord's obligations to construct the Tenant Improvements to the Expansion Premises shall further be contingent upon the existing tenant timely and properly vacating the same in accordance with the parties' written agreement.

7. No Additional Extensions. Tenant shall have no right to further extend the term of the Lease beyond the last day of the New Term, unless agreed to by Landlord in writing.

8. Brokerage Fees. Tenant represents that Tenant has not dealt with any brokers in connection with this Amendment other than DePaul Real Estate Advisors and Colliers International, acting as Landlord's brokers. Tenant agrees to indemnify and defend Landlord from any claims or demands of any brokers claiming to be Tenant's representative.

9. No Rental Abatement. Tenant shall not receive nor be entitled to claim any free rent or rental abatement in connection with this Amendment. Monthly installments of Base Rent shall be due and payable as set forth herein and in the Lease, on the first day of each month.

10. Counterparts. Each parties' signatures may be executed in any number of counterparts which may be transmitted by electronic signature or via e-mail in a "PDF" format and

shall be used in place of original signatures on this Amendment, if signatures are processed electronically, and all of which when taken together, shall constitute one and the same agreement. Each party intends to be bound by such party's electronic signature or "PDF" format signature on this Amendment and is aware that the other party is relying on such party's electronic or "PDF" signature format, and hereby waives any and all defenses to the enforcement of this Amendment based upon the form of signature including, but not limited to, authenticity.

11. Ratification. Except as expressly amended, modified or changed herein, all of the terms, conditions and covenants of the Lease shall remain in full force and effect during the remaining Term and during the New Term and Landlord and Tenant hereby ratify and reaffirm such terms, conditions and covenants and shall be bound thereby. Tenant further acknowledges that Landlord is not in default under the Lease and Tenant has no claims against Landlord for failure to perform any of its obligations thereunder.

IN WITNESS WHEREOF, the parties hereto have entered into this First Amendment as of the day and year first above written.

LANDLORD:
DePaul Inverness, LLC,
a Colorado limited liability company

By: DePaul Management LLC, Manager

DocuSigned by:
By: Paul T. DeCrescentis
Paul T. DeCrescentis
Manager

ROSEBEN IP, LLC,
a Colorado limited liability company
DocuSigned by:
By: Robert W. Lom
Name: Robert W. Lom
Its: Manager

Windy River Retail 8, LLC,
a Colorado limited liability company
DocuSigned by:
By: Carrie Burns
Name: Carrie Burns
Its: President

TENANT:
Lightwave Logic, Inc.,
a Nevada corporation

By:
Name: James S Marcelli
Its: President & COO

EXHIBIT A

Expansion Premises

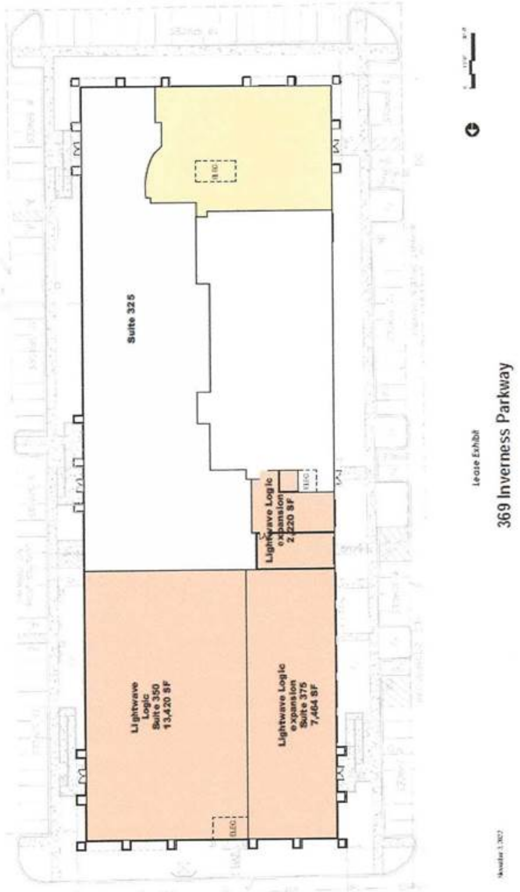


EXHIBIT 10.26

PURCHASE AGREEMENT

THIS PURCHASE AGREEMENT (the "Agreement"), dated as of February 28, 2023 is made by and between **LIGHTWAVE LOGIC, INC.**, a Nevada corporation (the "Company"), and **LINCOLN PARK CAPITAL FUND, LLC**, an Illinois limited liability company (the "Investor").

WHEREAS:

Subject to the terms and conditions set forth in this Agreement, the Company wishes to sell to the Investor, and the Investor wishes to buy from the Company, up to Thirty Million Dollars ($30,000,000) of the Company's common stock, $0.001 par value per share (the "Common Stock"). The shares of Common Stock to be purchased hereunder (including the Initial Purchase Shares (as defined in Section 2(a) hereof), if any) are referred to herein as the "Purchase Shares."

NOW THEREFORE, in consideration of the mutual covenants contained in this Agreement, and for other good and valuable consideration, the receipt and adequacy of which are hereby acknowledged, the Company and the Investor hereby agree as follows:

1. CERTAIN DEFINITIONS.

For purposes of this Agreement, the following terms shall have the following meanings:

(a) "Accelerated Purchase Date" means, with respect to any Accelerated Purchase made pursuant to Section 2(c) hereof, the Business Day immediately following the applicable Purchase Date with respect to the corresponding Regular Purchase referred to in Section 2(b) hereof.

(b) "Accelerated Purchase Minimum Price Threshold" means, with respect to any Accelerated Purchase made pursuant to Section 2(c) hereof, any minimum per share threshold set forth by the Company in the applicable Accelerated Purchase Notice.

(c) "Accelerated Purchase Notice" means, with respect to an Accelerated Purchase made pursuant to Section 2(c) hereof, an irrevocable written notice from the Con the Investor directing the Investor to purchase the applicable Accelerated Purchase Share Amount at the Accelerated Purchase Price on the Accelerated Purchase Date for suc Accelerated Purchase in accordance with this Agreement, and specifying any Additional Accelerated Purchase Minimum Price Threshold determined by the Company.

(d) "Accelerated Purchase Price" means, with respect to an Accelerated Purchase made pursuant to Section 2(c) hereof, the lower of (i) ninety-six and one half perc (96.5%) of the VWAP for the period beginning at 9:30:01 a.m., Eastern time, on the applicable Accelerated Purchase Date, or such other time publicly announced by the Principal Market as the official open (or commencement) of trading on the Principal Market on such applicable Accelerated Purchase Date (the "Accelerated Purchase Commencement Time"), and ending at the earliest of (A) 4:00:00 p.m., Eastern time, on such applicable Accelerated Purchase Date, or such other time publicly announced by the Principal Market as the official close of trading on the Principal Market on such applicable Accelerated Purchase Date, (B) such time, from and after the Accelerated Purchase Commencement Time for such Accelerated Purchase, that the total number (or volume) of shares of Common Stock traded on the Principal Market has exceeded the applicable Accelerated Purchase Share Volume Maximum, and (C) such time, from and after the Accelerated Purchase Commencement Time for such Accelerated Purchase, that the Sale Price has fallen below the applicable Accelerated Purchase Minimum Price Threshold (such earliest of (i)(A), (i)(B) and (i)(C) above, the "Accelerated Purchase Termination Time"), and (ii) the Closing Sale Price of the Common Stock on such applicable Accelerated Purchase Date (to be appropriately adjusted for any reorganization, recapitalization, non-cash dividend, stock split, reverse stock split or other similar transaction).

(e) "Accelerated Purchase Share Amount" means, with respect to an Accelerated Purchase made pursuant to Section 2(c) hereof, the number of Purchase Shares dir by the Company to be purchased by the Investor in an Accelerated Purchase Notice, which number of Purchase Shares shall not exceed the lesser of (i) 300% of the number of Purchase Shares directed by the Company to be purchased by the Investor pursuant to the corresponding Regular Purchase Notice for the corresponding Regular Purchase referred to in Section 2(c) hereof (subject to the Purchase Share limitations contained in Section 2(b) hereof) and (ii) an amount equal to (A) the Accelerated Purchase Share Percentage multiplied by (B) the total number (or volume) of shares of Common Stock traded on the Principal Market during the period on the applicable Accelerated Purchase Date beginning at the Accelerated Purchase Commencement Time for such Accelerated Purchase and ending at the Accelerated Purchase Termination Time for such Accelerated Purchase.

(f) "Accelerated Purchase Share Percentage" means, with respect to an Accelerated Purchase made pursuant to Section 2(c) hereof, thirty percent (30%).

(g) "Accelerated Purchase Share Volume Maximum" means, with respect to an Accelerated Purchase made pursuant to Section 2(c) hereof, a number of shares of C Stock equal to (i) the applicable Accelerated Purchase Share Amount properly directed by the Company to be purchased by the Investor in the applicable Accelerated Purchase Notice for such Accelerated Purchase, divided by (ii) the Accelerated Purchase Share Percentage (to be appropriately adjusted for any reorganization, recapitalization, non-cash dividend, stock split, reverse stock split or other similar transaction).

(h) "Additional Accelerated Purchase Date" means, with respect to an Additional Accelerated Purchase made pursuant to Section 2(d) hereof, the Business Day (i) th the Accelerated Purchase Date with respect to the corresponding Accelerated Purchase referred to in Section 2(c) hereof and (ii) on which the Investor receives, prior to 1:00 p.m., Eastern time, on such Business Day, a valid Additional Accelerated Purchase Notice for such Additional Accelerated Purchase in accordance with this Agreement.

(i) "Additional Accelerated Purchase Minimum Price Threshold" means, with respect to an Additional Accelerated Purchase made pursuant to Section 2(d) hereof, a minimum per share price threshold set forth by the Company in the applicable Additional Accelerated Purchase Notice.

(j) "Additional Accelerated Purchase Notice" means, with respect to an Additional Accelerated Purchase made pursuant to Section 2(d) hereof, an irrevocable writte from the Company to the Investor directing the Investor to purchase the applicable Additional Accelerated Purchase Share Amount at the Additional Accelerated Purchase Pric for such Additional Accelerated Purchase in accordance with this Agreement, and specifying any Additional Accelerated Purchase Minimum Price Threshold determined by the Company.

(k) "Additional Accelerated Purchase Price" means, with respect to an Additional Accelerated Purchase made pursuant to Section 2(d) hereof, the lower of (i) ninety- one half percent (96.5%) of (i) the VWAP for the period on the applicable Additional Accelerated Purchase Date, beginning at the latest of (A) the applicable Accelerated Purchase Termination Time with respect to the corresponding Accelerated Purchase referred to in Section 2(d) hereof on such Additional Accelerated Purchase Date, (B) the applicable Additional Accelerated Purchase Termination Time with respect to the most recently completed prior Additional Accelerated Purchase on such Additional Accelerated Purchase Date, as applicable, and (C) the time at which all Purchase Shares subject to all prior Accelerated Purchases and Additional Accelerated Purchases (as applicable) including, without limitation, those that have been effected on the same Business Day as the applicable Additional Accelerated Purchase Date with respect to which the applicable Additional Accelerated Purchase relates, have theretofore been received by the Investor as

DWAC Shares in accordance with this Agreement (such latest of (i)(A), (i)(B) and (i)(C) above, the "Additional Accelerated Purchase Commencement Time"), and ending at the earliest of (X) 4:00 p.m., Eastern time, on such Additional Accelerated Purchase Date, or such other time publicly announced by the Principal Market as the official close o trading on the Principal Market on such Additional Accelerated Purchase Date, (Y) such time, from and after the Additional Accelerated Purchase Commencement Time for suc Additional Accelerated Purchase, that the total number (or volume) of shares of Common Stock traded on the Principal Market has exceeded the applicable Additiona Accelerated Purchase Share Volume Maximum, and (Z) such time, from and after the Additional Accelerated Purchase Commencement Time for such Additional Accelerate Purchase, that the Sale Price has fallen below the applicable Additional Accelerated Purchase Minimum Price Threshold (such earliest of (i)(X), (i)(Y) and (i)(Z) above, th "Additional Accelerated Purchase Termination Time"), and (ii) the Closing Sale Price of the Common Stock on such Additional Accelerated Purchase Date (to be appropriatel adjusted for any reorganization, recapitalization, non-cash dividend, stock split, reverse stock split or other similar transaction).

(l) "Additional Accelerated Purchase Share Amount" means, with respect to an Additional Accelerated Purchase made pursuant to Section 2(d) hereof, the number o Purchase Shares directed by the Company to be purchased by the Investor on an Additional Accelerated Purchase Notice, which number of Purchase Shares shall not exceed th lesser of (i) 300% of the number of Purchase Shares directed by the Company to be purchased by the Investor pursuant to the corresponding Regular Purchase Notice for th corresponding Regular Purchase referred to in Section 2(b) hereof (subject to the Purchase Share limitations contained in Section 2(b) hereof) and (ii) an amount equal to (A) the Additional Accelerated Purchase Share Percentage multiplied by (B) the total number (or volume) of shares of Common Stock traded on the Principal Market during the period c the applicable Additional Accelerated Purchase Date beginning at the Additional Accelerated Purchase Commencement Time for such Additional Accelerated Purchase an ending at the Additional Accelerated Purchase Termination Time for such Additional Accelerated Purchase.

(m) "Additional Accelerated Purchase Share Percentage" means, with respect to an Additional Accelerated Purchase made pursuant to Section 2(d) hereof, thirty perc (30%).

(n) "Additional Accelerated Purchase Share Volume Maximum" means, with respect to an Additional Accelerated Purchase made pursuant to Section 2(d) hereof, a r of shares of Common Stock equal to (i) the applicable Additional Accelerated Purchase Share Amount properly directed by the Company to be purchased by the Investor in th applicable Additional Accelerated Purchase Notice for such Additional Accelerated Purchase, divided by (ii) the Additional Accelerated Purchase Share Percentage (to b appropriately adjusted for any reorganization, recapitalization, non-cash dividend, stock split, reverse stock split or other similar transaction).

(o) "Alternate Adjusted Regular Purchase Share Limit" means, with respect to a Regular Purchase made pursuant to Section 2(b) hereof, the maximum number of Pu Shares which, taking into account the applicable per share Purchase Price therefor calculated in accordance with this Agreement, would enable the Company to deliver to the Investor, on the applicable Purchase Date for such Regular Purchase, a Regular Purchase Notice for a Purchase Amount equal to, or as closely approximating without exceedin Three Hundred Fifty Thousand Dollars ($350,000).

(p) "Available Amount" means, initially, Thirty Million Dollars ($30,000,000) in the aggregate, which amount shall be reduced by the Purchase Amount each time the In purchases shares of Common Stock pursuant to Section 2 hereof.

(q) "Bankruptcy Law" means Title 11, U.S. Code, or any similar federal or state law for the relief of debtors.

(r) "Base Prospectus" means the Company's final base prospectus, dated July 9, 2021, as updated December 9, 2022, a preliminary form of which is included in the Registration Statement, including the documents incorporated by reference therein.

(s) "Business Day" means any day on which the Principal Market is open for trading, including any day on which the Principal Market is open for trading for a period less than the customary time.

(t) "Closing Sale Price" means, for any security as of any date, the last closing sale price for such security on the Principal Market as reported by the Principal Marke

(u) "Confidential Information" means any information disclosed by either party to the other party, either directly or indirectly, in writing, orally or by inspection of tangib objects (including, without limitation, documents, prototypes, samples, plant and equipment), which is designated, either orally or in writing, as "Confidential," "Proprietary" or some similar designation. Information communicated orally shall be considered Confidential Information if such information is confirmed in writing as being Confidential Informatio within ten (10) Business Days after the initial disclosure. Confidential Information may also include information disclosed to a disclosing party by third parties. Confidentia Information shall not, however, include any information which (i) was publicly known and made generally available in the public domain prior to the time of disclosure by the disclosing party; (ii) becomes publicly known and made generally available after disclosure by the disclosing party to the receiving party through no action or inaction of the receiving party; (iii) is already in the possession of the receiving party without confidential restriction at the time of disclosure by the disclosing party as shown by the receiving party's files and records immediately prior to the time of disclosure; (iv) is obtained by the receiving party from a third party without a breach of such third party's obligations of confidentiality; (v) is independently developed by the receiving party without use of or reference to the disclosing party's Confidential Information, as shown by documents and other competent evidence in the receiving party's possession; or (vi) is required by law to be disclosed by the receiving party, provided that the receiving party gives the disclosing party prompt written notice of such requirement prior to such disclosure and assistance in obtaining an order protecting the information from public disclosure.

(v) "Custodian" means any receiver, trustee, assignee, liquidator or similar official under any Bankruptcy Law.

(w) "DTC" means The Depository Trust Company, or any successor performing substantially the same function for the Company.

(x) "DWAC Shares" means shares of Common Stock that are (i) issued in electronic form, (ii) freely tradable and transferable and without restriction on resale and (ii credited by the Company, once a DWAC notice is received, to the Investor's or its designee's specified Deposit/Withdrawal at Custodian (DWAC) account with DTC under i Fast Automated Securities Transfer (FAST) Program, or any similar program hereafter adopted by DTC performing substantially the same function.

(y) "Exchange Act" means the Securities Exchange Act of 1934, as amended, and the rules and regulations promulgated thereunder.

(z) "Fully Adjusted Regular Purchase Share Limit" means, with respect to any reorganization, recapitalization, non-cash dividend, stock split, reverse stock split or othe transaction from and after the date of this Agreement, the Regular Purchase Share Limit (as defined in Section 2(b) hereof) in effect on the applicable date of determination, after giving effect to the full proportionate adjustment thereto made pursuant to Section 2(b) hereof for or in respect of such reorganization, recapitalization, non-cash dividend, stock split, reverse stock split or other similar transaction.

(aa) "Initial Prospectus Supplement" means the prospectus supplement of the Company relating to the Securities, including the accompanying Base Prospectus, to be pr and filed by the Company with the SEC pursuant to Rule 424(b)(5) under the Securities Act and in accordance with Section 5(a) hereof, together with all documents and information incorporated therein by reference.

(bb) "Material Adverse Effect" means any material adverse effect on (i) the enforceability of any Transaction Document, (ii) the results of operations, assets, business financial condition of the Company and its subsidiaries, taken as a whole, other than any material adverse effect that resulted exclusively from (A) any change in the United States or foreign economies or securities or financial markets in general that does not have a disproportionate effect on the Company and its subsidiaries, taken as a whole, (B) any change that generally affects the industry in which the Company and its subsidiaries operate that does not have a disproportionate effect on the Company and its subsidiaries, taken as a whole, (C) any change arising in connection with earthquakes, hostilities, acts of war, sabotage or terrorism or military actions or any escalation or material worsening of any such hostilities, acts of war, sabotage or terrorism or military actions existing as of the date hereof, (D) any action taken by the Investor, its affiliates or its or their successors and assigns with respect to the transactions contemplated by this Agreement, (E) the effect of any change in applicable laws or accounting rules that does not have a disproportionate effect on the Company and its subsidiaries, taken as a whole, or (F) any change resulting from compliance with terms of this Agreement or the consummation of the transactions contemplated by this Agreement, or (iii) the Company's ability to perform in any material respect on a timely basis its obligations under any Transaction Document to be performed as of the date of determination.

(cc) "Maturity Date" means the first day of the month immediately following the thirty-six (36) month anniversary of the Commencement Date.

(dd) "PEA Period" means the period commencing at 9:30 a.m., Eastern time, on the tenth (10^{th}) Business Day immediately prior to the filing of any post-effective amer to the Registration Statement (as defined herein) or New Registration Statement (as such term is defined in the Registration Rights Agreement), and ending at 9:30 a.m., Easter time, on the Business Day immediately following, the effective date of any post-effective amendment to the Registration Statement (as defined herein) or New Registratio Statement (as such term is defined in the Registration Rights Agreement).

(ee) "Person" means an individual or entity including but not limited to any limited liability company, a partnership, a joint venture, a corporation, a trust, an unincorporate organization and a government or any department or agency thereof.

(ff) "Principal Market" means The Nasdaq Capital Market (or any nationally recognized successor thereto); provided, however, that in the event the Company's Comn Stock is ever listed or traded on The Nasdaq Global Select Market, The Nasdaq Global Market, the New York Stock Exchange, the NYSE American, the NYSE Arca, the O Bulletin Board, or the OTCQX or OTCQB operated by the OTC Markets Group, Inc. (or any nationally recognized successor to any of the foregoing), then the "Principal Mark shall mean such other market or exchange on which the Company's Common Stock is then listed or traded.

(gg) "Prospectus" means the Base Prospectus, as supplemented from time to time by any Prospectus Supplement (including the Initial Prospectus Supplement), includin documents and information incorporated by reference therein.

(hh) "Prospectus Supplement" means any prospectus supplement to the Base Prospectus (including the Initial Prospectus Supplement) filed with the SEC pursuant to R 424(b) under the Securities Act in connection with the transactions contemplated by this Agreement, including the documents and information incorporated by reference therein.

(ii) "Purchase Amount" means, with respect to the Initial Purchase, any Regular Purchase, any Accelerated Purchase, or any Additional Accelerated Purchase mad hereunder, as applicable, the portion of the Available Amount to be purchased by the Investor pursuant to Section 2 hereof.

(jj) "Purchase Date" means, with respect to a Regular Purchase made pursuant to Section 2(b) hereof, the Business Day on which the Investor receives, after 4:00 p.1 Eastern time, but prior to 6:00 p.m., Eastern time, on such Business Day, a valid Regular Purchase Notice for such Regular Purchase in accordance with this Agreement.

(kk) "Purchase Price" means, with respect to a Regular Purchase made pursuant to Section 2(b) hereof, the lower of: (i) the lowest Sale Price on the Purchase Date fc Regular Purchase and (ii) the arithmetic average of the three (3) lowest Closing Sale Prices for the Common Stock during the ten (10) consecutive Business Days ending on th Business Day immediately preceding such Purchase Date for such Regular Purchase (in each case, to be appropriately adjusted for any reorganization, recapitalization, non-cas dividend, stock split, reverse stock split or other similar transaction that occurs on or after the date of this Agreement).

(ll) "Registration Rights Agreement" means that certain Registration Rights Agreement, of even date herewith between the Company and the Investor.

(mm) "Registration Statement" has the meaning set forth in the Registration Rights Agreement.

(nn) "Regular Purchase Notice" means, with respect to a Regular Purchase pursuant to Section 2(b) hereof, an irrevocable written notice from the Company to the Inve directing the Investor to buy a specified number of Purchase Shares (subject to the Purchase Share limitations contained in Section 2(b) hereof) at the applicable Purchase Price for such Regular Purchase in accordance with this Agreement.

(oo) "Sale Price" means any trade price for the shares of Common Stock on the Principal Market as reported by the Principal Market.

(pp) "SEC" means the U.S. Securities and Exchange Commission.

(qq) "Securities" means, collectively, the Purchase Shares and the Commitment Shares (as defined below).

(rr) "Securities Act" means the Securities Act of 1933, as amended, and the rules and regulations promulgated thereunder.

(ss) "Shelf Registration Statement" has the meaning set forth in the Registration Rights Agreement.

(tt) "Subsidiary" means any Person the Company wholly-owns or controls, or in which the Company, directly or indirectly, owns a majority of the voting stock or simila interest, in each case that would be disclosable pursuant to Item 601(b)(21) of Regulation S-K promulgated under the Securities Act.

(uu) "Transaction Documents" means, collectively, this Agreement and the schedules and exhibits hereto, the Registration Rights Agreement and the schedules and exh thereto.

(vv) "Transfer Agent" means Broadridge Corporate Issuer Solutions, Inc., or such other Person who is then serving as the transfer agent for the Company in respect of Common Stock.

(ww) "VWAP" means in respect of an Accelerated Purchase Date and an Additional Accelerated Purchase Date, as applicable, the volume weighted average price o the Common Stock on the Principal Market, as reported on the Principal Market.

2. PURCHASE OF COMMON STOCK.

Subject to the terms and conditions set forth in this Agreement, the Company has the right to sell to the Investor, and the Investor has the obligation to purchase from the Company, Purchase Shares as follows:

(a) Initial Purchase of Common Stock. Upon the satisfaction of the conditions set forth in Sections 7 and 8 hereof (the "Commencement" and the date of satisfaction c conditions the "Commencement Date"), the Investor shall purchase 545,455 Purchase Shares at a purchase price of Three Million Dollars ($3,000,000) (such purchase the "Initial Purchase" and such Purchase Shares, the "Initial Purchase Shares").

(b) Commencement of Regular Sales of Common Stock. Beginning one Business Day following the Commencement Date and thereafter, the Company shall have the but not the obligation, to direct the Investor, by its delivery to the Investor of a Regular Purchase Notice from time to time, to purchase up to Two Hundred Fifty Thousan (250,000) Purchase Shares, if the Closing Sale Price of the Common Stock on the applicable Purchase Date is not below $0.10, subject to adjustment as set forth below in th Section 2(b) (such maximum number of Purchase Shares, as may be adjusted from time to time, the "Regular Purchase Share Limit"), at the Purchase Price on the Purchase Date (each such purchase a "Regular Purchase"); all of which share and dollar amounts shall be appropriately proportionately adjusted for any reorganization, recapitalization, non-cash dividend, stock split, reverse stock split or other similar transaction; provided that if, after giving effect to the full proportionate adjustment to the Regular Purchase Share Limi therefor, the Fully Adjusted Regular Purchase Share Limit then in effect would preclude the Company from delivering to the Investor a Regular Purchase Notice hereunder for Purchase Amount (calculated by multiplying (X) the number of Purchase Shares equal to the Fully Adjusted Regular Purchase Share Limit, by (Y) the Purchase Price p Purchase Share covered by such Regular Purchase Notice on the applicable Purchase Date therefor) equal to or greater than the Alternate Adjusted Regular Purchase Shar Limit, the Regular Purchase Share Limit for such Regular Purchase Notice shall not be fully adjusted to equal the applicable Fully Adjusted Regular Purchase Share Limit, b rather the Regular Purchase Share Limit for such Regular Purchase Notice shall be adjusted to equal the applicable Alternate Adjusted Regular Purchase Share Limit as of tl applicable Purchase Date for such Regular Purchase Notice; and provided, further, however, that the Investor's committed obligation under any single Regular Purchase, other than any Regular Purchase with respect to which an Alternate Adjusted Regular Purchase Share Limit shall apply, shall not exceed Three Million Dollars ($3,000,000) an provided, further, however, that the parties may mutually agree to increase the Regular Purchase Share Limit for any Regular Purchase to a number of shares greater than th Regular Purchase Share limit then in effect. If the Company delivers any Regular Purchase Notice for a Purchase Amount in excess of the limitations contained in the immediately preceding sentence, such Regular Purchase Notice shall be void *ab initio* only with respect to the extent of the amount

by which the number of Purchase Shares set forth in such Regular Purchase Notice exceeds the number of Purchase Shares which the Company is permitted to include in suc Purchase Notice in accordance herewith, and the Investor shall have no obligation to purchase such excess Purchase Shares in respect of such Regular Purchase Notice provided, however, that the Investor shall remain obligated to purchase the number of Purchase Shares which the Company is permitted to include in such Regular Purchase Notice. The Company may deliver multiple Regular Purchase Notices to the Investor as often as every Business Day, so long as the Company has not failed to deliver Purchas Shares for the most recent prior Regular Purchase. Notwithstanding the foregoing, the Company shall not deliver any Regular Purchase Notices during the PEA Period.

(c) Accelerated Purchases. Subject to the terms and conditions of this Agreement, from and after one (1) Business Day following the Commencement Date, in additio purchases of Purchase Shares as described in Section 2(b) hereof, the Company shall also have the right, but not the obligation, to direct the Investor, by its delivery to the Investor of an Accelerated Purchase Notice from time to time in accordance with this Agreement, to purchase the applicable Accelerated Purchase Share Amount at the Accelerated Purchase Price on the Accelerated Purchase Date therefor in accordance with this Agreement (each such purchase, an "Accelerated Purchase"); provided however, that the parties may mutually agree to increase the Accelerated Purchase Share Amount. The Company may deliver an Accelerated Purchase Notice to the Investor only on a Purchas Date on which the Company also properly submitted a Regular Purchase Notice providing for a Regular Purchase of a number of Purchase Shares not less than the Regul Purchase Share Limit then in effect on such Purchase Date in accordance with this Agreement (including, without limitation, giving effect to any automatic increase to the Regula Purchase Share Limit as a result of the Closing Sale Price of the Common Stock exceeding certain thresholds set forth in Section 2(b) hereof on such Purchase Date and any other adjustments to the Regular Purchase Share Limit, in each case pursuant to Section 2(b) hereof). If the Company delivers any Accelerated Purchase Notice directing the Investor to purchase an amount of Purchase Shares that exceeds the Accelerated Purchase Share Amount that the Company is then permitted to include in such Accelerate Purchase Notice, such Accelerated Purchase Notice shall be void *ab initio* only with respect to the extent of the amount by which the number of Purchase Shares set forth in such Accelerated Purchase Notice exceeds the Accelerated Purchase Share Amount that the Company is then permitted to include in such Accelerated Purchase Notice (whic shall be confirmed in an Accelerated Purchase Confirmation), and the Investor shall have no obligation to purchase such excess Purchase Shares in respect of such Accelerate Purchase Notice; provided, however, that the Investor shall remain obligated to purchase the Accelerated Purchase Share Amount which the Company is permitted to include in such Accelerated Purchase Notice. Within one (1) Business Day after completion of each Accelerated Purchase Date for an Accelerated Purchase, the Investor will provide t the Company a written confirmation of such Accelerated Purchase setting forth the applicable Accelerated Purchase Share Amount and Accelerated Purchase Price for suc Accelerated Purchase (each, an "Accelerated Purchase Confirmation"). Notwithstanding the foregoing, the Company shall not deliver any Accelerated Purchase Notices durin the PEA Period.

(d) Additional Accelerated Purchases. Subject to the terms and conditions of this Agreement, from and after one Business Day following the Commencement Date, in addition to purchases of Purchase Shares as described in Section 2(b) and Section 2(c) hereof, the Company shall also have the right, but not the obligation, to direct the Investor, by its timely delivery to the Investor of an Additional Accelerated Purchase Notice on an Additional Accelerated Purchase Date in accordance with this Agreement, to purchase the applicable Additional Accelerated Purchase Share Amount at the applicable Additional Accelerated Purchase Price therefor in accordance with this Agreement (each such purchase, an "Additional Accelerated Purchase"); provided however, that the parties may mutually agree to increase the Additional Accelerated Purchase Share Amount for any Additional Accelerated Purchase. The Company may deliver

multiple Additional Accelerated Purchase Notices to the Investor on an Additional Accelerated Purchase Date; provided, however, that the Company may deliver an Additional Accelerated Purchase Notice to the Investor only (i) on a Business Day that is also the Accelerated Purchase Date for an Accelerated Purchase with respect to which th Company properly submitted to the Investor an Accelerated Purchase Notice in accordance with this Agreement on the applicable Purchase Date for a Regular Purchase of number of Purchase Shares not less than the Regular Purchase Share Limit then in effect in accordance with this Agreement (including, without limitation, giving effect to an automatic increase to the Regular Purchase Share Limit as a result of the Closing Sale Price of the Common Stock exceeding certain thresholds set forth in Section 2(b) hereof on such Purchase Date and any other adjustments to the Regular Purchase Share Limit, in each case pursuant to Section 2(b) hereof), and (ii) if all Purchase Shares subject to al prior Regular Purchases, Accelerated Purchases and Additional Accelerated Purchases, including, without limitation, those that have been effected on the same Business Day a the applicable Additional Accelerated Purchase Date with respect to which the applicable Additional Accelerated Purchase relates, in each case have theretofore been receive by the Investor as DWAC Shares in accordance with this Agreement. If the Company delivers any Additional Accelerated Purchase Notice directing the Investor to purchase a amount of Purchase Shares that exceeds the Additional Accelerated Purchase Share Amount that the Company is then permitted to include in such Additional Accelerate Purchase Notice, such Additional Accelerated Purchase Notice shall be void *ab initio* only with respect to the extent of the amount by which the number of Purchase Shares se forth in such Additional Accelerated Purchase Notice exceeds the Additional Accelerated Purchase Share Amount that the Company is then permitted to include in suc

Additional Accelerated Purchase Notice (which shall be confirmed in an Additional Accelerated Purchase Confirmation), and the Investor shall have no obligation to purchase such excess Purchase Shares in respect of such Additional Accelerated Purchase Notice; provided, however, that the Investor shall remain obligated to purchase the Additional Accelerated Purchase Share Amount which the Company is permitted to include in such Additional Accelerated Purchase Notice. Within one (1) Business Day after completion of each Additional Accelerated Purchase Date, the Investor will provide to the Company a written confirmation of each Additional Accelerated Purchase on such Additional Accelerated Purchase Date setting forth the applicable Additional Accelerated Purchase Share Amount and Additional Accelerated Purchase Price for each such Additional Accelerated Purchase on such Additional Accelerated Purchase Date (each, an "Additional Accelerated Purchase Confirmation"). Notwithstanding the foregoing, the Company shall not deliver any Additional Accelerated Purchase Notices during the PEA Period.

(e) Compliance with Principal Market Rules. Notwithstanding anything in this Agreement to the contrary, and in addition to the limitations set forth in Section 2(g) hereof, the Company shall not issue more than 22,565,270 shares (including the Commitment Shares) of Common Stock (the "Exchange Cap") under this Agreement, which equals 19.99% of the Company's outstanding shares of Common Stock as of the date hereof, unless stockholder approval is obtained to issue in excess of the Exchange Cap; provided, however, that the foregoing limitation shall not apply if at any time the Exchange Cap is reached and at all times thereafter the average price paid for all shares of Common Stock issued under this Agreement is equal to or greater than $5.658 (the "Minimum Price"), a price equal to the lower of (i) the Nasdaq Official Closing Price immediately preceding the execution of this Agreement or (ii) the arithmetic average of the five (5) Nasdaq Official Closing Prices for the Common Stock immediately preceding the execution of this Agreement, as calculated in accordance with the rules of the Principal Market (in such circumstance, for purposes of the Principal Market, the transaction contemplated hereby would not be "below market" and the Exchange Cap would not apply). Notwithstanding the foregoing, the Company shall not be required or permitted to issue, and the Investor shall not be required to purchase, any shares of Common Stock under this Agreement if such issuance would violate the rules or regulations of the Principal Market. The Company may, in its sole discretion, determine whether to obtain stockholder approval to issue more than 19.99% of its outstanding shares of Common Stock hereunder if such issuance would require stockholder approval under the rules or regulations of the Principal Market. The Exchange Cap shall be reduced, on a share-for-share basis, by the number of shares of Common Stock issued or issuable that may be aggregated with the transactions contemplated by this Agreement under applicable rules of the Principal Market.

(f) Payment for Purchase Shares. For the Initial Purchase and each Regular Purchase, the Investor shall pay to the Company an amount equal to the Purchase Amount with respect to such Initial Purchase or Regular Purchase, as applicable, as full payment for such Purchase Shares via wire transfer of immediately available funds on the same Business Day that the Investor receives such Purchase Shares, if such Purchase Shares are received by the Investor before 1:00 p.m., Eastern time, or, if such Purchase Shares are received by the Investor after 1:00 p.m., Eastern time, the next Business Day. For each Accelerated Purchase and each Additional Accelerated Purchase, the Investor shall pay to the Company an amount equal to the Purchase Amount with respect to such Accelerated Purchase and Additional Accelerated Purchase, respectively, as full payment for such Purchase Shares via wire transfer of immediately available funds on the second Business Day following the date that the Investor receives such Purchase Shares. If the Company or the Transfer Agent shall fail for any reason or for no reason to electronically transfer any Purchase Shares as DWAC Shares with respect to any Regular Purchase, Accelerated Purchase or Additional Accelerated Purchase (as applicable) within two (2) Business Days following the receipt by the Company of the Purchase Price, Accelerated Purchase Price or Additional Accelerated Purchase Price, respectively, therefor in compliance with this Section 2(f), and if on or after such Business Day the Investor purchases (in an open market transaction or otherwise) shares of Common Stock to deliver in satisfaction of a sale by the Investor of such Purchase Shares that the Investor anticipated receiving from the Company in respect of such Initial Purchase, Regular Purchase, Accelerated Purchase or Additional Accelerated Purchase (as applicable), then the Company shall, within two (2) Business Days after the Investor's request, either (i) pay cash to the Investor in an amount equal to the Investor's total purchase price (including customary brokerage commissions, if any) for the shares of Common Stock so purchased (the "Cover Price"), at which point the Company's obligation to deliver such Purchase Shares as DWAC Shares shall terminate, or (ii) promptly honor its obligation to deliver to the Investor such Purchase Shares as DWAC Shares and pay cash to the Investor in an amount equal to the excess (if any) of the Cover Price over the total Purchase Amount paid by the Investor pursuant to this Agreement for all of the Purchase Shares to be purchased by the Investor in connection with such purchases. The Company shall not issue any fraction of a share of Common Stock upon the Initial Purchase, any Regular Purchase, Accelerated Purchase or Additional Accelerated Purchase. If the issuance would result in the issuance of a fraction of a share of Common Stock, the Company shall round such fraction of a share of Common Stock up or down to the nearest whole share. All payments made under this Agreement shall be made in lawful money of the United States of America or wire transfer of immediately available funds to such account as the Company may from time to time designate by written notice in accordance with the provisions of this Agreement. Whenever any amount expressed to be due by the terms of this Agreement is due on any day that is not a Business Day, the same shall instead be due on the next succeeding day that is a Business Day.

(g) Beneficial Ownership Limitation. Notwithstanding anything to the contrary contained in this Agreement, the Company shall not issue or sell, and the Investor shall not purchase or acquire, any shares of Common Stock under this Agreement which, when aggregated with all other shares of Common Stock then beneficially owned by the Investor and its affiliates (as calculated pursuant to Section 13(d) of the Exchange Act and Rule 13d-3 promulgated thereunder), would result in the beneficial ownership by the Investor and its affiliates of more than 9.99% of the then issued and outstanding shares of Common Stock (the "Beneficial Ownership Limitation"). Upon the written or oral request of the Investor, the Company shall promptly (but not later than one Business Day) confirm orally or in writing to the Investor the number of shares of Common Stock then outstanding. The Investor and the Company shall each cooperate in good faith in the determinations required hereby and the application hereof. The Investor's written certification to the Company of the applicability of the Beneficial Ownership Limitation, and the resulting effect thereof hereunder at any time, shall be conclusive with respect to the applicability thereof and such result absent manifest error.

3. INVESTOR'S REPRESENTATIONS AND WARRANTIES.

The Investor represents and warrants to the Company that as of the date hereof and as of the Commencement Date:

(a) Organization, Authority. Investor is an entity duly organized, validly existing and in good standing under the laws of the jurisdiction of its organization, with the requisite power and authority to enter into and to consummate the transactions contemplated by this Agreement and the other Transaction Documents to which it is a party and otherwise to carry out its obligations hereunder and thereunder.

(b) Investment Purpose. The Investor is acquiring the Securities as principal for its own account for investment only and not with a view to or for distributing or reselling such Securities or any part thereof in violation of the Securities Act or any applicable state securities law, has no present intention of distributing any of such Securities in violation of the Securities Act or any applicable state securities law and has no direct or indirect arrangement or understandings with any other Persons to distribute or regarding the distribution of such Securities in violation of the Securities Act or any applicable state securities law (this representation and warranty not limiting the Investor's right to sell the Securities at any time pursuant to the Registration Statement described herein or otherwise in compliance with applicable federal and state securities laws). The Investor is acquiring the Securities hereunder in the ordinary course of its business.

(c) Accredited Investor Status. The Investor is an "accredited investor" as that term is defined in Rule 501(a)(3) of Regulation D promulgated under the Securities Act.

(d) Information. The Investor understands that its investment in the Securities involves a high degree of risk. The Investor (i) is able to bear the economic risk of an investment in the Securities including a total loss thereof, (ii) has such knowledge and experience in financial and business matters that it is capable of evaluating the merits and risks of the proposed investment in the Securities and (iii) has had an opportunity to ask questions of and receive answers from the officers of the Company concerning the financial condition and business of the Company and others matters related to an investment in the Securities. Neither such inquiries nor any other due diligence investigations conducted by the Investor or its representatives shall modify, amend or affect the Investor's right to rely on the Company's representations and warranties contained in Section 4 hereof. The Investor has sought such accounting, legal and tax advice as it has considered necessary to make an informed investment decision with respect to its acquisition of the Securities and is not relying on any accounting, legal tax or other advice from the Company or its officers, employees or representatives. The Investor acknowledges and agrees that the Company neither makes nor has made any representations or warranties with respect to the transactions contemplated hereby other than those specifically set forth in Section 4 hereof.

(e) No Governmental Review. The Investor understands that no U.S. federal or state agency or any other government or governmental agency has passed on or made recommendation or endorsement of the Securities or the fairness or suitability of an investment in the Securities nor have such authorities passed upon or endorsed the merits of the offering of the Securities.

(f) Validity; Enforcement. This Agreement and the other Transactional Documents have been duly and validly authorized, executed and delivered on behalf of the Inve and each is a valid and binding agreement of the Investor enforceable against the Investor in accordance with its terms, subject as to enforceability to general principles of equity and to applicable bankruptcy, insolvency, reorganization, moratorium, liquidation and other similar laws relating to, or affecting generally, the enforcement of applicable creditors' rights and remedies.

(g) Residency. The Investor's principal place of business is located in of the State of Illinois.

(h) No Short Selling The Investor represents and warrants to the Company that at no time prior to the date of this Agreement has any of the Investor, its agents representatives or affiliates engaged in or effected, in any manner whatsoever, directly or indirectly, any (i) "short sale" (as such term is defined in Rule 200 of Regulation SHO of the Exchange Act) of the Common Stock or (ii) hedging transaction, which establishes a net short position with respect to the Common Stock.

4. REPRESENTATIONS AND WARRANTIES OF THE COMPANY.

The Company represents and warrants to the Investor that, as of the date hereof and as of the Commencement Date:

(a) Organization and Qualification. The Company and each of its Subsidiaries is an entity duly incorporated or otherwise organized, validly existing and in good standing the laws of the jurisdiction of its incorporation or organization, with the requisite corporate power and authority to own and use its properties and assets and to carry on its business as currently conducted. Neither the Company nor any of its Subsidiaries is in violation or default of any of the provisions of its respective certificate or articles of formation or incorporation, bylaws or other organizational or charter documents. Each of the Company and its Subsidiaries is duly qualified to conduct business and is in good standing as a foreign corporation or other entity in each jurisdiction in which the nature of the business conducted or property owned by it makes such qualification necessary, and no proceeding has been instituted in any such jurisdiction revoking, limiting or curtailing or seeking to revoke, limit or curtail such power and authority or qualification, except where the failure to be so qualified or in good standing or such proceeding, as the case may be, would not reasonably be expected to result in a Material Adverse Effect. The Company has no Subsidiaries except for the subsidiaries set forth on Exhibit 21.1 to the Company's Annual Report on Form 10-K for the year ended December 31, 2021.

(b) Authorization; Enforcement; Validity. (i) The Company has the requisite corporate power and authority to enter into and perform its obligations under this Agreeme each of the other Transaction Documents, and to issue the Securities in accordance with the terms hereof and thereof, (ii) the execution and delivery of the Transaction Documents by the Company and the consummation by it of the transactions contemplated hereby and thereby, including without limitation, the issuance of the Commitment Shares (as defined below in Section 5(e)), the reservation for issuance and the issuance of the Purchase Shares issuable under this Agreement, have been duly authorized by the Company's board of directors, or a validly authorized committee thereof (collectively, the "Board of Directors"), and no further consent or authorization is required by the Company, its Board of Directors or any committee thereof, or its stockholders (save to the extent provided in this Agreement), (iii) this Agreement has been, and each other Transaction Document shall be on the Commencement Date, duly executed and delivered by the Company and (iv) this Agreement constitutes, and each other Transaction Document upon its execution on behalf of the Company, shall constitute, the valid and binding obligations of the Company enforceable against the Company in accordance with their terms, except as such enforceability may be limited by general principles of equity or applicable bankruptcy, insolvency, reorganization, moratorium, liquidation or similar laws relating to, or affecting generally, the enforcement of creditors' rights and remedies. The Board of Directors of the Company has approved the resolutions (the "Signing Resolutions") substantially in the form as set forth as Exhibit B attached hereto to authorize this Agreement and the transactions contemplated hereby. The Signing Resolutions are valid, in full force and effect and have not been modified or supplemented in any respect. The Company has delivered to the Investor a true and correct copy of a

unanimous written consent adopting the Signing Resolutions executed by all of the members of the Board of Directors of the Company. Except as set forth in this Agreement, no other approvals or consents of the Board of Directors, any other authorized committee thereof, and/or stockholders is necessary under applicable laws and the Company's Certificate of Incorporation and/or Bylaws to authorize the execution and delivery of this Agreement or any of the transactions contemplated hereby, including, but not limited to, the issuance of the Commitment Shares and the issuance of the Purchase Shares.

(c) Capitalization. As of the date hereof, the authorized capital stock of the Company consists of 250,000,000 shares of $0.001 par value Common Stock and 1,000,000 of $0.001 par value preferred stock. Except as disclosed in the SEC Documents (as defined below), (i) no shares of the Company's capital stock are subject to preemptive rights or any other similar rights or any liens or encumbrances suffered or permitted by the Company, (ii) there are no outstanding debt securities, (iii) there are no outstanding options, warrants, scrip, rights to subscribe to, calls or commitments of any character whatsoever relating to, or securities or rights convertible into, any shares of capital stock of the Company or any of its Subsidiaries, or contracts, commitments, understandings or arrangements by which the Company or any of its Subsidiaries is or may become bound to issue additional shares of capital stock of the Company or any of its Subsidiaries or options, warrants, scrip, rights to subscribe to, calls or commitments of any character whatsoever relating to, or securities or rights convertible into, any shares of capital stock of the Company or any of its Subsidiaries, (iv) there are no agreements or arrangements under which the Company or any of its Subsidiaries is obligated to register the sale of any of their securities under the Securities Act (except the Registration Rights Agreement and those registration rights for which a registration statement has been filed and is effective), (v) there are no outstanding securities or instruments of the Company or any of its Subsidiaries which contain any redemption or similar provisions, and there are no contracts, commitments, understandings or arrangements by which the Company or any of its Subsidiaries is or may become bound to redeem a security of the Company or any of its Subsidiaries, (vi) there are no securities or instruments containing anti-dilution or similar provisions that will be triggered by the issuance of the Securities as described in this Agreement and (vii) the Company does not have any stock appreciation rights or "phantom stock" plans or agreements or any similar plan or agreement. The Company has furnished to the Investor true and correct copies of the Articles of Incorporation and the Bylaws, each as in effect on the date hereof, and copies of any documents containing the material rights of holders of securities convertible or exercisable for Common Stock, to the extent not filed as an exhibit to the Company's Annual Report on Form 10-K for the fiscal year ended December 31, 2021 or other Exchange Act reports.

(d) Issuance of Securities. Upon issuance and payment therefor in accordance with the terms and conditions of this Agreement, the Purchase Shares (including, withou limitation, the Initial Purchase Shares) shall be validly issued, fully paid and nonassessable and free from all taxes, liens, charges, restrictions, rights of first refusal and preemptive rights with respect to the issue thereof, with the holders being entitled to all rights accorded to a holder of Common Stock. Five Million Five Hundred Thousand (5,500,000) share of Common Stock have been duly authorized and reserved for issuance upon purchase under this Agreement as Purchase Shares. Fifty Thousand Eight Hundred Ninety-Or (50,891) shares of Common Stock (subject to equitable adjustment for any reorganization, recapitalization, non-cash dividend, stock split, reverse stock split or other similar transaction) have been duly authorized and reserved for issuance as Initial Commitment Shares (as defined below in Section 5(e)) in accordance with this Agreement. The Initial Commitment Shares shall be validly issued, fully paid and nonassessable and free from all taxes, Liens, charges, restrictions, rights of first refusal and preemptive rights with respect to the issue thereof, with the holders being entitled to all rights accorded to a holder of Common Stock. One

Hundred One Thousand Seven Hundred Eighty-One (101,781) shares of Common Stock (subject to equitable adjustment for any reorganization, recapitalization, non-cash dividend, stock split, reverse stock split or other similar transaction) have been duly authorized and reserved for issuance as Additional Commitment Shares (as defined below in Section 5(e)) in accordance with this Agreement. When issued in accordance with this Agreement, the Additional Commitment Shares shall be validly issued, fully paid and nonassessable and free from all taxes, liens, charges, restrictions, rights of first refusal and preemptive rights with respect to the issue thereof, with the holders being entitled to all rights accorded to a holder of Common Stock. The Securities are being issued pursuant to the Registration Statement, and the issuance of the Securities has been registered by the Company pursuant to the Securities Act. Upon receipt of the Purchase Shares and the Commitment Shares, the Investor will have good and marketable title to such Securities and such Securities will be immediately freely tradable on the Principal Market by any holder who is not an "affiliate" under the Act.

(e) No Conflicts. The execution, delivery and performance of the Transaction Documents by the Company and the consummation by the Company of the transactions contemplated hereby and thereby (including, without limitation, the reservation for issuance and issuance of the Purchase Shares and the Commitment Shares) will not (i) result in a violation of the Articles of Incorporation, any Certificate of Designations, Preferences and Rights of any outstanding series of preferred stock of the Company or the Bylaws or (ii) conflict with, or constitute a default (or an event which with notice or lapse of time or both would become a default) under, or give to others any rights of termination, amendment, acceleration or cancellation of, any agreement, indenture or instrument to which the Company or any of its Subsidiaries is a party, or result in a violation of any law, rule, regulation, order, judgment or decree (including federal and state securities laws and regulations and the rules and regulations of the Principal Market applicable to the Company or any of its Subsidiaries) or by which any property or asset of the Company or any of its Subsidiaries is bound or affected, except in the case of conflicts, defaults, terminations, amendments, accelerations, cancellations and violations under clause (ii), which would not reasonably be expected to result in a Material Adverse Effect. Neither the Company nor its Subsidiaries is in violation of any term of or in default under its Articles of Incorporation, any Certificate of Designation, Preferences and Rights of any outstanding series of preferred stock of the Company or Bylaws or their organizational charter or bylaws, respectively. Neither the Company nor any of its Subsidiaries is in violation of any term of or is in default under any material contract, agreement, mortgage, indebtedness, indenture, instrument, judgment, decree or order or any statute, rule or regulation applicable to the Company or its Subsidiaries, except for possible conflicts, defaults, terminations or amendments that would not reasonably be expected to have a Material Adverse Effect. The business of the Company and its Subsidiaries is not being conducted, and shall not be conducted, in violation of any law, ordinance or regulation of any governmental entity, except for possible violations, the sanctions for which either individually or in the aggregate would not reasonably be expected to have a Material Adverse Effect. Except as specifically contemplated by this Agreement and as required under the Securities Act or applicable state securities laws and the rules and regulations of the Principal Market, the Company is not required to obtain any consent, authorization or order of, or make any filing or registration with, any court or governmental agency or any regulatory or self-regulatory agency in order for it to execute, deliver or perform any of its obligations under or contemplated by the Transaction Documents in accordance with the terms hereof or thereof. Except as set forth elsewhere in this Agreement, (i) all consents, authorizations, orders, filings and registrations which the Company is required to obtain pursuant to the preceding sentence on or prior to the date hereof or on or prior to the Commencement Date shall be obtained or effected on or prior to the date hereof and on or prior to the Commencement Date, respectively, and (ii) all consents, authorizations, orders, filings and registrations which the Company is required to obtain pursuant to the preceding sentence with respect to the Commencement shall be obtained or effected on or prior to the Commencement Date.

(f) SEC Documents; Financial Statements. The Company has filed all reports, schedules, forms, statements and other documents required to be filed by the Company under the Securities Act and the Exchange Act, including pursuant to Section 13(a) or 15(d) thereof, for the twelve months preceding the date hereof (or such shorter period as the Company was required by law or regulation to file such material) (the foregoing materials, including the exhibits thereto and documents incorporated by reference therein, together with each Prospectus, being collectively referred to herein as the "SEC Documents") on a timely basis or has received a valid extension of such time of filing and has filed any such SEC Documents prior to the expiration of any such extension. As of their respective dates, the SEC Documents complied in all material respects with the requirements of the Securities Act and the Exchange Act, as applicable. None of the SEC Documents, when filed, contained any untrue statement of a material fact or omitted to state a material fact required to be stated therein or necessary in order to make the statements therein, in the light of the circumstances under which they were made, not misleading. The financial statements of the Company included in the SEC Documents comply in all material respects with applicable accounting requirements and the rules and regulations of the SEC with respect thereto as in effect at the time of filing. Such financial statements have been prepared in accordance with United States generally accepted accounting principles applied on a consistent basis during the periods involved ("GAAP"), except as may be otherwise specified in such financial statements or the notes thereto and except that unaudited financial statements may not contain all footnotes required by GAAP, and fairly present in all material respects the financial position of the Company and its consolidated Subsidiaries as of and for the dates thereof and the results of operations and cash flows for the periods then ended, subject, in the case of unaudited statements, to normal, immaterial, year-end audit adjustments. Except as publicly available through the SEC's Electronic Data Gathering, Analysis, and Retrieval system (EDGAR) or in connection with a confidential treatment request submitted to the SEC, the Company has received no notices or correspondence from the SEC for the one year preceding the date hereof other than SEC comment letters relating to the Company's filings under the Exchange Act and the Securities Act. There are no "open" SEC comments. To the Company's knowledge, the SEC has not commenced any enforcement proceedings against the Company or any of its Subsidiaries.

(g) Absence of Certain Changes Except as disclosed in the SEC Documents, since September 30, 2022, there has been no material adverse change in the business, properties, operations, financial condition or results of operations of the Company or its Subsidiaries. The Company has not taken any steps, and does not currently expect to take any steps, to seek protection pursuant to any Bankruptcy Law nor does the Company or any of its Subsidiaries have any knowledge or reason to believe that its creditors intend to initiate involuntary bankruptcy or insolvency proceedings. The Company is financially solvent and is generally able to pay its debts as they become due.

(h) Absence of Litigation. Except as disclosed in the SEC Documents, there is no action, suit, proceeding, inquiry or investigation before or by any court, public board, government agency, self-regulatory organization or body pending or, to the knowledge of the Company or any of its Subsidiaries, threatened against the Company, the Common Stock or any of the Company's or its Subsidiaries' officers or directors in their capacities as such, which could reasonably be expected to have a Material Adverse Effect.

(i) Acknowledgment Regarding Investor's Status. The Company acknowledges and agrees that the Investor is acting solely in the capacity of arm's length purchaser with respect to the Transaction Documents and the transactions contemplated hereby and thereby. The Company further acknowledges that the Investor is not acting as a financial advisor or fiduciary of the Company (or in any similar capacity) with respect to the Transaction Documents and the transactions contemplated hereby and thereby and any advice given by the Investor or any of its representatives or agents in connection with the Transaction Documents and the transactions contemplated hereby and thereby is merely incidental to the Investor's purchase of the Securities. The Company further represents to the Investor that the Company's decision to enter into the Transaction Documents has been based solely on the independent evaluation by the Company and its representatives and advisors.

(j) No Aggregated Offering. Neither the Company, nor any of its affiliates, nor any Person acting on its or their behalf has, directly or indirectly, made any offers or sa any security or solicited any offers to buy any security, under circumstances that would cause this offering of the Securities to be integrated or aggregated with prior offerings by the Company in a manner that would require stockholder approval pursuant to the rules of the Principal Market on which any of the securities of the Company are listed o designated. The issuance and sale of the Commitment Shares and Initial Purchase Shares hereunder does not, and subject to the terms of this Agreement, the issuance and sale o the additional Purchase Shares will not, contravene the rules and regulations of the Principal Market.

(k) Intellectual Property Rights. The Company and its Subsidiaries own or possess adequate rights or licenses to use all material trademarks, trade names, service marl service mark registrations, service names, patents, patent rights, copyrights, inventions, licenses, approvals, governmental authorizations, trade secrets and rights necessary to conduct their respective businesses as now conducted. None of the Company's material trademarks, trade names, service marks, service mark registrations, service names, patents, patent rights, copyrights, inventions, licenses, approvals, government authorizations, trade secrets or other intellectual property rights have expired or terminated, or, by the terms and conditions thereof, could expire or terminate within two years from the date of this Agreement, except as would not reasonably be expected to have a Material Adverse Effect. Except as set forth in the SEC Documents, the Company and its Subsidiaries do not have any knowledge of any infringement by the Company or its Subsidiaries of ar material trademark, trade name rights, patents, patent rights, copyrights, inventions, licenses, service names, service marks, service mark registrations, trade secret or other similar rights of others, or of any such development of similar or identical trade secrets or technical information by others, and there is no claim, action or proceeding that has been brought against, or to the Company's knowledge, being threatened against, the Company or its Subsidiaries regarding trademark, trade name, patents, patent rights, invention, copyright license, service names, service marks, service mark registrations, trade secret or other infringement, which could reasonably be expected to have a Material Adverse Effect.

(l) Environmental Laws. To the Company's knowledge, the Company and its Subsidiaries (i) are in compliance with any and all applicable foreign, federal, state and lo laws and regulations relating to the protection of human health and safety, the environment or hazardous or toxic substances or wastes, pollutants or contaminants ("Environmental Laws"), (ii) have received all permits, licenses or other approvals required of them under applicable Environmental Laws to conduct their respective businesses and (iii) are ir compliance with all terms and conditions of any such permit, license or approval, except where, in each of the three foregoing clauses, the failure to so comply could not reasonably be expected to have, individually or in the aggregate, a Material Adverse Effect.

(m) Title. Except as set forth in the SEC Documents, the Company and its Subsidiaries have good and marketable title in fee simple to all real property owned by them good and marketable title in all personal property owned by them that is material to the business of the Company and its Subsidiaries, taken as a whole, in each case free and clear of all liens, encumbrances and defects ("Liens") and, except for Liens as do not materially affect the value of such property and do not materially interfere with the use made and proposed to be made of such property by the Company and its Subsidiaries and Liens for the payment of federal, state or other taxes, the payment of which is neither delinquen nor subject to penalties. Any real property and facilities held under lease by the Company and its Subsidiaries are held by them under valid, subsisting and enforceable leases with which the Company and its Subsidiaries are in compliance with such exceptions as are not material and do not interfere with the use made and proposed to be made of such property and buildings by the Company and its Subsidiaries, taken as a whole, except for such interference which would not reasonably be expected to have a Material Adverse Effect.

(n) Insurance. The Company and each of its Subsidiaries are insured by insurers of recognized financial responsibility against such losses and risks and in such amount management of the Company believes to be prudent and customary in the businesses in which the Company and its Subsidiaries are engaged. Neither the Company nor any sucl Subsidiary has been refused any insurance coverage sought or applied for and neither the Company nor any such Subsidiary has any reason to believe that it will not be able tc renew its existing insurance coverage as and when such coverage expires or to obtain similar coverage from similar insurers as may be necessary to continue its business at a cost that would not materially and adversely affect the condition, financial or otherwise, or the earnings, business or operations of the Company and its Subsidiaries, taken as a whole.

(o) Regulatory Permits. Except as disclosed in the SEC Documents, the Company and its Subsidiaries possess all material certificates, authorizations and permits issue appropriate federal, state or foreign regulatory authorities necessary to conduct their respective businesses as currently conducted and neither the Company nor any such Subsidiary has received any notice of proceedings relating to the revocation or modification of any such certificate, authorization or permit, except in the case of each of the two foregoing clauses, as would not reasonably be expected to have a Material Adverse Effect.

(p) Tax Status. The Company and each of its Subsidiaries has made or filed all foreign, federal and state income and all other material tax returns, reports and declarat required by any jurisdiction to which it is subject or otherwise filed timely extensions (unless and only to the extent that the Company and each of its Subsidiaries has set aside or its books provisions reasonably adequate for the payment of all unpaid and unreported taxes) and has paid all taxes and other governmental assessments and charges that are material in amount, shown or determined to be due on such returns, reports and declarations, except those being contested in good faith and has set aside on its books provision reasonably adequate for the payment of all taxes for periods subsequent to the periods to which such returns, reports or declarations apply.

(q) Transactions With Affiliates. Except as disclosed in the SEC Documents, none of the Company's stockholders, officers or directors or any family member or affilia any of the foregoing, has either directly or indirectly an interest in, or is a party to, any transaction that would be required to be disclosed as a related party transaction pursuant to Item 404 of Regulation S-K promulgated under the Securities Act.

(r) Application of Takeover Protections. The Company and its board of directors have taken or will take prior to the Commencement Date all necessary action, if any, order to render inapplicable any control share acquisition, business combination, poison pill (including any distribution under a rights agreement) or other similar anti-takeover provision under the Articles of Incorporation or the laws of the state of its incorporation which is or could become applicable to the Investor as a result of the transactions contemplated by this Agreement, including, without limitation, the Company's issuance of the Securities and the Investor's ownership of the Securities.

(s) Disclosure. Except with respect to the material terms and conditions of the transactions contemplated by the Transaction Documents or any other agreements to be entered into by the Company and the Investor that, in each case, which shall be timely publicly disclosed by the Company, the Company confirms that neither it nor any other Person acting on its behalf has provided the Investor or its agents or counsel with any information that the Company believes constitutes or might constitute material, non-public information which is not otherwise disclosed in the Registration Statement or the SEC Documents. The Company understands and confirms that the Investor will rely on th foregoing representation in effecting

purchases and sales of securities of the Company. All of the disclosure furnished by or on behalf of the Company to the Investor regarding the Company, its business and the transactions contemplated hereby, including the disclosure schedules to this Agreement, is true and correct and does not contain any untrue statement of a material fact or omit to state any material fact necessary in order to make the statements made therein, in light of the circumstances under which they were made, not misleading. The press releases disseminated by the Company during the twelve (12) months preceding the date of this Agreement taken as a whole do not contain any untrue statement of a material fact or omit to state a material fact required to be stated therein or necessary in order to make the statements therein, in light of the circumstances under which they were made and when made, not misleading. The Company acknowledges and agrees that the Investor neither makes nor has made any representations or warranties with respect to the transactions contemplated hereby other than those specifically set forth in Section 3 hereof.

(t) Foreign Corrupt Practices. Neither the Company nor any of its Subsidiaries nor, to the knowledge of the Company, any director, officer, agent, employee or affiliate Company or any Subsidiary is aware of or has taken any action, directly or indirectly, that would result in a violation by such persons of the Foreign Corrupt Practices Act of 1977 as amended, and the rules and regulations thereunder (the "FCPA"), including, without limitation, making use of the mails or any means or instrumentality of interstate commerce corruptly in furtherance of an offer, payment, promise to pay or authorization of the payment of any money, or other property, gift, promise to give, or authorization of the giving of anything of value to any "foreign official" (as such term is defined in the FCPA) or any foreign political party or official thereof or any candidate for foreign political office, ir contravention of the FCPA; and the Company, each of its Subsidiaries and, to the knowledge of the Company, its affiliates have conducted their businesses in compliance with the FCPA and have instituted and maintain policies and procedures designed to ensure, and which are reasonably expected to continue to ensure, continued compliance therewith. The operations of the Company and each of its Subsidiaries are and have been conducted at all times in compliance with applicable financial recordkeeping and reporting requirements and the money laundering statutes and the rules and regulations thereunder and any related or similar rules, regulations or guidelines, issued, administered or enforced by any applicable governmental agency, including, without limitation, Title 18 U.S. Code section 1956 and 1957, the Patriot Act, the Bank Secrecy Act, and international anti-mone laundering principles or procedures by an intergovernmental group or organization, such as the Financial Action Task Force on Money Laundering, of which the United States is a member and with which designation the United States representative to the group or organization continues to concur, all as amended, and any Executive order, directive or regulation pursuant to the authority of any of the foregoing, or any orders or licenses issued thereunder (collectively, the "Money Laundering Laws"), and no action, suit or proceeding by or before any court or governmental agency, authority or body or any arbitrator involving the Company or any of its Subsidiaries with respect to the Money Laundering Laws is pending or, to the knowledge of the Company, threatened. Neither the Company nor any of its Subsidiaries, nor to the knowledge of the Company any of the directors, officers or employees, agents, affiliates or representatives of the Company or each of its Subsidiaries, is an individual or entity that is, or is owned or controlled by ar individual or entity that is: (i) the subject of any sanctions administered or enforced by the U.S. Department of Treasury's Office of Foreign Assets Control, the United Nation Security Council, the European Union, Her Majesty's Treasury, or other relevant sanctions authority (collectively, "Sanctions"), nor (ii) located, organized or resident in a country or territory that is the subject of Sanctions (including, without limitation, the Balkans, Belarus, Burma/Myanmar, Cote D'Ivoire, Cuba, Democratic Republic of Congo, Iran, Ira Liberia, Libya, North Korea, Sudan, Syria, Venezuela and Zimbabwe). Neither the Company nor any of its Subsidiaries will, directly or indirectly, use the proceeds of th transactions contemplated hereby, or lend, contribute or otherwise make available such proceeds to any subsidiary, joint venture partner or other individual or entity: (i) to fund or facilitate any activities or business of or with any individual or entity or in any country or territory that, at the time of such funding or facilitation, is the

subject of Sanctions or (ii) in any other manner that will result in a violation of Sanctions by any individual or entity (including any individual or entity participating in the transactions contemplated hereby, whether as underwriter, advisor, investor or otherwise). For the past five years, neither the Company nor any of its Subsidiaries has knowingly engaged in and is not now knowingly engaged in, any dealings or transactions with any individual or entity, or in any country or territory, that at the time of the dealing or transaction is or was the subject of Sanctions.

(u) DTC Eligibility. The Company, through the Transfer Agent, currently participates in the DTC Fast Automated Securities Transfer (FAST) Program and the Comm Stock can be transferred electronically to third parties via the DTC Fast Automated Securities Transfer (FAST) Program.

(v) Sarbanes-Oxley. The Company is in material compliance with all provisions of the Sarbanes-Oxley Act of 2002, as amended, which are applicable to it as of the da hereof.

(w) Certain Fees. No brokerage or finder's fees or commissions are or will be payable by the Company to any broker, financial advisor or consultant, finder, placement investment banker, bank or other Person with respect to the transactions contemplated by the Transaction Documents. The Investor shall have no obligation with respect to any fees or with respect to any claims made by or on behalf of other Persons for fees of a type contemplated in this Section 4(w) that may be due in connection with the transactions contemplated by the Transaction Documents.

(x) Investment Company. The Company is not required to be registered as, and immediately after receipt of payment for the Purchase Shares will not be required to b registered as, an "investment company" within the meaning of the Investment Company Act of 1940, as amended.

(y) Listing and Maintenance Requirements. The Common Stock is registered pursuant to Section 12(b) of the Exchange Act, and the Company has taken no action de to, or which to its knowledge is likely to have the effect of, terminating the registration of the Common Stock pursuant to the Exchange Act nor has the Company received any notification that the SEC is currently contemplating terminating such registration. The Securities have been approved for listing on the Principal Market prior to issuance. Th Company has taken no action designed to, or likely to have the effect of, delisting the Common Stock from the Principal Market, nor has the Company received any notice fror any Person to the effect that the Company is not in compliance with the listing or maintenance requirements of the Principal Market. The Company is, and has no reason to believ that it will not in the foreseeable future continue to be, in compliance with all such listing and maintenance requirements.

(z) Accountants. The Company's accountants are set forth in the SEC Documents and, to the knowledge of the Company, such accountants are an independent regist public accounting firm as required by the Securities Act.

(aa) No Market Manipulation. The Company has not, and to its knowledge no Person acting on its behalf has, (i) taken, directly or indirectly, any action designed to caus result in the stabilization or manipulation of the price of any security of the Company to facilitate the sale or resale of any of the Securities, (ii) sold, bid for, purchased, or, paid any compensation for soliciting purchases of, any of the Securities, or (iii) paid or agreed to pay to any Person any compensation for soliciting another to purchase any other securities of the Company in connection with the transactions contemplated in this Agreement.

(bb) Shell Company Status. The Company is not currently an issuer identified in Rule 144(i)(1) under the Securities Act.

(cc) No Disqualification Events. None of the Company, any of its predecessors, any affiliated issuer, any director, executive officer, other officer of the Company partic in the offering contemplated hereby, any beneficial owner of 20% or more of the Company's outstanding voting equity securities, calculated on the basis of voting power, nor any promoter (as that term is defined in Rule 405 under the Securities Act) connected with the Company in any capacity at the time of sale (each, an "Issuer Covered Person") is subject to any of the "Bad Actor" disqualifications described in Rule 506(d)(1)(i) to (viii) under the Securities Act (a "Disqualification Event"), except for a Disqualification Event covered by Rule 506(d)(2) or (d)(3) under the Securities Act. The Company has exercised reasonable care to determine whether any Issuer Covered Person is subject to Disqualification Event.

(dd) Registration Statement. The Company has prepared and filed the Shelf Registration Statement with the SEC in accordance with the Securities Act. The Shelf Regi Statement was declared effective by order of the SEC on July 9, 2021. The Shelf Registration Statement is effective pursuant to the Securities Act and available for the issuanc of the Securities thereunder. No stop order suspending the effectiveness of the Shelf Registration Statement has been issued by the SEC, and no proceeding for that purpose c pursuant to Section 8A of the Securities Act against the Company or related to the offering of the Securities has been initiated or, to the knowledge of the Company, threatened by the SEC. The "Plan of Distribution" section of the Prospectus permits the issuance of the Securities under the terms of this Agreement. At the time the Shelf Registratic Statement and any amendments thereto became effective, at the date of this Agreement and at each deemed effective date thereof pursuant to Rule 430B(f)(2) of the Securities Act, the Shelf Registration Statement and any amendments thereto complied and will comply in all material respects with the requirements of the Securities Act and did not an will not contain any untrue statement of a material fact or omit to state any material fact required to be stated therein or necessary to make the statements therein not misleading; and the Base Prospectus and any Prospectus Supplement thereto, at the time such Base Prospectus or such Prospectus Supplement thereto was issued and on th

Commencement Date, complied and will comply in all material respects with the requirements of the Securities Act and did not and will not contain an untrue statement of a material fact or omit to state a material fact necessary in order to make the statements therein, in light of the circumstances under which they were made, not misleading; provided that this representation and warranty does not apply to statements in or omissions from any Prospectus Supplement made in reliance upon and in conformity with information relating to the Investor furnished to the Company in writing by or on behalf of the Investor expressly for use therein. The Company meets all of the requirements for the use of a registration statement on Form S-3 pursuant to the Securities Act for the offering and sale of the Securities contemplated by this Agreement in reliance on General Instructio I.B.1., and the SEC has not notified the Company of any objection to the use of the form of the Registration Statement pursuant to Rule 401(g)(1) of the Securities Act. Th Company hereby confirms that the issuance of the Securities to the Investor in accordance with this Agreement would not result in non-compliance with the Securities Act or any of the General Instructions to Form S-3. The Registration Statement, as of its effective date, meets the requirements set forth in Rule 415(a)(1)(x) pursuant to the Securities Ac At the earliest time after the filing of the Registration Statement that the Company or another offering participant made a bona fide offer (within the meaning of Rule 164(h)(2) o the Securities Act) relating to any of the Securities, the Company was, and as of the date of this Agreement the Company is, not an Ineligible Issuer (as defined in Rule 405 of th Securities Act). The Company has not distributed any offering material in connection with the offering, issuance and sale of any of the Securities, other than the Shelf Registratio Statement or any amendment thereto, the Prospectus or any Prospectus Supplement required pursuant to applicable law or the Transaction Documents. The Company has no made an offer relating to the Securities that would constitute a "free writing prospectus" as defined in Rule 405 under the Securities Act.

(ee) Absence of Schedules. In the event that on the date hereof, or the Commencement Date, the Company does not deliver any disclosure schedule contemplated by t Agreement, the Company hereby acknowledges and agrees that each such undelivered disclosure schedule shall be deemed to read as follows: "Nothing to Disclose."

5. COVENANTS.

(a) Filing of Current Report and Initial Prospectus Supplement. The Company agrees that it shall, within the time required under the Exchange Act, file with the SEC a Current Report on Form 8-K relating to the transactions contemplated by, and describing the material terms and conditions of, the Transaction Documents (the "Current Report"). The Company further agrees that it shall, within the time required under Rule 424(b) under the Securities Act, file with the SEC the Initial Prospectus Supplement pursuant to Ru 424(b) under the Securities Act specifically relating to the transactions contemplated by, and describing the material terms and conditions of, the Transaction Documents, containing information previously omitted at the time of effectiveness of the Shelf Registration Statement in reliance on Rule 430B under the Securities Act, and disclosing a information relating to the transactions contemplated hereby required to be disclosed in the Shelf Registration Statement and the Prospectus as of the date of the Initial Prospectu Supplement, including, without limitation, information required to be disclosed in the section captioned "Plan of Distribution" in the Prospectus. The Investor acknowledges that will be identified in the Initial Prospectus Supplement as an underwriter within the meaning of Section 2(a)(11) of the Securities Act. The Company shall permit the Investor t review and comment upon the Current Report and the Initial Prospectus Supplement at least two (2) Business Days prior to their filing with the SEC, the Company shall give du consideration to all such comments. The Investor shall use its reasonable best efforts to provide any comments upon the Current Report and the Initial Prospectus Supplemer within one (1) Business Day from the date the Investor receives a substantially complete draft thereof from the Company. The Investor shall furnish to the Company suc information regarding itself, the Securities held by it and the intended method of distribution thereof, including any arrangement between the Investor and any other Person relating to the sale or distribution of the Securities, as shall be reasonably requested by the Company in connection with the preparation and filing of the Current Report and the Initia Prospectus Supplement, and shall otherwise cooperate with the Company as reasonably requested by the Company in connection with the preparation and filing of the Curren Report and the Initial Prospectus Supplement with the SEC.

(b) Blue Sky. The Company shall take all such action, if any, as is reasonably necessary in order to obtain an exemption for or to register or qualify (i) the issuance and sale of the Securities to the Investor under this Agreement and (ii) any subsequent resale of all Commitment Shares and all Purchase Shares by the Investor, in each case, unde applicable securities or "Blue Sky" laws of the states of the United States in such states as is reasonably requested by the Investor from time to time, and shall provide evidence o any such action so taken to the Investor.

(c) Listing/DTC. The Company shall use commercially reasonable efforts to maintain, so long as any shares of Common Stock shall be so listed, such listing of all Purc Shares and Commitment Shares from time to time issuable hereunder. The Company shall use commercially reasonable efforts to maintain the listing of the Common Stock on th Principal Market and shall use commercially reasonable efforts to comply in all respects with the Company's reporting, filing and other obligations under the bylaws or rules and regulations of the Principal Market. The Company shall not take any action that would reasonably be expected to result in the delisting or suspension of the Common Stock on th Principal Market. The Company shall promptly, and in no event later than the following Business Day, provide to

the Investor copies of any notices it receives from any Person regarding the continued eligibility of the Common Stock for listing on the Principal Market; provided, however, tha the Company shall not be required to provide the Investor copies of any such notice that the Company reasonably believes constitutes material non-public information and the Company would not be required to publicly disclose such notice in any report or statement filed with the SEC and under the Exchange Act or the Securities Act. The Compan shall pay all fees and expenses in connection with satisfying its obligations under this Section 5(c). The Company shall take all commercially reasonable action necessary to ensure that its Common Stock can be transferred electronically as DWAC Shares.

(d) Prohibition of Short Sales and Hedging Transactions. The Investor agrees that beginning on the date of this Agreement and ending on the date of termination of this Agreement as provided in Section 11 hereof, the Investor and its agents, representatives and affiliates shall not in any manner whatsoever enter into or effect, directly or indirectly, any (i) "short sale" (as such term is defined in Rule 200 of Regulation SHO of the Exchange Act) of the Common Stock or (ii) hedging transaction, which establishes a net sho position with respect to the Common Stock.

(e) Issuance of Commitment Shares. In consideration for the Investor's execution and delivery of this Agreement, the Company shall cause the Transfer Agent to issu date of this Agreement Fifty Thousand Eight Hundred Ninety-One (50,891) shares of Common Stock (the "Initial Commitment Shares") directly to the Investor and shall deliver to the Transfer Agent the Irrevocable Transfer Agent Instructions in the form as set forth in Section 6 hereof. For the avoidance of doubt, all of the Initial Commitment Shares shal be fully earned as of the date of this Agreement, whether or not the Commencement shall occur or any Purchase Shares are purchased by the Investor under this Agreement and irrespective of any termination of this Agreement. In connection with each Regular Purchase and each Accelerated Purchase of Purchase Shares hereunder, the Company sha issue to the Investor a number of shares of Common Stock (the "Additional Commitment Shares" and, together with the Initial Commitment Shares, the "Commitment Shares") equal to the product of (x) One Hundred One Thousand Seven Hundred Eighty-One (101,781) and (y) the Purchase Amount Fraction. The "Purchase Amount Fraction" shall mean a fraction, the numerator of which is the Purchase Amount purchased by the Investor with respect to such Regular Purchase and Accelerated Purchase (as applicable) o Purchase Shares and the denominator of which is Thirty Million Dollars ($30,000,000). The Additional Commitment Shares shall be issued to the Investor on the same Busine Day as Purchase Shares are issued to the Investor in connection with the applicable Regular Purchase and Accelerated Purchase (as applicable) in accordance with Section 2 hereof. In no event shall the amount of the Additional Commitment Shares to be issued under this Agreement exceed One Hundred One Thousand Seven Hundred Eighty-O (101,781) shares of Common Stock, provided that such Additional Commitment Shares shall be equitably adjusted for any reorganization, recapitalization, non-cash dividend, stoc split, reverse stock split or other similar transaction.

(f) Due Diligence; Non-Public Information. During the term of this Agreement, the Investor shall have the right, from time to time as the Investor may reasonably dee appropriate, and upon reasonable advance notice to the Company, to perform reasonable due diligence on the Company during normal business hours. The Company and its officers and employees shall provide material information and reasonably cooperate with the Investor in connection with any reasonable request by the Investor related to the Investor's due diligence of the Company. Each party hereto agrees not to disclose any Confidential Information of the other party to any third party and shall not use the Confidential Information for any purpose other than in connection with, or in furtherance of, the transactions contemplated hereby. Each

party hereto acknowledges that the Confidential Information shall remain the property of the disclosing party and agrees that it shall take all reasonable measures to protect the secrecy of any Confidential Information disclosed by the other party. The receiving party may disclose Confidential Information to the extent such information is required to be disclosed by law, regulation or order of a court of competent jurisdiction or regulatory authority, provided that the receiving party shall promptly notify the disclosing party when such requirement to disclose arises, and shall cooperate with the disclosing party so as to enable the disclosing party to: (i) seek an appropriate protective order; and (ii) make any applicable claim of confidentiality in respect of such Confidential Information; and provided, further, that the receiving party shall disclose Confidential Information only to the extent required by the protective order or other similar order, if such an order is obtained, and, if no such order is obtained, the receiving party shall disclose only the minimum amount of such Confidential Information required to be disclosed in order to comply with the applicable law, regulation or order. In addition, any such Confidential Informatior disclosed pursuant to this section shall continue to be deemed Confidential Information. Notwithstanding anything in this Agreement to the contrary, the Company shall not be obligated to provide the Investor with any information that constitutes or may reasonably be considered to constitute material, non-public information pursuant to a request for information hereunder, and the Company and the Investor agree that neither the Company nor any other Person acting on its behalf shall provide the Investor or its agents o counsel with any information that constitutes or may reasonably be considered to constitute material, non-public information, unless a simultaneous public announcement thereof is made by the Company in the manner contemplated by Regulation FD. In the event of a breach of the foregoing covenant by the Company or any Person acting on its behalf (a determined in the reasonable good faith judgment of the Investor), in addition to any other remedy provided herein or in the other Transaction Documents, if the Investor is holding any Securities at the time of the disclosure of such material non-public information, the Investor shall have the right to make a public disclosure, in the form of a press release, public advertisement or otherwise, of such material, non-public information without the prior approval by the Company; provided the Investor shall have first provided notice to the Company that it believes it has received information that constitutes material, non-public information; and the Company shall have at least two Business Days from such notice to either publicly disclose such material, non-public information or to demonstrate to the Investor that such information does not constitute material, non-public information, and (assuming the Investor and Investor's counsel disagree in their reasonable good faith judgment with the Company's determination) prior to any such disclosure by the Investor; and the Company shall have failed to publicly disclose such material, non-public information. The Investor shall not have any liability to the Company, any of its Subsidiaries, or any o their respective directors, officers, employees, stockholders or agents, for any such disclosure in accordance with this Section 5(f). The Company understands and confirms that the Investor shall be relying on the foregoing covenants in effecting transactions in securities of the Company.

(g) Purchase Records. The Investor and the Company shall each maintain records showing the remaining Available Amount at any given time and the dates and Purch Amounts for each Regular Purchase, Accelerated Purchase and Additional Accelerated Purchase or shall use such other method, reasonably satisfactory to the Investor and th Company.

(h) Taxes. The Company shall pay any and all transfer, stamp or similar taxes that may be payable with respect to the issuance and delivery of any shares of Common to the Investor made under this Agreement.

(i) Use of Proceeds. The Company will use the net proceeds from the offering for any corporate purpose at the sole discretion of the Company.

(j) Other Transactions. The Company shall not enter into, announce or recommend to its stockholders any agreement, plan, arrangement or transaction in or of which t terms thereof would restrict, materially delay, conflict with or impair the ability or right of the Company to perform its obligations under the Transaction Documents, including without limitation, the obligation of the Company to deliver the Initial Purchase Shares or the Commitment Shares to the Investor in accordance with the terms of the Transactio Documents.

(k) Aggregation. From and after the date of this Agreement, neither the Company, nor or any of its affiliates will, and the Company shall use its reasonable best efforts ensure that no Person acting on their behalf will, directly or indirectly, make any offers or sales of any security or solicit any offers to buy any security, under circumstances that would cause this offering of the Securities by the Company to the Investor to be aggregated with other offerings by the Company in a manner that would require stockholde approval pursuant to the rules of the Principal Market on which any of the securities of the Company are listed or designated, unless stockholder approval is obtained before the closing of such subsequent transaction in accordance with the rules of such Principal Market.

(l) Limitation on Variable Rate Transactions. From and after the date of this Agreement until the thirty-six (36) month anniversary of the date of this Agreement (irres of any earlier termination of this Agreement), the Company shall be prohibited from effecting or entering into an agreement to effect any issuance by the Company or any of its Subsidiaries of Common Stock involving a Variable Rate Transaction other than with the Investor. "Variable Rate Transaction" means an "equity line of credit" or substantially similar transaction whereby an investor is irrevocably bound to purchase securities over a period of time from the Company at a price based on the market price of the Company's Common Stock at the time of each such purchase, provided, however, that this Section 5(l) shall not be deemed to prohibit the issuance and sale of Common Stock pursuant to ar "at-the-market offering" by the Company exclusively through a registered broker-dealer acting as agent of the Company pursuant to a written agreement between the Company and such registered broker-dealer.

6. TRANSFER AGENT INSTRUCTIONS.

(a) Commitment Shares. On the date of this Agreement, the Company shall issue to the Transfer Agent (and any subsequent transfer agent) irrevocable instructions, ir form agreed to prior to the date hereof (the "Irrevocable Transfer Agent Instructions"), to issue the Commitment Shares in accordance with the terms of this Agreement. Al Commitment Shares to be issued to or for the benefit of the Investor pursuant to this Agreement shall be issued as DWAC Shares. The Company warrants to the Investor tha while the Agreement is effective, no instruction other than the Irrevocable Transfer Agent Instructions referred to in this Section 6 will be given by the Company to the Transfer Agent with respect to the Commitment Shares, and the Commitment Shares shall otherwise be freely transferable on the books and records of the Company.

(b) Purchase Shares. On the date of the Initial Prospectus Supplement, the Company shall issue to the Transfer Agent, and any subsequent transfer agent, irrevocabl instructions in the form agreed to prior to the date hereof (the "Commencement Irrevocable Transfer Agent Instructions") to issue the Purchase Shares in accordance with the terms of this Agreement and the Registration Rights Agreement. All Purchase Shares to be issued from and after Commencement to or for the benefit of the Investor pursuant to this Agreement shall be issued only as DWAC Shares. The Company represents and warrants to the Investor that, while this Agreement is effective, no instruction other than a contemplated by the Commencement Irrevocable Transfer Agent Instructions and any Notice of Effectiveness of Registration

Statement (as defined in the Registration Rights Agreement) will be given by the Company to the Transfer Agent with respect to the Purchase Shares from and afte Commencement, and no instruction or other communication to the Transfer Agent with respect to the issuance of the Purchase Shares shall be made without the approval of the Investor. The Company shall provide confirmation of receipt by the Transfer Agent of all instructions pursuant to the Commencement Irrevocable Transfer Agent Instructions with respect to Purchase Shares within one Business Day of delivery of any Purchase Notice. The Purchase Shares covered by the Registration Statement shall otherwise be free transferable on the books and records of the Company.

7. CONDITIONS TO THE COMPANY'S RIGHT TO COMMENCE SALES OF SHARES OF COMMON STOCK.

The right of the Company hereunder to commence sales of Purchase Shares is subject to the satisfaction, or where legally permissible, the waiver of each of the followin conditions:

(a) The Investor shall have executed each of the Transaction Documents and delivered the same to the Company;

(b) The representations and warranties of the Investor shall be true and correct in all material respects as of the date hereof and as of the Commencement Date as tho made at that time; and

(c) No stop order with respect to the Registration Statement shall be pending or threatened by the SEC.

8. CONDITIONS TO THE INVESTOR'S OBLIGATION TO PURCHASE SHARES OF COMMON STOCK.

The obligation of the Investor to buy Purchase Shares under this Agreement is subject to the satisfaction or, where legally permissible, the waiver of each of the followin conditions on or prior to the Commencement Date and, once such conditions have been initially satisfied, there shall not be any ongoing obligation to satisfy such conditions afte the Commencement has occurred:

(a) The Company shall have executed each of the Transaction Documents and delivered the same to the Investor;

(b) The Company shall have issued or caused to be issued to the Investor a number of shares of Common Stock equal to the number of Commitment Shares as DWA Shares, in each case in accordance with Section 6;

(c) The Common Stock shall be listed on the Principal Market, and the Company shall have filed with The Nasdaq Stock Market a Notification Form: Listing of Additi Shares for the listing of the Securities, and Nasdaq shall have raised no objection to the consummation of the transactions contemplated by this Agreement;

(d) The Investor shall have received the opinions and negative assurances letter of the Company's legal counsel dated as of the Commencement Date substantially in t forms agreed prior to the date of this Agreement by the Company's legal counsel and the Investor's legal counsel;

(e) The representations and warranties of the Company shall be true and correct in all material respects (except to the extent that any of such representations and war is already qualified as to materiality in Section 4 hereof, in which case, such representations and warranties shall be true and correct without further qualification) as of the date hereof and as of the Commencement Date as though made at that time (except for representations and warranties that speak as of a specific date, which shall be true and correct in all material respects as of such date) and the Company shall have performed, satisfied and complied in all material respects with the covenants, agreements and conditions required by the Transaction Documents to be performed, satisfied or complied with by the Company at or prior to the Commencement Date. The Investor shall have received certificate, executed by the CEO, President or CFO of the Company, dated as of the Commencement Date, to the foregoing effect in the form attached hereto as **Exhibit A**;

(f) The Board of Directors of the Company shall have adopted resolutions in substantially the form attached hereto as **Exhibit B** which shall be in full force and effec without any amendment or supplement thereto as of the Commencement Date;

(g) As of the Commencement Date, the Company shall have reserved out of its authorized and unissued Common Stock, (i) solely for the purpose of effecting purchas Purchase Shares hereunder, Five Million Five Hundred Thousand (5,500,000) shares of Common Stock; and (ii) solely for the purpose of effecting the issuance of Addition Commitment Shares hereunder, One Hundred One Thousand Seven Hundred Eighty-One (101,781) shares of Common Stock;

(h) Each of the Irrevocable Transfer Agent Instructions and the Commencement Irrevocable Transfer Agent Instructions shall have been delivered to and acknowledg writing by the Company and the Transfer Agent (or any successor transfer agent);

(i) The Company shall have delivered to the Investor a certificate evidencing the incorporation and good standing of the Company in the State of Nevada issued by the Secretary of State of the State of Nevadaand a certificate or its equivalent evidencing the good standing of the Company as a foreign corporation in any other jurisdiction where the Company is duly qualified to conduct business, in each case, as of a date within ten (10) Business Days of the Commencement Date;

(j) The Company shall have delivered to the Investor a certified copy of the Articles of Incorporation as certified by the Secretary of State of the State of Nevada wit (10) Business Days of the Commencement Date;

(k) The Company shall have delivered to the Investor a secretary's certificate executed by the Secretary of the Company, dated as of the Commencement Date, in the attached hereto as **Exhibit C**;

(l) The Shelf Registration Statement shall continue to be effective and no stop order with respect to the Shelf Registration Statement shall be pending or threatened by SEC. The Company shall have a maximum dollar amount certain of Common Stock registered under the Shelf Registration Statement which is sufficient to issue to the Invest not less than (i) the full Available Amount worth of Purchase Shares plus (ii) all of the Commitment Shares. The Current Report and the Initial Prospectus Supplement each sha have been filed with the SEC, as required pursuant toSection 5(a), and copies of the Prospectus shall have been delivered to the Investor in accordance with the terms of the Registration Rights Agreement. The Prospectus shall be current and available for issuances and sales of all of the Securities by the Company to the Investor. Any othe Prospectus Supplements required to have been filed by the Company with the

SEC under the Securities Act at or prior to the Commencement Date shall have been filed with the SEC within the applicable time periods prescribed for such filings under th Securities Act. All reports, schedules, registrations, forms, statements, information and other documents required to have been filed by the Company with the SEC at or prior to the Commencement Date pursuant to the reporting requirements of the Exchange Act shall have been filed with the SEC within the applicable time periods prescribed for such filing under the Exchange Act;

(m) No Suspension Event has occurred, and no event which, after notice and/or lapse of time, would reasonably be expected to become a Suspension Event ha occurred;

(n) The Exchange Cap has not been reached (to the extent the Exchange Cap is applicable pursuant to Section 2(e) hereof);

(o) All federal, state and local governmental laws, rules and regulations applicable to the transactions contemplated by the Transaction Documents and necessary for tl execution, delivery and performance of the Transaction Documents and the consummation of the transactions contemplated thereby in accordance with the terms thereof shall have been complied with, and all consents, authorizations and orders of, and all filings and registrations with, all federal, state and local courts or governmental agencies and all federal, state and local regulatory or self-regulatory agencies necessary for the execution, delivery and performance of the Transaction Documents and the consummation of the transactions contemplated thereby in accordance with the terms thereof shall have been obtained or made, including, without limitation, in each case those required under the Securities Act, the Exchange Act, applicable state securities or "Blue Sky" laws or applicable rules and regulations of the Principal Market, or otherwise required by the SEC, tl Principal Market or any state securities regulators;

(p) No statute, regulation, order, decree, writ, ruling or injunction shall have been enacted, entered, promulgated, threatened or endorsed by any federal, state or local o court or governmental authority of competent jurisdiction which prohibits the consummation of or which would materially modify or delay any of the transactions contemplated by the Transaction Documents;

(q) No action, suit or proceeding before any federal, state, local or foreign arbitrator or any court or governmental authority of competent jurisdiction shall have been commenced or threatened, and no inquiry or investigation by any federal, state, local or foreign governmental authority of competent jurisdiction shall have been commenced or threatened, against the Company, or any of the officers, directors or affiliates of the Company, seeking to restrain, prevent or change the transactions contemplated by the Transaction Documents, or seeking material damages in connection with such transactions; and

(r) The Company shall have provided the Investor with the information requested by the Investor in connection with its due diligence requests in accordance with the t Section 5(f) hereof.

9. INDEMNIFICATION.

In consideration of the Investor's execution and delivery of the Transaction Documents and acquiring the Purchase Shares hereunder and in addition to all of th Company's other obligations under the Transaction Documents, the Company shall defend, protect, indemnify and hold harmless the Investor and all of its affiliates, stockholders officers, directors and employees and any of the foregoing Person's agents or other representatives (including, without limitation, those retained in connection with the transactions contemplated by this Agreement) (collectively, the "Indemnitees") from and against any and all actions, causes of action, suits, claims, losses, costs, penalties, fees, liabilities and damages, and

reasonable expenses in connection therewith (irrespective of whether any such Indemnitee is a party to the action for which indemnification hereunder is sought), and including reasonable attorneys' fees and disbursements (the "Indemnified Liabilities"), incurred by any Indemnitee as a result of, or arising out of, or relating to (a) any misrepresentation or breach of any representation or warranty made by the Company in the Transaction Documents or any other certificate, instrument or document executed by the Company contemplated hereby or thereby, (b) any breach of any covenant, agreement or obligation of the Company contained in the Transaction Documents or any other certificate, instrument or document executed by the Company contemplated hereby or thereby, (c) any cause of action, suit or claim brought or made against such Indemnitee and arising out of or resulting from the execution, delivery, performance or enforcement of the Transaction Documents or any other certificate, instrument or document contemplated hereby or thereby, other than, in the case of clause (c) with respect to Indemnified Liabilities which directly and primarily result from the fraud, gross negligence or willful misconduct of an Indemnitee. The indemnity in this Section 9 shall not apply to amounts paid in settlement of any claim if such settlement is effected without the prior written consent of the Company, which consent shall not be unreasonably withheld, conditioned or delayed. To the extent that the foregoing undertaking by the Company may be unenforceable for any reason, the Company shall make the maximum contribution to the payment and satisfaction of each of the Indemnified Liabilities which is permissible under applicable law. Payment under this indemnification shall be made within thirty (30) days from the date the Investor makes written request for it. A certificate containing reasonable detail as to the amount of such indemnification submitted to the Company by the Investor shall be conclusive evidence, absent manifest error, of the amount due from the Company to the Investor, provided that the Indemnitee shall undertake to repay any amounts paid to it hereunder if it is ultimately determined, by a final and non-appealable order of a court of competent jurisdiction, that the Indemnitee is not entitled to be indemnified against such Indemnified Liabilities by the Company pursuant to this Agreement. If any action shall b brought against any Indemnitee in respect of which indemnity may be sought pursuant to this Agreement, such Indemnitee shall promptly notify the Company in writing, and the Company shall have the right to assume the defense thereof with counsel of its own choosing reasonably acceptable to the Indemnitee. Any Indemnitee shall have the right t employ separate counsel in any such action and participate in the defense thereof, but the fees and expenses of such counsel shall be at the expense of such Indemnitee, except to the extent that (i) the employment thereof has been specifically authorized by the Company in writing, (ii) the Company has failed after a reasonable period of time to assume such defense and to employ counsel or (iii) in such action there is, in the reasonable opinion of such separate counsel, a material conflict on any material issue between the position of the Company and the position of such Indemnitee, in which case the Company shall be responsible for the reasonable fees and expenses of no more than one such separate counsel.

10. SUSPENSION EVENTS.

A "Suspension Event" shall be deemed to have occurred at any time as any of the following events occurs:

(a) the effectiveness of a Registration Statement registering the sale or resale of the Securities lapses for any reason (including, without limitation, the issuance of a sto or similar order) or such registration statement (or the prospectus forming a part thereof) is unavailable to the Investor for sale or resale of any or all of the Securities to be issued to the Investor under the Transaction Documents that are required to be included therein, and such lapse or unavailability continues for a period of ten (10) consecutive Business Days or for more than an aggregate of thirty (30) Business Days in any 365-day period, but excluding a lapse or unavailability where (i) the Company terminates a Registratio Statement after the Investor has confirmed in writing that all of the Securities covered thereby have been resold or (ii) the Company supersedes one Registration Statement wit another Registration Statement, including

(without limitation) by terminating a prior Registration Statement when it is effectively replaced with a new Registration Statement covering Securities (provided in the case of thi clause (ii) that all of the Securities covered by the superseded (or terminated) Registration Statement that have not theretofore been resold are included in the superseding (or new) Registration Statement);

(b) the suspension of the Common Stock from trading on the Principal Market for a period of at least one (1) Business Day, provided that the Company may not direct Investor to purchase any shares of Common Stock during any such suspension;

(c) the delisting of the Common Stock from The Nasdaq Capital Market provided, however, that the Common Stock is not immediately thereafter trading on The Nasd

Capital Market, The Nasdaq Global Market, The Nasdaq Global Select Market, the New York Stock Exchange, the NYSE American, the NYSE Arca, the OTC Bulletin Bo or the OTCQB or the OTCQX operated by the OTC Markets Group, Inc. (or any nationally recognized successor to any of the foregoing);

(d) the failure for any reason by the Transfer Agent to issue (i) the Additional Commitment Shares to the Investor within two (2) Business Days after the date on whic Investor is entitled to receive such Additional Commitment Shares pursuant to Section 5(e) hereof and (ii) Purchase Shares to the Investor within two (2) Business Days after th applicable Purchase Date, Accelerated Purchase Date or Additional Accelerated Purchase Date (as applicable) on which the Investor is entitled to receive such Securities;

(e) the Company breaches any representation, warranty, covenant or other term or condition under any Transaction Document if such breach could have a Material A Effect and except, in the case of a breach of a covenant which is reasonably curable, only if such breach continues for a period of at least five (5) Business Days;

(f) if any Person commences a proceeding against the Company pursuant to or within the meaning of any Bankruptcy Law;

(g) if the Company is at any time insolvent, or, pursuant to or within the meaning of any Bankruptcy Law, (i) commences a voluntary case, (ii) consents to the entry of order for relief against it in an involuntary case, (iii) consents to the appointment of a Custodian of it or for all or substantially all of its property, or (iv) makes a general assignment for the benefit of its creditors or is generally unable to pay its debts as the same become due;

(h) a court of competent jurisdiction enters an order or decree under any Bankruptcy Law that (i) is for relief against the Company in an involuntary case, (ii) appoints Custodian of the Company or for all or substantially all of its property, or (iii) orders the liquidation of the Company; or

(i) if at any time the Company is not eligible to transfer its Common Stock electronically as DWAC Shares or if the Company fails to maintain the service of its Transf Agent (or a successor Transfer Agent) with respect to the issuance of Purchase Shares under this Agreement, including but not limited to, maintaining the effectiveness of the Commencement Irrevocable Transfer Instructions, payment of all fees owed to the Transfer Agent and satisfaction of all conditions required by the Transfer Agent to issue Purchase Shares pursuant to the Commencement Irrevocable Transfer Agent Instructions.

In addition to any other rights and remedies under applicable law and this Agreement, so long as (i) a Suspension Event has occurred and is continuing, or if any event that after notice and/or lapse of time, would reasonably be expected to become a Suspension Event, has occurred and is continuing or (ii) if at any time after the Commencement Date the Exchange Cap is reached (to the extent the Exchange Cap is applicable pursuant to Section 2(e) hereof), the Company shall not deliver to the Investor any Regular Purchase Notice, Accelerated Purchase Notice or Additional Purchase Notice.

11. TERMINATION

This Agreement may be terminated only as follows:

(a) If pursuant to or within the meaning of any Bankruptcy Law, the Company commences a voluntary case or any Person commences a proceeding against the Comp Custodian is appointed for the Company or for all or substantially all of its property, or the Company makes a general assignment for the benefit of its creditors (any of which would be a Suspension Event as described in Sections 10(f), 10(g) and 10(h) hereof), this Agreement shall automatically terminate without any liability or payment to the Company (except as set forth below) without further action or notice by any Person.

(b) At any time after the Commencement Date, the Company shall have the option to terminate this Agreement for any reason or for no reason by delivering notice (a "Company Termination Notice") to the Investor electing to terminate this Agreement without any liability whatsoever of any party to any other party under this Agreement (except as set forth below). The Company Termination Notice shall not be effective until one (1) Business Day after it has been received by the Investor.

(c) This Agreement shall automatically terminate on the date that the Company sells and the Investor purchases the full Available Amount as provided herein, without a action or notice on the part of any party and without any liability whatsoever of any party to any other party under this Agreement (except as set forth below).

(d) If, for any reason or for no reason, the full Available Amount has not been purchased in accordance with Section 2 of this Agreement by the Maturity Date, this Agreement shall automatically terminate on the Maturity Date, without any action or notice on the part of any party and without any liability whatsoever of any party to any other party under this Agreement (except as set forth below).

Except as set forth in Sections 11(a) (in respect of a Suspension Event under Sections 10(f), 10(g) and 10(h)), and 11(d), any termination of this Agreement pursuant to this Section 11 shall be effected by written notice from the Company to the Investor, or the Investor to the Company, as the case may be, setting forth the basis for the termination hereof. The representations and warranties and covenants of the Company and the Investor contained in Sections 3, 4, 5, and 6 hereof, the indemnification provisions set forth in Section 9 hereof and the agreements and covenants set forth in Sections 10, 11 and 12 shall survive the execution and delivery of this Agreement and any termination of this Agreement. No termination of this Agreement shall (i) affect the Company's or the Investor's rights or obligations under (A) this Agreement with respect to any pending Initia Purchase, Regular Purchases, Accelerated Purchases, or Additional Purchases, and the Company and the Investor shall complete their respective obligations with respect to an pending Initial Purchase, Regular Purchases, Accelerated Purchases and Additional Purchases under this Agreement and (B) the Registration Rights Agreement, which sha survive any such termination, or (ii) be deemed to release the Company or the Investor from any liability for intentional misrepresentation or willful breach of any of the Transaction Documents.

12. MISCELLANEOUS.

(a) Governing Law; Jurisdiction; Jury Trial The corporate laws of the State of Nevada shall govern all issues concerning the relative rights of the Company and its stockholders. All other questions concerning the construction, validity, enforcement and interpretation of this Agreement and the other Transaction Documents shall be governed by the internal laws of the State of Illinois, without giving effect to any choice of law or conflict of law provision or rule (whether of the State of Illinois or any other jurisdictions) tha would cause the application of the laws of any jurisdictions other than the State of Illinois. Each party hereby irrevocably submits to the exclusive jurisdiction of the state anc federal courts sitting in the State of Illinois, County of Cook, for the adjudication of any dispute hereunder or under the other Transaction Documents or in connection herewith o therewith, or with any transaction contemplated hereby or discussed herein, and hereby irrevocably waives, and agrees not to assert in any suit, action or proceeding, any claim that it is not personally subject to the jurisdiction of any such court, that such suit, action or proceeding is brought in an inconvenient forum or that the venue of such suit, action or proceeding is improper. Each party hereby irrevocably waives personal service of process and consents to process being served in any such suit, action or proceeding by mailing a copy thereof to such party at the address for such notices to it under this Agreement and agrees that such service shall constitute good and sufficient service of process and notice thereof. Nothing contained herein shall be deemed to limit in any way any right to serve process in any manner permitted by law. **EACH PARTY HEREBY IRREVOCABI WAIVES ANY RIGHT IT MAY HAVE, AND AGREES NOT TO REQUEST, A JURY TRIAL FOR THE ADJUDICATION OF ANY DISPUTE HERI OR IN CONNECTION HEREWITH OR ARISING OUT OF THIS AGREEMENT OR ANY TRANSACTION CONTEMPLATED HEREBY.**

(b) Counterparts. This Agreement may be executed in two or more identical counterparts, all of which shall be considered one and the same agreement and shall become effective when counterparts have been signed by each party and delivered to the other party; provided that a facsimile signature or signature delivered by e-mail in a ".pdf" format data file shall be considered due execution and shall be binding upon the signatory thereto with the same force and effect as if the signature were an original signature.

(c) Headings. The headings of this Agreement are for convenience of reference and shall not form part of, or affect the interpretation of, this Agreement.

(d) Severability. If any provision of this Agreement shall be invalid or unenforceable in any jurisdiction, such invalidity or unenforceability shall not affect the validity or enforceability of the remainder of this Agreement in that jurisdiction or the validity or enforceability of any provision of this Agreement in any other jurisdiction.

(e) Entire Agreement. The Transaction Documents supersede all other prior oral or written agreements between the Investor, the Company, their affiliates and Person on their behalf with respect to the subject matter thereof, and this Agreement, the other Transaction Documents and the instruments referenced herein contain the entire understanding of the parties with respect to the matters covered herein and therein and, except as specifically set forth herein or therein, neither the Company nor the Investor makes any representation, warranty, covenant or undertaking with respect to such matters. The Company acknowledges and agrees that is has not relied on, in any manner whatsoever, any representations or statements, written or oral, other than as expressly set forth in the Transaction Documents. The Investor acknowledges and agrees that it has not relied on, in any manner whatsoever, any representations or statements, written or oral, other than as expressly set forth in the Transaction Documents.

(f) Notices. Any notices, consents or other communications required or permitted to be given under the terms of this Agreement must be in writing and will be deemed have been delivered: (i) upon receipt when delivered personally; (ii) upon receipt when sent by facsimile or email (provided confirmation of transmission is mechanically or electronically generated and kept on file by the sending party); or (iii) one Business Day after deposit with a nationally recognized overnight delivery service, in each case properly addressed to the party to receive the same. The addresses for such communications shall be:

If to the Company:

Lightwave Logic, Inc.
369 Inverness Parkway, Suite 350
Englewood, CO 80112
Telephone: (720) 340-4949
E-mail: jim@lightwavelogic.com
Attention: James S. Marcelli, President

With a copy to (which shall not constitute notice or service of process):

K&L Gates LLP
200 S. Biscayne Blvd., Suite 3900
Miami, FL 33131
Telephone: (305) 539-3306
Facsimile: (305) 358-7095
E-mail: clayton.parker@klgates.com
Attention: Clayton E. Parker, Esq.

If to the Investor:

Lincoln Park Capital Fund, LLC
440 North Wells, Suite 410
Chicago, IL 60654
Telephone: (312) 822-9300
Facsimile: (312) 822-9301
E-mail: jscheinfeld@lpcfunds.com/jcope@lpcfunds.com
Attention: Josh Scheinfeld/Jonathan Cope

If to the Transfer Agent:

Broadridge Corporate Issuer Solutions, Inc.
51 Mercedes Way
Edgewood, NY 11717
Telephone: (979) 218-8194
Email: autumn.tallaksen@broadridge.com
Attention: Autumn Tallaksen

or at such other address, email address and/or facsimile number and/or to the attention of such other Person as the recipient party has specified by written notice given to each other party three (3) Business Days prior to the effectiveness of such change. Written confirmation of receipt (A) given by the recipient of such notice, consent or other communication, (B) mechanically or electronically generated by the sender's facsimile machine or email account containing the time, date, and recipient facsimile number or email address, as applicable, or (C) provided by a nationally recognized overnight delivery service, shall be rebuttable evidence of personal service, receipt by facsimile or email or receipt from a nationally recognized overnight delivery service in accordance with clause (i), (ii) or (iii) above, respectively.

(g) Successors and Assigns. This Agreement shall be binding upon and inure to the benefit of the parties and their respective successors and assigns. The Company sh assign this Agreement or any rights or obligations hereunder without the prior written consent of the Investor, including by merger or consolidation. The Investor may not assign its rights or obligations under this Agreement.

(h) No Third Party Beneficiaries. This Agreement is intended for the benefit of the parties hereto and their respective permitted successors and assigns, and is not for benefit of, nor may any provision hereof be enforced by, any other Person.

(i) Publicity. The Company shall afford the Investor and its counsel with the opportunity to review and comment upon, shall consult with the Investor and its counsel o form and substance of, and shall give due consideration to all such comments from the Investor or its counsel on, the Prospectus Supplement, any press release or any Curren Report on Form 8-K by or on behalf of the Company relating to the Investor, its purchases hereunder or any aspect to the Transaction Documents or the transaction contemplated thereby, not less than twenty-four (24) hours prior to the issuance, filing or public disclosure thereof. The Investor must be provided with a final version of any such press release or SEC filing at least 24 hours prior to any release, filing or use by the Company thereof.

(j) Further Assurances. Each party shall do and perform, or cause to be done and performed, all such further acts and things, and shall execute and deliver all such otl agreements, certificates, instruments and documents, as the other party may reasonably request in order to consummate and make effective, as soon as reasonably possible, the Commencement, and to carry out the intent and accomplish the purposes of this Agreement and the consummation of the transactions contemplated hereby.

(k) No Financial Advisor, Placement Agent, Broker or Finder. The Company represents and warrants to the Investor that it has not engaged any financial advisor, plac agent, broker or finder in connection with the transactions contemplated hereby. The Investor represents and warrants to the Company that it has not engaged any financia advisor, placement agent, broker or finder in connection with the transactions contemplated hereby. The Company shall be responsible for the payment of any fees or commissions, if any, of any financial advisor, placement agent, broker or finder relating to or arising out of the transactions contemplated hereby. The Company shall pay, and hold the Investor harmless against, any liability, loss or expense (including, without limitation, reasonable attorneys' fees and out of pocket expenses) arising in connection with any such claim made by a third party for any such fees or commissions.

(l) No Strict Construction. The language used in this Agreement will be deemed to be the language chosen by the parties to express their mutual intent, and no rules o construction will be applied against any party.

(m) Remedies, Other Obligations, Breaches and Injunctive Relief. The Investor's remedies provided in this Agreement, including, without limitation, the Investor's reme provided in Section 9, shall be cumulative and in addition to all other remedies available to the Investor under this Agreement, at law or in equity (including a decree of specific performance and/or other injunctive relief). No remedy of the Investor contained herein shall be deemed a waiver of compliance with the provisions giving rise to such remedy anc nothing herein shall limit the Investor's right to pursue actual damages for any failure by the Company to comply with the terms of this Agreement. The Company acknowledge that a breach by it of its obligations hereunder will cause irreparable harm to the Investor and that the remedy at law for any such breach may be inadequate. The Company therefore agrees that, in the event of any such breach or threatened breach, the Investor shall be entitled, in addition to all other available remedies, to an injunction restraining any breach, without the necessity of showing economic loss and without any bond or other security being required.

(n) Enforcement Costs. If: (i) this Agreement is placed by the Investor in the hands of an attorney for enforcement or is enforced by the Investor through any lega proceeding; (ii) an attorney is retained to represent the Investor in any bankruptcy, reorganization, receivership or other proceedings affecting creditors' rights and involving a claim under this Agreement; or (iii) subject to Section 9, an attorney is retained to represent the Investor in any other proceedings whatsoever in connection with this Agreement, then the Company shall pay to the Investor, as incurred by the Investor, all reasonable costs and expenses including attorneys' fees incurred in connection therewith, in addition to all other amounts due hereunder.

(o) Amendment and Waiver; Failure or Indulgence Not Waiver. No provision of this Agreement (i) may be amended other than by a written instrument signed by both hereto and (ii) may be waived other than in a written instrument signed by the party against whom enforcement of such waiver is sought. No failure or delay in the exercise of any power, right or privilege hereunder shall operate as a waiver thereof, nor shall any single or partial exercise of any such power, right or privilege preclude other or further exercise thereof or of any other right, power or privilege.

* * * * *

IN WITNESS WHEREOF, the Investor and the Company have caused this Purchase Agreement to be duly executed as of the date first written above.

THE COMPANY:

LIGHTWAVE LOGIC, INC.

By: /s/ James S. Marcelli
Name: James S. Marcelli
Title: President and Chief Operating Officer

THE INVESTOR:

LINCOLN PARK CAPITAL FUND, LLC
BY: LINCOLN PARK CAPITAL, LLC
BY: ROCKLEDGE CAPITAL CORPORATION

By: /s/ Joshua Scheinfeld
Name: Joshua Scheinfeld
Title: President

EXHIBITS

EXHIBIT A

FORM OF OFFICER'S CERTIFICATE

This Officer's Certificate ("**Certificate**") is being delivered pursuant to Section 8(e) of that certain Purchase Agreement dated as of February 28, 2023, ("**Purchase Agreement**"), by and between **LIGHTWAVE LOGIC, INC**., a Nevada corporation (the "**Company**"), and **LINCOLN PARK CAPITAL FUND, LLC** (the "**Investor**"). Terms used herein and not otherwise defined shall have the meanings ascribed to them in the Purchase Agreement.

The undersigned, James S. Marcelli, President and Chief Operating Officer of the Company, hereby certifies, on behalf of the Company and not in his individual capacit as follows:

1. I am the Chief Operating Officer of the Company;

2. The representations and warranties of the Company contained in the Purchase Agreement are true and correct in all material respects (except to the exter any of such representations and warranties is already qualified as to materiality in Section 4 of the Purchase Agreement, in which case, such representations anc warranties are true and correct without further qualification) as of the date of the Purchase Agreement and as of the Commencement Date as though made at that time (except for representations and warranties that speak as of a specific date, in which case such representations and warranties are true and correct in all material respects as of such date);

3. The Company has performed, satisfied and complied in all material respects with covenants, agreements and conditions required by the Transaction Docun be performed, satisfied or complied with by the Company at or prior to the Commencement Date, to the extent not otherwise waived.

4. The Company has not taken any steps, and does not currently expect to take any steps, to seek protection pursuant to any Bankruptcy Law nor does the C or any of its Subsidiaries have any knowledge or reason to believe that its creditors intend to initiate involuntary bankruptcy or insolvency proceedings. The Company is financially solvent and is generally able to pay its debts as they become due.

IN WITNESS WHEREOF, I have hereunder signed my name on this ___ day of ____________, 2023.

Name:
Title:

The undersigned as Secretary of **LIGHTWAVE LOGIC, INC**., a Nevada corporation, hereby certifies that James S. Marcelli is the duly elected, appointed, qualifiec and acting Chief Operating Officer of the Company, and that the signature appearing above is his genuine signature.

___________________, Secretary

EXHIBIT B

FORM OF COMPANY RESOLUTIONS
FOR SIGNING PURCHASE AGREEMENT
UNANIMOUS WRITTEN CONSENT OF
LIGHTWAVE LOGIC, INC.

In accordance with the corporate laws of the state of Nevada, the undersigned, being all of the directors of **LIGHTWAVE LOGIC, INC**., a Nevada corporation (the "Company") do hereby consent to and adopt the following resolutions as the action of the Board of Directors for and on behalf of the Company and hereby direct that this Consen be filed with the minutes of the proceedings of the Board of Directors:

WHEREAS, there has been presented to the Board of Directors of the Company a draft of the Purchase Agreement (the "Purchase Agreement") by and between the Company and Lincoln Park Capital Fund, LLC ("Lincoln Park"), providing for the purchase by Lincoln Park of up to Thirty Million Dollars ($30,000,000) of the Company's common stock, $0.001 par value per share (the "Common Stock"); and

WHEREAS, after careful consideration of the Purchase Agreement, the documents incident thereto and other factors deemed relevant by the Board of Directors, th Board of Directors has determined that it is advisable and in the best interests of the Company to engage in the transactions contemplated by the Purchase Agreement, including but not limited to, the issuance of Fifty Thousand Eight Hundred Ninety-One (50,891) shares of Common Stock to Lincoln Park as an initial commitment fee (the "Initial Commitment Shares") and the sale of shares of Common Stock to Lincoln Park up to the available amount under the Purchase Agreement (the "Purchase Shares").

Transaction Documents

NOW, THEREFORE, BE IT RESOLVED, that the transactions described in the Purchase Agreement are hereby approved and James S. Marcelli and Michael S. Lo (the "Authorized Officers") are severally authorized to execute and deliver the Purchase Agreement, and any other agreements or documents contemplated thereby including, without limitation, a registration rights agreement (the "Registration Rights Agreement") providing for the registration of the shares of the Company's Common Stock issuable in respect of the Purchase Agreement on behalf of the Company, with such amendments, changes, additions and deletions as the Authorized Officers may deem to be appropriate and approve on behalf of, the Company, such approval to be conclusively evidenced by the signatures of the Authorized Officers thereon; and

FURTHER RESOLVED, that the terms and provisions of the Registration Rights Agreement by and among the Company and Lincoln Park are hereby approved and t Authorized Officers are authorized to execute and deliver the Registration Rights Agreement (pursuant to the terms of the Purchase Agreement), with such amendments, changes additions and deletions as the Authorized Officers may deem appropriate and approve on behalf of, the Company, such approval to be conclusively evidenced by the signature of an Authorized Officer thereon; and

FURTHER RESOLVED, that the terms and provisions of the forms of Commencement Irrevocable Transfer Agent Instructions and Notice of Effectiveness Registration Statement (collectively, the "Instructions") are hereby approved and the Authorized Officers are authorized to execute and deliver the Instructions on behalf of the Company in accordance with the Purchase Agreement, with such amendments, changes, additions and deletions as the Authorized Officers may deem appropriate and approve or behalf of, the Company, such approval to be conclusively evidenced by the signature of an Authorized Officer thereon; and

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Execution of Purchase Agreement

FURTHER RESOLVED, that the Company be and it hereby is authorized to execute the Purchase Agreement providing for the purchase of up to Thirty Million Doll ($30,000,000) of the Company's Common Stock; and

Issuance of Common Stock

FURTHER RESOLVED, that the Company is hereby authorized to issue to Lincoln Park Capital Fund, LLC, Fifty Thousand Eight Hundred Ninety-One (50,891) share Common Stock as Initial Commitment Shares and that upon issuance of the Initial Commitment Shares pursuant to the Purchase Agreement the Initial Commitment Shares shall be duly authorized, validly issued, fully paid and nonassessable with no personal liability attaching to the ownership thereof; and

FURTHER RESOLVED, that the Company is hereby authorized to issue One Hundred One Thousand Seven Hundred Eighty-One (101,781) shares of Common St (subject to equitable adjustment for any reorganization, recapitalization, non-cash dividend, stock split, reverse stock split or other similar transaction) in connection with the purchase of Purchase Shares (the "Additional Commitment Shares") in accordance with the terms of the Purchase Agreement and that, upon issuance of the Additional Commitment Shares pursuant to the Purchase Agreement, the Additional Commitment Shares will be duly authorized, validly issued, fully paid and nonassessable with no persona liability attaching to the ownership thereof; and

FURTHER RESOLVED, that the Company shall initially reserve One Hundred One Thousand Seven Hundred Eighty-One (101,781) shares of Common Stock (subjec equitable adjustment for any reorganization, recapitalization, non-cash dividend, stock split, reverse stock split or other similar transaction) for issuance as Additional Commitment Shares under the Purchase Agreement, and the Corporation shall adjust such reserve from time to time as shall be necessary, proper or desirable to carry into effect the purpose, obligations under, and intent of the Purchase Agreement; and

FURTHER RESOLVED, that the Company is hereby authorized to issue shares of Common Stock upon the purchase of Purchase Shares up to the Available Amou under the Purchase Agreement in accordance with the terms of the Purchase Agreement and that, upon issuance of the Purchase Shares pursuant to the Purchase Agreement the Purchase Shares will be duly authorized, validly issued, fully paid and nonassessable with no personal liability attaching to the ownership thereof; and

FURTHER RESOLVED, that the Company shall initially reserve Five Million Five Hundred Thousand (5,500,000) shares of Common Stock for issuance as Purch Shares under the Purchase Agreement, and the Corporation shall adjust such reserve from time to time as shall be necessary, proper or desirable to carry into effect the purpose, obligations under, and intent of the Purchase Agreement.

Approval of Actions

FURTHER RESOLVED, that, without limiting the foregoing, the Authorized Officers are, and each of them hereby is authorized and directed to proceed on behalf of t Company and to take all such steps as deemed necessary or appropriate, with the advice and assistance of counsel, to cause the Company to consummate the agreements referred to herein and to perform its obligations under such agreements; and

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FURTHER RESOLVED, that the Authorized Officer be, and hereby is, authorized, empowered and directed on behalf of and in the name of the Corporation, to take cause to be taken all such further actions and to execute and deliver or cause to be executed and delivered all such further agreements, amendments, documents, certificates, reports, schedules, applications, notices, letters and undertakings and to incur and pay all such fees and expenses as in their judgment shall be necessary, proper or desirable to carry into effect the purpose and intent of any and all of the foregoing resolutions, and that all actions heretofore taken by any officer or director of the Corporation in connection with the transactions contemplated by the agreements described herein are hereby approved, ratified and confirmed in all respects.

IN WITNESS WHEREOF, the Board of Directors has executed and delivered this Consent effective as of ___________, 2023.

By: ______________________	By: ______________________
Date:	Date:
By: ______________________	By: ______________________
Date:	Date:
By: ______________________	By: ______________________
Date:	Date:

By: ______________________________
Date:

EXHIBIT C

FORM OF SECRETARY'S CERTIFICATE

This Secretary's Certificate ("Certificate") is being delivered pursuant to Section 8(k) of that certain Purchase Agreement dated as of February 28, 2023 ("Purchase Agreement"), by and between **LIGHTWAVE LOGIC, INC.**, a Nevada corporation (the "Company"), and **LINCOLN PARK CAPITAL FUND, LLC** (the "Investor"), pursuant to which the Company may sell to the Investor up to Thirty Million Dollars ($30,000,000) of the Company's Common Stock, $0.001 par value per share (the "Common Stock"). Terms used herein and not otherwise defined shall have the meanings ascribed to them in the Purchase Agreement.

The undersigned, _______________, Secretary of the Company, hereby certifies, on behalf of the Company and not in his individual capacity, as follows:

1. I am the Secretary of the Company.

2. Attached hereto as Exhibit A and Exhibit B are true, correct and complete copies of the Company's Restated Bylaws ("Bylaws") and Articles of Incorporation, as amended by two Certificates of Amendment ("Charter"), and no action has been taken by the Company, its directors, officers or stockholders, in contemplation of the filing of any further amendment relating to or affecting the Bylaws or Charter.

3. Attached hereto as Exhibit C are true, correct and complete copies of the resolutions duly adopted by the Board of Directors of the Company by unanimous written consent effective as of ________, 2023. Such resolutions have not been amended, modified or rescinded and remain in full force and effect and such resolutions are the only resolutions adopted by the Board of Directors, or any committee thereof, or the stockholders of the Company relating to or affecting (i) the entering into and performance of the Purchase Agreement, or the issuance, offering and sale of the Purchase Shares and the Commitment Shares and (ii) and the performance of the Company of its obligation under the Transaction Documents as contemplated therein.

4. As of the date hereof, the authorized, issued and reserved capital stock of the Company is as set forth on Exhibit D hereto.

IN WITNESS WHEREOF, I have hereunder signed my name on this ___ day of _____________, 2023.

____
Secretary

The undersigned as Chief Operating Officer of **LIGHTWAVE LOGIC, INC.**, a Nevada corporation, hereby certifies that _______________ is the duly elected, appointed, qualified and acting Secretary of Lightwave Logic, Inc., and that the signature appearing above is his genuine signature.

____
Chief Operating Officer

EXHIBIT 10.27

REGISTRATION RIGHTS AGREEMENT

THIS REGISTRATION RIGHTS AGREEMENT (this “Agreement”), dated as of February 28, 2023, is entered into by and between **LIGHTWAVE LOGIC, INC.**, a Nevada corporation (the “Company”), and **LINCOLN PARK CAPITAL FUND, LLC**, an Illinois limited liability company (together with its permitted assigns, the “Investor”). Capitalized terms used herein and not otherwise defined herein shall have the respective meanings set forth in the Purchase Agreement by and between the parties hereto, dated as of the date hereof (as amended, restated, supplemented or otherwise modified from time to time, the “Purchase Agreement”).

WHEREAS:

A. Upon the terms and subject to the conditions of the Purchase Agreement, (i) the Company has agreed to issue to the Investor, and the Investor has agreed to purch to Thirty Million Dollars ($30,000,000) of the Company's common stock, par value $0.001 per share (the “Common Stock”), pursuant to the Purchase Agreement (such shares, the “Purchase Shares”), and (ii) the Company has agreed to issue to the Investor such number of shares of Common Stock as is required pursuant to the Purchase Agreement (the “Commitment Shares”); and

B. To induce the Investor to enter into the Purchase Agreement, the Company has agreed to provide certain registration rights under the Securities Act of 1933, as am and the rules and regulations thereunder, or any similar successor statute (collectively, the “Securities Act”), and applicable state securities laws.

NOW, THEREFORE, in consideration of the promises and the mutual covenants contained herein and other good and valuable consideration, the receipt and sufficiency of which are hereby acknowledged, the Company and the Investor hereby agree as follows:

1. DEFINITIONS.

For purposes of this Agreement, the following terms shall have the following meanings:

(a) “Register,” “Registered,” and “Registration” refer to a registration effected by preparing and filing one or more registration statements of the Company in c the Securities Act and providing for offering securities on a continuous basis, and the declaration or ordering of effectiveness of such registration statement(s) by the SEC.

(b) “Registrable Securities” means the Purchase Shares that may from time to time be issued or issuable to the Investor upon purchases of the Available Amo Purchase Agreement (without regard to any limitation or restriction on purchases), the Commitment Shares issued or issuable to the Investor, and any Common Stock issued o issuable with respect to the Purchase Shares, the Commitment Shares or the Purchase Agreement as a result of any stock split, stock dividend, recapitalization, exchange or similar event, without regard to any limitation on purchases under the Purchase Agreement.

(c) “Registration Statement” means the Shelf Registration Statement and any other registration statement of the Company that Registers Registrable Securities New Registration Statement, as amended when each became effective, including all documents filed as part thereof or incorporated by reference therein, and including any information contained in a Prospectus subsequently filed with the SEC.

(d) “Shelf Registration Statement” means the Company’s existing registration statement on Form S-3 (File No. 333-257670).

2. REGISTRATION.

(a) Mandatory Registration. The Company agrees that it shall, within the time required under Rule 424(b) under the Securities Act, file with the SEC the Initia Supplement pursuant to Rule 424(b) under the Securities Act specifically relating to the transactions contemplated by, and describing the material terms and conditions of, the Transaction Documents, containing information previously omitted at the time of effectiveness of the Registration Statement in reliance on Rule 430B under the Securities Act, and disclosing all information relating to the transactions contemplated hereby required to be disclosed in the Registration Statement and the Prospectus as of the date of the Initial Prospectus Supplement, including, without limitation, information required to be disclosed in the section captioned “Plan of Distribution” in the Prospectus. The Investor acknowledges that it will be identified in the Initial Prospectus Supplement as an underwriter within the meaning of Section 2(a)(11) of the Securities Act. The Company sha permit the Investor to review and comment upon the Initial Prospectus Supplement at least two (2) Business Days prior to its filing with the SEC, the Company shall give du consideration to all such comments, and the Company shall not file the Initial Prospectus Supplement with the SEC in a form to which the Investor reasonably objects. The Investor shall use its reasonable best efforts to comment upon the Initial Prospectus Supplement within one (1) Business Day from the date the Investor receives a substantially complete draft thereof from the Company. The Investor shall furnish to the Company such information regarding itself, the Securities held by it and the intended method of distribution thereof, including any arrangement between the Investor and any other Person relating to the sale or distribution of the Securities, as shall be reasonably requested by the Company in connection with the preparation and filing of the Initial Prospectus Supplement, and shall otherwise cooperate with the Company as reasonably requested by the Company in connection with the preparation and filing of the Initial Prospectus Supplement with the SEC.

(b) Effectiveness. The Company shall use its reasonable best efforts to keep the Registration Statement effective pursuant to Rule 415 promulgated under the and to keep the Registration Statement and the Prospectus current and available for issuances and sales of all possible Registrable Securities by the Company to the Investor, and for the resale of all of the Registrable Securities by the Investor, at all times until the earlier of (i) the date on which the Investor shall have sold all the Securities and no Available Amount remains under this Agreement and (ii) 180 days following the earlier of termination of this Agreement and the Maturity Date (the "Registration Period"). Without limiting the generality of the foregoing, during the Registration Period, the Company shall (a) take all action necessary to cause the Common Stock to continue to be Registered as a class of securities under Section 12(b) of the Exchange Act and shall not take any action or file any document (whether or not permitted by the Exchange Act) to terminate or suspend such registration and (b) file or furnish on or before their respective due dates all reports and other documents required to be filed or furnished by the Company pursuant to Sections 13(a), 13(c), 14, 15(d) or any other provision of or under the Exchange Act, and shall not take any action or file any document (whether or not permitted by the Exchange Act) to terminate or suspend its reporting and filing obligations under the Exchange Act. The Registration Statement (including any amendments or supplements thereto and prospectuses contained therein) shall not contain any untrue statement of a material fact or omit to state a material fact necessary to make the statements therein not misleading.

(c) Prospectus Amendments or Supplements. Except as provided in this Agreement and other than periodic and current reports required to be filed pursuant to Act, the Company shall not file with the SEC any amendment to the Registration Statement or any supplement to the Base Prospectus that refers to the Investor, the Transactic Documents or the transactions contemplated thereby (including, without limitation, any Prospectus Supplement filed in connection with the transactions contemplated by the Transaction Documents), in each case with respect to which (a) the Investor shall not previously have been advised and afforded the opportunity to review and comment thereon at least two (2) Business Days prior to filing with the SEC, as the case may be, (b) the Company shall not have given due consideration to any comments thereon received from the Investor or its counsel, or (c) the Investor shall reasonably object, unless the Company reasonably has determined that it is necessary to amend the Registration Statement o make any supplement to the Prospectus to comply with the Securities Act or any other applicable law or regulation, in which case (i) the Company shall promptly (but in no even later than 24 hours) so inform the Investor, (ii) the Investor shall be provided with a reasonable opportunity to review and comment upon any disclosure referring to the Investor, the Transaction Documents or the transactions contemplated thereby, as applicable, and (iii) the Company shall expeditiously furnish to the Investor a copy thereof. In addition, fo so long as, in the reasonable opinion of counsel for the Investor, the Prospectus is required to be delivered in connection with any acquisition or sale of Securities by the Investor the Company shall not file any Prospectus Supplement with respect to the Securities without furnishing to the Investor as many copies of such Prospectus Supplement, togethe with the Prospectus, as the Investor may reasonably request.

(d) Sufficient Number of Shares Registered. In the event the number of shares available under the Shelf Registration Statement at any time is insufficient to c Registrable Securities, the Company shall, to the extent necessary and permissible, amend the Shelf Registration Statement or file a new registration statement (together with an prospectuses or prospectus supplements thereunder, a "New Registration Statement"), so as to cover all of such Registrable Securities as soon as reasonably practicable, but in any event not later than ten (10) Business Days after the necessity therefor arises. The Company shall use its reasonable best efforts to have such amendment and/or Nev Registration Statement become effective as soon as reasonably practicable following the filing thereof.

(e) Offering. If the SEC seeks to characterize any offering pursuant to a Registration Statement filed pursuant to this Agreement as constituting an offering of does not permit such Registration Statement to become effective and be used by the Investor under Rule 415 at then-prevailing market prices (and not fixed prices), or if after the filing of the Initial Prospectus Supplement with the SEC pursuant to Section 2(a) hereof, the Company is otherwise required by the Staff or the SEC to reduce the number o Registrable Securities included in such initial Registration Statement, then the Company shall reduce the number of Registrable Securities to be included in such initial Registratio Statement (with the prior consent, which shall not be unreasonably withheld, of the Investor and its legal counsel as to the specific Registrable Securities to be removed therefrom until such time as the SEC shall so permit such Registration Statement to become effective and be used as aforesaid. In the event of any reduction in Registrable Securitie pursuant to this paragraph, the Company shall file one or more New Registration Statements in accordance with Section 2(d) hereof until such time as all Registrable Securities have been included in Registration Statements that have been declared effective and the prospectuses contained therein is available for use by the Investor.

3. RELATED OBLIGATIONS.

With respect to the Registration Statement and whenever any Registrable Securities are to be Registered pursuant to Section 2 hereof, including on the Shelf Registration Statement or on any New Registration Statement, the Company shall use its reasonable best efforts to effect the registration of the Registrable Securities in accordance with th intended method of disposition thereof and, pursuant thereto, the Company shall have the following obligations:

(a) Notifications. The Company will notify the Investor promptly of the time when any subsequent amendment to the Shelf Registration Statement or any New Statement, other than documents incorporated by reference, has been filed with the SEC and/or has become effective or where a receipt has been issued therefor or an subsequent supplement to a Prospectus has been filed and of any request by the SEC for any amendment or supplement to the Registration Statement, any New Registratio Statement or any Prospectus or for additional information.

(b) Amendments. The Company will prepare and file with the SEC, promptly upon the Investor's request, any amendments or supplements to the Shelf Regist Statement, any New Registration Statement or any Prospectus, as applicable, that, in the reasonable opinion of the Investor and the Company, may be necessary or advisable i connection with any acquisition or sale of Registrable Securities by the Investor (provided, however, that the failure of the Investor to make such request shall not relieve the Company of any obligation or liability hereunder).

(c) Investor Review. The Company will not file any amendment or supplement to the Registration Statement, any New Registration Statement or any Prospec documents incorporated by reference, relating to the Investor, the Registrable Securities or the transactions contemplated hereby unless (A) the Investor shall have been advise and afforded the opportunity to review and comment thereon at least two (2) Business Days prior to filing with the SEC, (B) the Company shall have given due consideration t any comments thereon received from the Investor or its counsel, and (C) the Investor has not reasonably objected thereto (provided, however, that the failure of the Investor to make such objection shall not relieve the Company of any obligation or liability hereunder), and the Company will furnish to the Investor at the time of filing thereof a copy of an document that upon filing is deemed to be incorporated by reference into the Registration Statement or any Prospectus, except for those documents available via EDGAR.

(d) Form S-3. The Company will cause each amendment or supplement to the Prospectus, other than documents incorporated by reference, to be filed with the required pursuant to the rules of Form S-3.

(e) Copies Available. The Company will furnish to the Investor and its counsel (at the expense of the Company) copies of the Registration Statement, the Pros (including all documents incorporated by reference therein), any Prospectus Supplement, any New Registration Statement and all amendments and supplements to the Registratio Statement, the Prospectus or any New Registration Statement that are filed with the SEC during the Registration Period (including all documents filed with or furnished to the SE during such period that are deemed to be incorporated by reference therein), in each case as soon as reasonably practicable upon the Investor's request and in such quantities as the Investor may from time to time reasonably request and, at the Investor's request, will also furnish copies of the Prospectus to each exchange or market on which sales of the Registrable Securities may be made; provided, however, that the Company shall not be required to furnish any document (other than the Prospectus) to the Investor to the extent such document is available on EDGAR.

(f) Qualification. The Company shall take all such action, if any, as is reasonably necessary in order to obtain an exemption for or to qualify (i) the issuance of Commitment Shares and the sale of the Purchase Shares to the Investor under this Agreement and (ii) any subsequent resale of all Commitment Shares and all Purchase Share by the Investor, in each case, under applicable securities or "Blue Sky" laws of the states of the United States in such states as is reasonably requested by the Investor during the Registration Period, and shall provide evidence of any such action so taken to the Investor. During the Registration Period, the Company shall promptly notify the Investor of th receipt by the Company of any notification with respect to the suspension of the registration or qualification of any of the Registrable Securities for sale under the securities o "blue sky" laws of any jurisdiction in the United States or its receipt of actual notice of the initiation or threat of any proceeding for such purpose.

(g) Notification of Stop Orders; Material Changes. The Company shall advise the Investor promptly (but in no event later than 24 hours) and shall confirm sucl writing, in each case: (i) of the Company's receipt of notice of any request by the SEC or any other federal or state governmental authority for amendment of or a supplement to the Registration Statement or any Prospectus or for any additional information; (ii) of the Company's receipt of notice of the issuance by the SEC or any other federal or stat governmental authority of any stop order suspending the effectiveness of the Registration Statement or prohibiting or suspending the use of the Prospectus or Prospectus Supplement, or any New Registration Statement, or of the Company's receipt of any notification of the suspension of qualification of the Registrable Securities for offering or sal in any jurisdiction or the initiation or contemplated initiation of any proceeding for such purpose; and (iii) of the Company becoming aware of the happening of any event, which makes any statement of a material fact made in the Registration Statement or any Prospectus untrue or which requires the making of any additions to or changes to the statements then made in the Registration Statement or any Prospectus in order to state a material fact required by the Securities Act to be stated therein or necessary in order to make the statements then made therein (in the case of any Prospectus, in light of the circumstances under which they were made) not misleading, or of the necessity to amend the

Registration Statement or any Prospectus to comply with the Securities Act or any other law. If at any time the SEC, or any other federal or state governmental authority sha issue any stop order suspending the effectiveness of the Registration Statement or prohibiting or suspending the use of the Prospectus or Prospectus Supplement, the Compan shall use its reasonable best efforts to obtain the withdrawal of such order at the earliest practicable time. The Company shall furnish to the Investor, without charge, a copy of any correspondence from the SEC or the staff of the SEC, or any other federal or state governmental authority to the Company or its representatives relating to the Shelf Registratic Statement, any New Registration Statement or any Prospectus, or Prospectus Supplement as the case may be. The Company shall not deliver to the Investor any Regul Purchase Notice, Accelerated Purchase Notice or Additional Accelerated Purchase Notice, and the Investor shall not be obligated to purchase any shares of Common Stoc under the Purchase Agreement, during the continuation or pendency of any of the foregoing events. If at any time the SEC shall issue any stop order suspending the effectivenes of the Registration Statement or prohibiting or suspending the use of the Prospectus or any Prospectus Supplement, the Company shall use its reasonable best efforts to obtain th withdrawal of such order at the earliest practicable time. The Company shall furnish to the Investor, without charge, a copy of any correspondence from the SEC or the staff o the SEC to the Company or its representatives relating to the Registration Statement or the Prospectus, as the case may be.

(h) Listing on the Principal Market. The Company shall promptly secure the listing, or conditional listing as applicable, of all of the Purchase Shares and Comm be issued to the Investor hereunder on the Principal Market (subject to standard listing conditions, if any, for transactions of this nature, official notice of issuance and the Exchange Cap) and upon each other national securities exchange or automated quotation system, if any, upon which the Common Stock are then listed, and shall maintain, so long as any Common Stock shall be so listed, such listing of all such Registrable Securities from time to time issuable hereunder. The Company shall use its reasonable best efforts t maintain the listing of the Common Stock on the Principal Market and shall comply in all respects with the Company's reporting, filing and other obligations under the bylaws o rules and regulations of the Principal Market. The Company shall not take any action that would reasonably be expected to result in the delisting or suspension of the Commo Stock on the Principal Market. The Company shall promptly, and in no event later than the following Business Day, provide to the Investor copies of any notices it receives fro any Person regarding the continued eligibility of the Common Stock for listing on the Principal Market; provided, however, that the Company shall not provide the Investor copie of any such notice that the Company reasonably believes constitutes material non-public information and that the Company would not be required to publicly disclose such notice i any report or statement filed with the SEC under the Exchange Act (including on Form 8-K) or the Securities Act. The Company shall pay all fees and expenses in connectic with satisfying its obligations under this Section 3(h).

(i) Delivery of Shares. The Company shall cooperate with the Investor to facilitate the timely preparation and delivery of DWAC Shares (not bearing any rest representing the Registrable Securities to be offered pursuant to the Shelf Registration Statement or any New Registration Statement and enable such DWAC Shares to be in su denominations or amounts as the Investor may reasonably request and registered in such names as the Investor may request.

(j) Transfer Agent. The Company shall at all times maintain the services of the Transfer Agent with respect to its Common Stock.

(k) Approvals. The Company shall use its reasonable best efforts to cause the Registrable Securities covered by any Registration Statement to be Registered by such other governmental agencies or authorities in the United States as may be necessary to consummate the disposition of such Registrable Securities.

(l) Confirmation of Effectiveness. If reasonably requested by the Investor at any time, the Company shall deliver to the Investor a written confirmation from C counsel of whether or not the effectiveness of such Registration Statement has lapsed at any time for any reason (including, without limitation, the issuance of a stop order) an whether or not the Registration Statement is currently effective and available to the Company for sale of all of the Registrable Securities.

(m) Further Assurances. The Company agrees to take all other reasonable actions as necessary and reasonably requested by the Investor to expedite and facil by the Investor of Registrable Securities pursuant to any Registration Statement.

(n) Suspension of Sales. The Investor agrees that, upon receipt of any notice from the Company of the existence of any suspension or stop order as set forth i 3(g) hereof, the Investor will immediately discontinue disposition of Registrable Securities pursuant to any Registration Statement covering such Registrable Securities until th Investor's receipt of the copies of a notice regarding the resolution or withdrawal of the suspension or stop order as contemplated by Section 3(f) or 3(g) hereof. Notwithstanding anything to the contrary, the Company shall cause its transfer agent to promptly deliver to the Investor DWAC Shares without any restrictive legend in accordance with the term of the Purchase Agreement in connection with any sale of Registrable Securities with respect to which the Investor has entered into a contract for sale prior to the Investor' receipt of a notice from the Company of the happening of any event of the kind described in Section 3(f) or 3(g) hereof and for which the Investor has not yet settled.

(o) Transfer Agent Instructions. On or before the date the Registration Statement is declared effective by the SEC, the Company shall issue to the Transfer A Commencement Irrevocable Transfer Agent Instructions in the form agreed to prior to the date hereof, and on the date any Registration Statement which includes the Registrabl Securities is ordered effective by the SEC, the Company shall deliver, and shall cause legal counsel for the Company to deliver, to the Transfer Agent for such Registrabl Securities (with copies to the Investor) confirmation that such Registration Statement has been declared effective by the SEC in the form attached as an exhibit to th Commencement Irrevocable Transfer Agent Instructions. Thereafter, if requested by the Investor at any time, the Company shall require its legal counsel to deliver to the Investo a written confirmation whether or not the effectiveness of such Registration Statement has lapsed at any time for any reason (including, without limitation, the issuance of a stop order) and whether or not the Registration Statement is current and available to the Investor for sale of all of the Registrable Securities.

4. OBLIGATIONS OF THE INVESTOR.

(a) Investor Information. The Investor has furnished to the Company in Exhibit A hereto such information regarding itself, the Registrable Securities held by it, intended method of disposition thereof, including any arrangement between the Investor and any other Person relating to the sale or distribution of the Securities, as required t effect the registration of such Registrable Securities and shall execute such documents in connection with such registration as the Company may reasonably request. The Company shall notify the Investor in writing of any other information the Company reasonably requires from the Investor in connection with any Registration Statement hereunde The Investor will as promptly as practicable notify the Company of any material change in the information set forth in Exhibit A, other than changes in its ownership of Common Stock.

(b) Investor Cooperation. The Investor agrees to cooperate with the Company as reasonably requested by the Company in connection with the preparation an amendments and supplements to any Registration Statement or New Registration Statement hereunder.

5. EXPENSES OF REGISTRATION.

All reasonable expenses of the Company, other than sales or brokerage commissions and fees and disbursements of counsel for, and other expenses of, the Investor, incurred in connection with registrations, filings or qualifications pursuant to Sections 2 and 3 hereof, including, without limitation, all registration, listing and qualifications fees, printers and accounting fees, and fees and disbursements of counsel for the Company, shall be paid by the Company.

6. INDEMNIFICATION.

(a) To the fullest extent permitted by law, the Company will, and hereby does, indemnify, hold harmless and defend the Investor, each Person, if any, who cont Investor, the members, the directors, officers, partners, employees, members, managers, agents, representatives of the Investor and each Person, if any, who controls the Investor within the meaning of the Securities Act or the Exchange Act (each, an "Indemnified Person"), against any losses, claims, damages, liabilities, judgments, fines, penalties, charges, costs, reasonable attorneys' fees, amounts paid in settlement (with the consent of the Company, such consent not to be unreasonably withheld) or reasonable expenses, (collectively, "Claims") reasonably incurred in investigating, preparing or defending any action, claim, suit, inquiry, proceeding, investigation or appeal taken from the foregoing by or before any court or governmental,

administrative or other regulatory agency or body or the SEC, whether pending or threatened, whether or not an indemnified party is or may be a party thereto ("Indemnified Damages"), to which any of them may become subject insofar as such Claims (or actions or proceedings, whether commenced or threatened, in respect thereof) arise out of or are based upon: (i) any untrue statement or alleged untrue statement of a material fact in the Shelf Registration Statement, any New Registration Statement or any post-effective amendment thereto or in any filing made in connection with the qualification of the offering under the securities or other "blue sky" laws of any jurisdiction in which Registrable Securities are offered ("Blue Sky Filing"), or the omission or alleged omission to state a material fact required to be stated therein or necessary to make the statements therein not misleading, (ii) any untrue statement or alleged untrue statement of a material fact contained in the final Prospectus or the omission or alleged omission to state therein any material fact necessary to make the statements made therein, in light of the circumstances under which the statements therein were made, not misleading, (iii) any violation or alleged violation by the Company of the Securities Act, the Exchange Act, any other law, including, without limitation, any state securities law, or any rule or regulation thereunder relating to the offer or sale of the Registrable Securities pursuant to the Shelf Registration Statement or any New Registration Statementor (iv) any material violation by the Company of this Agreement (the matters in the foregoing clauses (i) through (iv) being, collectively, "Violations"). The Company shall reimburse each Indemnified Person promptly as such expenses are incurred and are due and payable, for any reasonable out-of-pocket legal fees or other reasonable expenses incurred by them in connection with investigating or defending any such Claim. Notwithstanding anything to the contrary contained herein, the indemnification agreement contained in this Section 6(a): (A) shall not apply to a Claim by an Indemnified Person arising out of or based upon a Violation which occurs in reliance upon and in conformity with information furnished in writing to the Company by the Investor or such Indemnified Person expressly for use in connection with the preparation of the Registration Statement, any New Registration Statement, the Prospectus or an such amendment thereof or supplement thereto, if such in each case if the foregoing was timely made available by the Company; (B) with respect to any superseded prospectus, shall not inure to the benefit of any such Person from whom the Person asserting any such Claim purchased the Registrable Securities that are the subject thereof (or to the benefit of any other Indemnified Person) if the untrue statement or omission of material fact contained in the superseded prospectus was corrected in the revised prospectus, as then amended or supplemented, if such revised prospectus was timely made available by the Company pursuant to Section 3(c) or Section 3(e) hereof, and the Indemnified Person was promptly advised in writing not to use the incorrect prospectus prior to the use giving rise to a violation; and (C) shall not apply to amounts paid in settlement of any Claim if such settlement is effected without the prior written consent of the Company, which consent shall not be unreasonably withheld. Such indemnity shall remain in full force and effect regardless of any investigation made by or on behalf of the Indemnified Person and shall survive the transfer of the Registrable Securities by the Investor pursuant toSection 8 hereof.

(b) In connection with the Shelf Registration Statement, any New Registration Statement or Prospectus, the Investor agrees to indemnify, hold harmless and de same extent and in the same manner as is set forth in Section 6(a) hereof, the Company, each of its directors, each of its officers who signed the Shelf Registration Statement or signs any New Registration Statement, each Person, if any, who controls the Company within the meaning of the Securities Act or the Exchange Act (collectively and together with an Indemnified Person, an "Indemnified Party"), against any Claim or Indemnified Damages to which any of them may become subject, under the Securities Act, the Exchange Act or otherwise, insofar as such Claim or Indemnified Damages arise out of or are based upon any Violation, in each case to the extent, and only to the extent, that such Violation occurs in reliance upon and in conformity with written information about the Investor set forth on Exhibit A attached hereto or updated from time to time in writing by the Investor and furnished to the Company by the Investor expressly for inclusion in the Shelf Registration Statement or Prospectus or any New Registration Statement or fro the

failure of the Investor to provide notice or to deliver or to cause to be delivered the prospectus made available by the Company, if such prospectus was timely made available by the Company pursuant to Section 3(c) or Section 3(e) hereof; and, subject to Section 6(d) hereof, the Investor will reimburse any reasonable out-of-pocket legal or other expenses reasonably incurred by them in connection with investigating or defending any such Claim; provided, however, that the indemnity agreement contained in this Section 6(b) and the agreement with respect to contribution contained in Section 7 hereof shall not apply to amounts paid in settlement of any Claim if such settlement is effected without the prior written consent of the Investor, which consent shall not be unreasonably withheld; provided, further, however, that the Investor shall be liable under this Section 6(b) for only that amount of a Claim or Indemnified Damages as does not exceed the net proceeds to the Investor as a result of the sale of Registrable Securities pursuant to such Registratio Statement. Such indemnity shall remain in full force and effect regardless of any investigation made by or on behalf of such Indemnified Party and shall survive the transfer of the Registrable Securities by the Investor pursuant to Section 8 hereof.

(c) Promptly after receipt by an Indemnified Person or Indemnified Party under this Section 6 of notice of the commencement of any action or proceeding (inc governmental action or proceeding) involving a Claim, such Indemnified Person or Indemnified Party shall, if a Claim in respect thereof is to be made against any indemnifying party under this Section 6, deliver to the indemnifying party a written notice of the commencement thereof, and the indemnifying party shall have the right to participate in, and, to the extent the indemnifying party so desires, jointly with any other indemnifying party similarly notified, to assume control of the defense thereof with counsel mutually satisfactory to the indemnifying party and the Indemnified Person or the Indemnified Party, as the case may be;provided, however, that an Indemnified Person or Indemnified Party shall have the right to retain its own counsel with the fees and expenses to be paid by the indemnifying party, if, in the reasonable opinion of counsel retained by the indemnifying party, the representation by such counsel of the Indemnified Person or Indemnified Party and the indemnifying party would be inappropriate due to actual or potential differing interests between such Indemnified Person or Indemnified Party and any other party represented by such counsel in such proceeding. The Indemnified Party or Indemnified Person sha cooperate with the indemnifying party in connection with any negotiation or defense of any such action or claim by the indemnifying party and shall furnish to the indemnifying party all information reasonably available to the Indemnified Party or Indemnified Person which relates to such action or claim. The indemnifying party shall keep the Indemnified Party or Indemnified Person fully apprised as to the status of the defense or any settlement negotiations with respect thereto. No indemnifying party shall be liable for any settlement of any action, claim or proceeding effected without its written consent, provided, however, that the indemnifying party shall not unreasonably withhold, delay or condition its consent. No indemnifying party shall, without the consent of the Indemnified Party or Indemnified Person, consent to entry of any judgment or enter into any settlement or other compromise which does not include as an unconditional term thereof the giving by the claimant or plaintiff to such Indemnified Party or Indemnified Person of a release from al liability in respect to such claim or litigation. Following indemnification as provided for hereunder, the indemnifying party shall be subrogated to all rights of the Indemnified Party or Indemnified Person with respect to all third parties, firms or corporations relating to the matter for which indemnification has been made. The failure to deliver written notice to the indemnifying party within a reasonable time of the commencement of any such action shall not relieve such indemnifying party of any liability to the Indemnified Person or Indemnified Party under this Section 6, except to the extent that the indemnifying party is prejudiced in its ability to defend such action.

(d) The indemnification required by this Section 6 shall be made by periodic payments of the amount thereof during the course of the investigation or defense, as and when bills are received or Indemnified Damages are incurred. Any Person receiving a payment pursuant to this Section 6 which person is later determined to not be entitled to such payment shall return such payment to the person making it.

(e) The indemnity agreements contained herein shall be in addition to (i) any cause of action or similar right of the Indemnified Party or Indemnified Person aga indemnifying party or others, and (ii) any liabilities the indemnifying party may be subject to pursuant to the law.

7. CONTRIBUTION.

To the extent any indemnification by an indemnifying party is prohibited or limited by law, the indemnifying party agrees to make the maximum contribution with respect to any amounts for which it would otherwise be liable under Section 6 hereof to the fullest extent permitted by law; provided, however, that: (i) no seller of Registrable Securities guilty of fraudulent misrepresentation (within the meaning of Section 11(f) of the Securities Act) shall be entitled to contribution from any seller of Registrable Securities who was not guilty of fraudulent misrepresentation; and (ii) contribution by any seller of Registrable Securities shall be limited in amount to the net amount of proceeds received by such seller from the sale of such Registrable Securities.

8. ASSIGNMENT OF REGISTRATION RIGHTS.

The Company shall not assign this Agreement or any rights or obligations hereunder without the prior written consent of the Investor; provided, however, that any transaction, whether by merger, reorganization, restructuring, consolidation, financing or otherwise, whereby the Company remains the surviving entity immediately after such transaction shall not be deemed an assignment. The Investor may not assign its rights under this Agreement without the prior written consent of the Company, other than to an affiliate of the Investor controlled by Jonathan Cope or Josh Scheinfeld, in which case the assignee must agree in writing to be bound by the terms and conditions of this Agreement.

9. AMENDMENT OF REGISTRATION RIGHTS.

No provision of this Agreement may be amended or waived by the parties from and after the date that is one Business Day immediately preceding the initial filing of the Initial Prospectus Supplement with the SEC. Subject to the immediately preceding sentence, no provision of this Agreement may be (i) amended other than by a written instrument signed by both parties hereto or (ii) waived other than in a written instrument signed by the party against whom enforcement of such waiver is sought. Failure of any party to exercise any right or remedy under this Agreement or otherwise, or delay by a party in exercising such right or remedy, shall not operate as a waiver thereof.

10. MISCELLANEOUS.

(a) Notices. Any notices, consents or other communications required or permitted to be given under the terms of this Agreement must be in writing and will be have been delivered: (i) upon receipt, when delivered personally; (ii) upon receipt, when sent by facsimile (provided confirmation of transmission is mechanically or electronically generated and kept on file by the sending party); (iii) upon receipt, when sent by electronic message (provided the recipient responds to the message and confirmation of both electronic messages are kept on file by the sending party); or (iv) one (1) Business Day after timely deposit with a nationally recognized overnight delivery service, in each case properly addressed to the party to receive the same. The addresses and facsimile numbers for such communications shall be:

Lightwave Logic, Inc.
369 Inverness Parkway, Suite 350
Englewood, CO 80112
Telephone: (720) 340-4949
E-mail: jim@lightwavelogic.com
Attention: James S. Marcelli, President

With a copy to (which shall not constitute notice or service of process):

K&L Gates, LLP
200 S. Biscayne Blvd., Ste. 3900
Miami, Florida 33131
Telephone: (305) 539-3306
Facsimile: (305) 358-7095
E-mail: clayton.parker@klgates.com
Attention: Clayton E. Parker, Esq.

If to the Investor:

Lincoln Park Capital Fund, LLC
440 North Wells, Suite 410
Chicago, IL 60654
Telephone: (312) 822-9300
Facsimile: (312) 822-9301
E-mail: jscheinfeld@lpcfunds.com/jcope@lpcfunds.com
Attention: Josh Scheinfeld/Jonathan Cope

If to the Transfer Agent:

Broadridge Corporate Issuer Solutions, Inc.
51 Mercedes Way
Edgewood, NY 11717
Telephone: (979) 218-8194
Email: autumn.tallaksen@broadridge.com
Attention: Autumn Tallaksen

or at such other address, e-mail address and/or facsimile number and/or to the attention of such other person as the recipient party has specified by written notice given to each other party at least one (1) Business Day prior to the effectiveness of such change. Written confirmation of receipt (A) given by the recipient of such notice, consent or other communication, (B) mechanically or electronically generated by the sender's facsimile machine containing the time, date, and recipient facsimile number, (C) electronically generated by the sender's electronic mail containing the time, date and recipient email address or (D) provided by a nationally recognized overnight delivery service, shall be rebuttable evidence of receipt in accordance with clause (i), (ii), (iii) or (iv) above, respectively. Any party to this Agreement may give any notice or other communication hereunder using any other means (including messenger service, ordinary mail or electronic mail), but no such notice or other communication shall be deemed to have been duly given unless it actually is received by the party for whom it is intended.

(b) <u>No Waiver.</u> No failure or delay in the exercise of any power, right or privilege hereunder shall operate as a waiver thereof, nor shall any single or partial ex such power, right or privilege preclude other or further exercise thereof or of any other right, power or privilege.

(c) <u>Governing Law</u>. All questions concerning the construction, validity, enforcement and interpretation of this Agreement shall be governed by the internal laws Illinois, without giving effect to any choice of law or conflict of law provision or rule (whether of the State of Illinois or any other jurisdictions) that would cause the application of the laws of any jurisdictions other than the State of Illinois. Each party hereby irrevocably submits to the exclusive jurisdiction of the state and federal courts sitting in the County of Cook, in the State of Illinois for the adjudication of any dispute hereunder or in connection herewith or with any transaction contemplated hereby or discussed herein, and hereby irrevocably waives, and agrees not to assert in any suit, action or proceeding, any claim that it is not personally subject to the jurisdiction of any such court, that such suit, action or proceeding is brought in an inconvenient forum or that the venue of such suit, action or proceeding is improper. Each party hereby irrevocably waives personal service of process and consents to process being served in any such suit, action or proceeding by mailing a copy thereof to such party at the address for such notices to it under this Agreement and agrees that such service shall constitute good and sufficient service of process and notice thereof. Nothing contained herein shall be deemed to limit in any way any right to serve process in any manner permitted by law. If any provision of this Agreement shall be invalid or unenforceable in any jurisdiction, such invalidity or unenforceability shall not affect the validity or enforceability of the remainder of this Agreement in that jurisdiction or the validity or enforceability of any provision of this Agreement in any other jurisdiction. **EACH PARTY HEREBY IRREVOCABLY WAIVES ANY RIGHT IT MAY HAVE, AND AGREES NOT TO REQUEST, A JURY TRIAL FO ADJUDICATION OF ANY DISPUTE HEREUNDER OR IN CONNECTION HEREWITH OR ARISING OUT OF THIS AGREEMENT TRANSACTION CONTEMPLATED HEREBY.**

(d) <u>Integration</u>. This Agreement**,** the Purchase Agreement and the other Transaction Documents constitute the entire understanding among the parties hereto the subject matter hereof and thereof. There are no restrictions, promises, warranties or undertakings, other than those set forth or referred to herein and therein. This Agreement**,** the Purchase Agreement and the other Transaction Documents supersede all other prior oral or written agreements between the Investor, the Company, their affiliates and persons acting on their behalf with respect to the subject matter hereof and thereof.

(e) <u>No Third Party Benefits</u>. Subject to the requirements of <u>Section 8</u> hereof, this Agreement shall inure to the benefit of and be binding upon the permitted suc assigns of each of the parties hereto.

(f) <u>Headings</u>. The headings in this Agreement are for convenience of reference and shall not form part of, or affect the interpretation of, this Agreement.

(g) <u>Counterparts</u>. This Agreement may be executed in two or more identical counterparts, all of which shall be considered one and the same agreement and sh effective when counterparts have been signed by each party and delivered to the other party; provided that a facsimile or pdf (or other electronic reproduction of a) signature shall be considered due execution and shall be binding upon the signatory thereto with the same force and effect as if the signature were an original, not a facsimile or pdf (or other electronic reproduction of a) signature.

(h) Each party shall do and perform, or cause to be done and performed, all such further acts and things, and shall execute and deliver all such other agreemen instruments and documents as the other party may reasonably request in order to carry out the intent and accomplish the purposes of this Agreement and the consummation of the transactions contemplated hereby.

(i) The language used in this Agreement will be deemed to be the language chosen by the parties to express their mutual intent and no rules of strict construct applied against any party.

(j) This Agreement is intended for the benefit of the parties hereto and their respective permitted successors and assigns, and is not for the benefit of, nor may hereof be enforced by, any other Person.

[Signature Page Follows]

IN WITNESS WHEREOF, the parties have caused this Registration Rights Agreement to be duly executed as of date first written above.

<u>THE COMPANY:</u>

LIGHTWAVE LOGIC, INC.

By: /s/ James S. Marcelli
Name: James S. Marcelli
Title: President and Chief Operating Officer

<u>THE INVESTOR:</u>

LINCOLN PARK CAPITAL FUND, LLC

BY: LINCOLN PARK CAPITAL, LLC
BY: ROCKLEDGE CAPITAL CORPORATION

By:	/s/ Joshua Scheinfeld
Name:	Joshua Scheinfeld
Title:	President

EXHIBIT A

Information About The Investor Furnished To The Company By The Investor
Expressly For Use In Connection With Each Registration Statement and Prospectus

Information With Respect to Lincoln Park Capital

Immediately prior to the date of the Purchase Agreement, Lincoln Park Capital Fund, LLC, beneficially owned 50,940 shares of Common Stock. Josh Scheinfeld a Jonathan Cope, the Managing Members of Lincoln Park Capital, LLC, the manager of Lincoln Park Capital Fund, LLC, are deemed to be beneficial owners of all of the Comn Stock owned by Lincoln Park Capital Fund, LLC. Messrs. Cope and Scheinfeld have shared voting and investment power over the shares being offered under the prospectu supplement filed with the SEC in connection with the transactions contemplated under the Purchase Agreement. Lincoln Park Capital, LLC is not a licensed broker dealer or a affiliate of a licensed broker dealer.

EXHIBIT 21.1

SUBSIDIARIES OF LIGHTWAVE LOGIC, INC.

None.

EXHIBIT 23.1

CONSENT OF INDEPENDENT REGISTERED PUBLIC ACCOUNTING FIRM

The Board of Directors of
Lightwave Logic, Inc.

We hereby consent to the incorporation by reference in the registration statements of Lightwave Logic, Inc. on:

- Form S-8 (No. 333-234737)
- Form S-8 (No. 333-213541)
- Form S-8 (No. 333-189943)
- Form S-8 (No. 333-198916)
- Form S-3 (No. 333-257670)

of our reports dated March 1, 2023, relating to the financial statements of Lightwave Logic, Inc. and the effectiveness of internal control over financial reporting.

/s/ Morison Cogen LLP

Blue Bell, Pennsylvania
Date: March 1, 2023

Exhibit 31.1

CERTIFICATION

I, Michael Lebby, certify that:

1. I have reviewed this Annual Report on Form 10-K of Lightwave Logic, Inc.;

2. Based on my knowledge, this report does not contain any untrue statement of a material fact or omit to state a material fact necessary to make the statements made, in light of the circumstances under which such statements were made, not misleading with respect to the period covered by this report;

3. Based on my knowledge, the financial statements, and other financial information included in this report, fairly present in all material respects the financial condition, results of operations and cash flows of the registrant as of, and for, the periods presented in this report;

4. The registrant's other certifying officer(s) and I are responsible for establishing and maintaining disclosure controls and procedures (as defined in Exchange Act Rules 13a-15(e) and 15d-15(e)) and internal control over financial reporting (as defined in Exchange Act Rules 13a-15(f) and 15d-15(f)) for the registrant and have:

(a) Designed such disclosure controls and procedures, or caused such disclosure controls and procedures to be designed under our supervision, to ensure that material information relating to the registrant, including its consolidated subsidiaries, is made known to us by others within those entities, particularly during the period in which this report is being prepared;

(b) Designed such internal control over financial reporting, or caused such internal control over financial reporting to be designed under our supervision, to provide reasonable assurance regarding the reliability of financial reporting and the preparation of financial statements for external purposes in accordance with generally accepted accounting principles;

(c) Evaluated the effectiveness of the registrant’s disclosure controls and procedures and presented in this report our conclusions about the effectiveness of the disclosure controls and procedures, as of the end of the period covered by this report based on such evaluation; and

(d) Disclosed in this report any change in the registrant’s internal control over financial reporting that occurred during the registrant’s most recent fiscal quarter (the registrant’s fourth fiscal quarter in the case of an annual report) that has materially affected, or is reasonably likely to materially affect, the registrant’s internal control over financial reporting; and

5. The registrant’s other certifying officer(s) and I have disclosed, based on our most recent evaluation of internal control over financial reporting, to the registrant’s auditors and the audit committee of the registrant’s board of directors (or persons performing the equivalent functions):

(a) All significant deficiencies and material weaknesses in the design or operation of internal control over financial reporting which are reasonably likely to adversely affect the registrant’s ability to record, process, summarize and report financial information; and

(b) Any fraud, whether or not material, that involves management or other employees who have a significant role in the registrant’s internal control over financial reporting.

Date: March 1, 2023

/s/ Michael Lebby
Michael Lebby
Chief Executive Officer
(Principal Executive Officer)

Exhibit 31.2

CERTIFICATION

I, James S. Marcelli, certify that:

1. I have reviewed this Annual Report on Form 10-K of Lightwave Logic, Inc.;

2. Based on my knowledge, this report does not contain any untrue statement of a material fact or omit to state a material fact necessary to make the statements made, in light of the circumstances under which such statements were made, not misleading with respect to the period covered by this report;

3. Based on my knowledge, the financial statements, and other financial information included in this report, fairly present in all material respects the financial condition, results of operations and cash flows of the registrant as of, and for, the periods presented in this report;

4. The registrant's other certifying officer(s) and I are responsible for establishing and maintaining disclosure controls and procedures (as defined in Exchange Act Rules 13a-15(e) and 15d-15(e)) and internal control over financial reporting (as defined in Exchange Act Rules 13a-15(f) and 15d-15(f)) for the registrant and have:

(a) Designed such disclosure controls and procedures, or caused such disclosure controls and procedures to be designed under our supervision, to ensure that material information relating to the registrant, including its consolidated subsidiaries, is made known to us by others within those entities, particularly during the period in which this report is being prepared;

(b) Designed such internal control over financial reporting, or caused such internal control over financial reporting to be designed under our supervision, to provide reasonable assurance regarding the reliability of financial reporting and the preparation of financial statements for external purposes in accordance with generally accepted accounting principles;

(c) Evaluated the effectiveness of the registrant's disclosure controls and procedures and presented in this report our conclusions about the effectiveness of the disclosure controls and procedures, as of the end of the period covered by this report based on such evaluation; and

(d) Disclosed in this report any change in the registrant's internal control over financial reporting that occurred during the registrant's most recent fiscal quarter (the registrant's fourth fiscal quarter in the case of an annual report) that has materially affected, or is reasonably likely to materially affect, the registrant's internal control over financial reporting; and

5. The registrant's other certifying officer(s) and I have disclosed, based on our most recent evaluation of internal control over financial reporting, to the registrant's auditors and the audit committee of the registrant's board of directors (or persons performing the equivalent functions):

(a) All significant deficiencies and material weaknesses in the design or operation of internal control over financial reporting which are reasonably likely to adversely affect the registrant's ability to record, process, summarize and report financial information; and

(b) Any fraud, whether or not material, that involves management or other employees who have a significant role in the registrant's internal control over financial reporting.

Date: March 1, 2023

/s/ James S. Marcelli
James S. Marcelli
Chief Operating Officer
(Principal Financial Officer)

Exhibit 32.1

CERTIFICATION PURSUANT TO
SECTION 1350, CHAPTER 63 OF TITLE 18, UNITED STATES CODE,
AS ADOPTED PURSUANT TO
SECTION 906 OF THE SARBANES-OXLEY ACT OF 2002

In connection with the Annual Report on Form 10-K of Lightwave Logic, Inc. (the "Company") for the year ended December 31, 2022 as filed with the Securities and Exchange Commission on the date hereof (the "Report"), I, Michael Lebby, Chief Executive Officer of our Company, certify, pursuant to Section 906 of the Sarbanes-Oxley Act of 2002 (subsections (a) and (b) of section 1350, Chapter 63 of Title 18, United States Code), that, to my knowledge:

1. The Report fully complies with the requirements of section 13(a) or 15(d) of the Securities Exchange Act of 1934; and

2. The information contained in the Report fairly presents, in all material respects, the financial condition and result of operations of our Company.

Date: March 1, 2023

/s/ Michael Lebby
Michael Lebby
Chief Executive Officer
(Principal Executive Officer)

The foregoing certification is being furnished solely pursuant to section 906 of the Sarbanes-Oxley Act of 2002 (subsections (a) and (b) of section 1350, Chapter 63 of Title 18, United States Code) and is not being filed as part of the Report or as a separate disclosure document.

Exhibit 32.2

**CERTIFICATION PURSUANT TO
SECTION 1350, CHAPTER 63 OF TITLE 18, UNITED STATES CODE,
AS ADOPTED PURSUANT TO
SECTION 906 OF THE SARBANES-OXLEY ACT OF 2002**

In connection with the Annual Report on Form 10-K of Lightwave Logic, Inc. (the "Company") for the year ended December 31, 2022 as filed with the Securities and Exchange Commission on the date hereof (the "Report"), I, James S. Marcelli, Chief Operating Officer of our Company, certify, pursuant to Section 906 of the Sarbanes-Oxley Act of 2002 (subsections (a) and (b) of section 1350, Chapter 63 of Title 18, United States Code), that, to my knowledge:

1. The Report fully complies with the requirements of section 13(a) or 15(d) of the Securities Exchange Act of 1934; and

2. The information contained in the Report fairly presents, in all material respects, the financial condition and result of operations of our Company.

Date: March 1, 2023

/s/ James S. Marcelli
James S. Marcelli
Chief Operating Officer
(Principal Financial Officer)

The foregoing certification is being furnished solely pursuant to section 906 of the Sarbanes-Oxley Act of 2002 (subsections (a) and (b) of section 1350, Chapter 63 of Title 18, United States Code) and is not being filed as part of the Report or as a separate disclosure document.