IPG PHOTONICS CORP
Form 10-K
February 27, 2019
10-KFALSEDec 31, 2018FY2018IPG PHOTONICS CORP0001111928--12-31Large Accelerated Filer52,962,009NoYesYesFALSEFALSEFALSE.0001.0001175,000,000175,000,00054,371,70154,007,70852,941,60753,629,

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UNITED STATES SECURITIES AND EXCHANGE COMMISSION
Washington, DC 20549

Form 10-K

(Mark One)

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

For the fiscal year ended December 31, 2018
OR

o **TRANSITION REPORT PURSUANT TO SECTION 13 OR 15(d) OF THE SECURITIES EXCHANGE ACT OF 1934**

Commission File Number: 001-33155

IPG PHOTONICS CORPORATION

(Exact name of registrant as specified in its charter)

Delaware	**04-3444218**
(State or other jurisdiction of incorporation or organization)	*(IRS Employer Identification No.)*
50 Old Webster Road, Oxford, Massachusetts	**01540**

(Address of principal executive offices) *(Zip Code)*

Registrant's telephone number, including area code:
(508) 373-1100
Securities registered pursuant to Section 12(b) of the Act:

Title of Class	Name of Exchange on Which Registered
Common Stock, Par Value $0.0001 per share	**The Nasdaq Stock Market LLC**

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 þ No o

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

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 s

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 þ No o

rmation statements incorporated by reference in Part III of this Form 10-K or any amendment to this Form 10-K. o

Indicate by check mark whether the registrant is a large accelerated filer, an accelerated filer, a non-accelerated filer, a smaller reporting company or emerging growth company. See 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	Accelerated filer	Non-accelerated filer	Emerging growth company	Smaller reporting company
þ	o	o	o	o

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If an emerging growth company, indicate by check mark 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. o

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

The aggregate market value of the registrant's common stock held by non-affiliates of the registrant was approximately $7.1 billion, calculated based upon the closing price as reported by the Nasdaq Global Select Market on June 30, 2018. For purposes of this disclosure, shares of common stock held by persons who own 5% or more of the outstanding common stock and shares of common stock held by each officer and director have been excluded in that such persons may be deemed to be "affiliates" as that term is defined under the Rules and Regulations of the Exchange Act. This determination of affiliate status is not necessarily conclusive.

As of February 24, 2019, 52,962,009 shares of the registrant's common stock were outstanding.

DOCUMENTS INCORPORATED BY REFERENCE

Portions of the registrant's Proxy Statement for its 2019 Annual Meeting of Stockholders to be filed pursuant to Regulation 14A within 120 days of the end of the registrant's fiscal year ended December 31, 2018 are incorporated by reference into Part III of this Annual Report on Form 10-K to the extent stated herein.

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This Annual Report on Form 10-K contains certain forward-looking statements within the meaning of Section 27A of the Securities Act of 1933, as amended, and Section 21E of the Securities Exchange Act of 1934, as amended, and we intend that such forward-looking statements be subject to the safe harbors created thereby. For this purpose, any statements contained in this Annual Report on Form 10-K except for historical information are forward-looking statements. Without limiting the generality of the foregoing, words such as "may," "will," "expect," "believe," "anticipate," "intend," "could," "estimate," or "continue" or the negative or other variations thereof or comparable terminology are intended to identify forward-looking statements. In addition, any statements that refer to projections of our future financial performance, trends in our businesses, or other characterizations of future events or circumstances are forward-looking statements.

The forward-looking statements included herein are based on current expectations of our management based on available information and involve a number of risks and uncertainties, all of which are difficult or impossible to accurately predict and many of which are beyond our control. As such, our actual results may differ significantly from those expressed in any forward-looking statements. Factors that may cause or contribute to such differences include, but are not limited to, those discussed in more detail in Item 1 (Business) and Item 1A (Risk Factors) of Part I and Item 7 (Management's Discussion and Analysis of Financial Condition and Results of Operations) of Part II of this Annual Report on Form 10-K. Readers should carefully review these risks, as well as the additional risks described in other documents we file from time to time with the Securities and Exchange Commission (the "SEC"). In light of the significant risks and uncertainties inherent in the forward-looking information included herein, the inclusion of such information should not be regarded as a representation by us or any other person that such results will be achieved, and readers are cautioned not to rely on such forward-looking information. We undertake no obligation to revise the forward-looking statements contained herein to reflect events or circumstances after the date hereof or to reflect the occurrence of unanticipated events.

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PART I

ITEM 1. ***BUSINESS***

Our Company

IPG Photonics Corporation ("IPG", the "Company", the "Registrant", "we", "us" or "our") is the leading developer and manufacturer of a broad line of high-performance fiber lasers, fiber amplifiers and diode lasers that are used for diverse applications, primarily in materials processing. Fiber lasers are a type of laser that combine the advantages of semiconductor diodes, such as long life and high efficiency, with the high amplification and precise beam qualities of specialty optical fibers to deliver superior performance, reliability and usability.

Our diverse lines of low, mid and high power lasers and amplifiers are used in materials processing, advanced communications and medical applications. We sell our products globally to original equipment manufacturers ("OEMs"), system integrators and end users. We market our products internationally primarily through our direct sales force. Our major manufacturing facilities are located in the United States, Germany and Russia. We have sales service offices and applications laboratories worldwide.

We are vertically integrated such that we design and manufacture most of the key components used in our finished products, from semiconductor diodes to optical fiber preforms, finished fiber lasers and amplifiers. We also manufacture complementary products used with our lasers including optical delivery cables, fiber couplers, beam switches, optical processing heads and chillers. In addition, we offer laser-based and non-laser based systems for certain markets and applications. Our vertically integrated operations allow us to reduce manufacturing costs, control quality, rapidly develop and integrate advanced products and protect our proprietary technology.

We are listed on the Nasdaq Global Select Market (ticker: IPGP). We began operations in 1990, and we were incorporated in Delaware in 1998. Our principal executive offices are located at 50 Old Webster Road, Oxford, Massachusetts 01540, and our telephone number is (508) 373-1100.

Industry Background

Laser technology has revolutionized a broad range of applications and products in various industries, including general manufacturing, automotive, medical, research, consumer products, electronics, semiconductors and communications. A laser works by converting electrical energy to optical energy. In a laser, an energy source excites or pumps a lasing medium, which converts the energy from the source into an emission consisting of particles of light, called photons, at particular wavelengths. Lasers provide flexible, non-contact and high-speed ways to process and treat various materials and are a key enabler of advanced manufacturing techniques including automation and miniaturization. They are incorporated into manufacturing, medical and other systems by OEMs, system integrators and end users. Also, they are widely used for various medical applications and test and measurement systems and to transmit large volumes of data in optical communications systems. For a wide variety of applications, lasers provide superior performance and a more cost-effective solution than non-laser technologies.

Lasers emit an intense light beam that can be focused on a small area, causing metals and other materials to melt, vaporize or change their character. These properties are utilized in materials processing applications requiring very high power densities, such as cutting, welding, marking and engraving, additive manufacturing, ablation, printing, drilling and cladding. Many different types of machine tools have been used within the materials processing industry to cut, form or otherwise process metal in the production of finished goods such as automobiles, consumer appliances, electronics, and heavy machinery. These machine tools include (but are not limited to) grinding machines, mechanical saws, milling machines, lathes, presses, stamping machines, electrical-discharge machines, plasma, water-jet and lasers. The Autumn 2018 Global Machine Tool Outlook by Oxford Economics estimates global machine tool consumption of $84 billion in 2018. Laser-based systems are increasingly gaining share within the materials processing market given the greater precision, processing speeds, and flexibility enabled by this technology. Because laser energy can be delivered remotely, with greater precision and power, the trends toward automated production, miniaturization and increasing product complexity are helping drive adoption of laser technology. Beyond materials processing, lasers are well-suited for imaging and inspection applications, and the ability to confine laser light to narrow wavelengths makes them particularly effective in medical and sensing applications.

Other Laser Technologies

Historically, carbon dioxide ("CO_2") gas lasers and crystal lasers have been the two principal laser types used in materials processing and many other applications. They are named for the materials used to create the lasing action. A

CO_2 laser produces light by electrically stimulating a gas-filled tube and delivers the beam through free space using mirrors to provide direction. A

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crystal laser uses an arc lamp, pulsed flash lamp or diode stack or array to optically pump a special crystal. The most common crystal lasers use yttrium aluminum garnet ("YAG") crystals infused with neodymium or ytterbium. Crystal lasers also use mirrors in free space to deliver the beam or direct the beam through fiber optics.

Fiber Lasers

Fiber lasers use semiconductor diodes as the light source to pump specialty optical fibers, which are infused with rare earth ions. These fibers are called active fibers and are comparable in diameter to a human hair. The laser emission is created within optical fibers and delivered through a flexible optical fiber cable. As a result of their different design and components, fiber lasers are more reliable, efficient, robust, compact and easier to operate than other laser technologies. In addition, fiber lasers free the end users from fine mechanical adjustments and the high maintenance costs that are typical for other laser technologies.

Although low power fiber lasers were introduced four decades ago, their increased adoption in the last decade has been driven primarily by our improvements in their output power levels and cost, as well as their superior performance, lower cost of ownership and greater reliability compared with other laser technologies. We have successfully increased output power levels by developing improved optical components such as diodes and active fibers that have increased their power capacities and improved their performance. Fiber lasers now offer output powers that exceed those of other laser technologies in many categories. Also, semiconductor diodes historically have represented the majority of the cost of fiber lasers. In the past, the high cost of diodes meant that fiber lasers could not compete with other laser technologies on price and limited their use to high value-added applications. Over the last twenty years, however, our semiconductor diodes have become more affordable and reliable due, in part, to substantial advancements in semiconductor diode technology, packaging design and increased production volumes. As a result, the average cost per watt of output power has decreased dramatically over the last fifteen years. Because of these improvements, our fiber lasers can now effectively compete with other laser technologies over a wide range of output powers and applications, and begin to compete with non-laser technologies in many applications that did not use lasers historically. As a pioneer in the development and commercialization of fiber lasers, we have contributed to many advancements in fiber laser technology and products.

Advantages of Fiber Lasers

We believe that fiber lasers provide a combination of benefits that include:

•*Superior Performance.* Fiber lasers provide uniform beam quality over the entire power range. In most other laser solutions, the beam quality is sensitive to output power, while in fiber lasers, the output beam is virtually non-divergent over a wide power range. A non-divergent beam enables higher levels of precision, increased power densities and the ability to deliver the beam over greater distances to where processing can be completed. The superior beam quality and greater intensity of a fiber laser's beam allow tasks to be accomplished more rapidly, with lower power units and with greater flexibility than comparable lasers.

•*Enhanced End User Productivity.* The near-infrared ("IR") wavelengths produced by ytterbium fiber lasers are absorbed well by metals, enabling faster processing speeds than other lasers and non-laser technologies across many metal-based materials processing applications. Because IPG fiber lasers utilize rigorously-tested long-lived semiconductor diodes, unique active fibers to prevent photo darkening and other leading-edge, proprietary technologies, our fiber lasers have demonstrated greater uptime and reliability in the field, with less required maintenance and fewer service interventions than many competing technologies.

•*Cost of Ownership.* Fiber lasers are less expensive to operate due to their faster processing speeds, higher energy efficiency and lower required maintenance costs. Fiber lasers convert electrical energy to optical energy approximately 2 to 3 times more efficiently than diode-pumped YAG lasers or disc lasers, approximately 3 to 4 times more efficiently than conventional CO_2 lasers and approximately 15 to 30 times more efficiently than lamp-pumped YAG lasers. Because fiber lasers are much more energy-efficient and place lower levels of thermal stress on their internal components, they have substantially lower cooling requirements compared to those of other lasers, which also improves overall energy efficiency. Fiber lasers have lower maintenance costs due to the high performance and long life of our single-emitter diodes, fiber optics and other optical components.

•*Ease of Use.* Fiber lasers have numerous features which make them easier to operate, maintain and integrate into laser-based systems as compared to other lasers, many of which require mirrors to direct the beam. There are no moving parts in fiber lasers and the beam is contained in a flexible fiber optic cable so they do not require adjustments

of internal components or mirrors to direct the beam.

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•*Compact Size.* Fiber lasers are typically smaller and lighter in weight than other lasers, saving valuable floor space. While other laser technologies are delicate due to the precise alignment of mirrors, fiber lasers are more durable and able to perform in variable environments.

•*Choice of Wavelengths and Precise Control of Beam.* The design of fiber lasers generally provides a broad range of wavelength choices, allowing users to select the precise wavelength that best matches their application and materials. As the beam is delivered through a flexible fiber optic cable, it can be directed to the work area over longer distances without loss of beam quality.

Fiber amplifiers are similar in design to fiber lasers, use many of the same components, such as semiconductor diodes and specialty optical fibers, and provide many of the same advantages in the applications that require amplification. Notwithstanding the benefits offered by fiber lasers, there remain applications and processes where other laser and non-laser technologies may provide superior performance with respect to particular features. For example, crystal lasers can provide higher peak power pulses necessary in certain applications and fiber lasers cannot generate the deep ("UV") light at the power levels required for photolithography in many semiconductor applications. In addition, CO_2 lasers operate at wavelengths that are optimal for use on many non-metallic materials, including organic materials like wood.

Our Competitive Strengths

Our key strengths and competitive advantages include:

World's Leading Producer of Fiber Laser Technology. We are the world's largest manufacturer of fiber lasers. As a pioneer and technology leader in fiber lasers, we have built leading positions in our various end markets with a large and diverse customer base. Based on our leadership positions, we are able to leverage our scale to reduce costs for our customers and drive the proliferation of fiber lasers in existing and new applications. We rely on several key proprietary technologies, including pumping and combining technologies, manufacturing fibers to withstand the high output powers of our lasers, fiber gain blocks and optics that contribute to the superior performance and reliability of our products. As a result of our technology leadership, we can commercially manufacture reliable high power fiber lasers in high volumes at a lower cost per watt than our competitors.

Vertically Integrated Development and Manufacturing. We develop and manufacture all of our key high-volume specialty components, including semiconductor diodes, active fibers, passive fibers and specialty optical components. We also produce beam switches, fiber optic delivery cables, certain optical processing heads, power suppliers, printed circuit boards and mechanical parts developed especially for use with our lasers. Recently, we have been able to expand our product portfolio by offering systems capabilities in certain applications. We believe that our vertical integration enhances our ability to meet customer requirements, reduce costs, accelerate and focus development, shorten lead times, limit the spread of trade secrets and provide competitive pricing advantages while maintaining high performance and quality standards.

Manufacturing Scale. We have invested extensively in our production capabilities allowing us to deliver large volumes of fiber lasers in short delivery cycles which provide us with a competitive advantage. In 2018, we shipped more than 43,000 devices across a wide variety of applications and end markets.

Breadth and Depth of Expertise. We have extensive know-how in materials sciences, which enables us to make our specialty optical fibers, semiconductor diodes and other critical components. We also have experience in optical, electrical, mechanical and semiconductor engineering, which we use to develop and manufacture our proprietary components, products, accessories and systems. We also operate numerous application development centers worldwide and offer custom engineered systems solutions which allow us to assist customers in improving their manufacturing using our deep experience with fiber lasers.

Broad Product Portfolio and Ability to Meet Customer Requirements. We offer a broad range of standard and custom fiber lasers operating at various wavelengths and pulse durations and amplifiers, enabling deployment in a wide variety of applications and end markets. Our vertically integrated manufacturing, broad technology expertise and investment in inventory enable us to design, prototype and commence high-volume production of our products rapidly, allowing us to meet customer requests for quick deliveries. In addition, IPG can further drive market penetration through our complete customer welding solutions driven by our recent acquisitions of automated welding systems.

Diverse Customer Base, End Markets and Applications. Our diverse customer base, end markets and applications provide us with many growth opportunities. In 2018, we shipped products to over 4,300 customers worldwide. Our principal end markets and representative applications within those markets include:

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General manufacturing	• Flat sheet, tube and 3D cutting • Welding, brazing and hardening • Marking, engraving and printing • 3D printing, selective laser melting and sintering • Ablation and cleaning
Automotive	• High-strength steel and aluminum cutting and welding • Welding tailored metal blanks, frames, seats and transmissions • Brazing and welding of auto frames • Seam welding • Electric vehicle battery welding
Consumer	• Welding, cutting and marking for smart phones, electronics and appliances • Electronics and credit card marking • Stent, pacemaker and medical device manufacturing
Heavy industry	• Hardening and welding pipes in nuclear and pipeline industries • Welding and cutting thick plates for ships and rail cars • Cladding of turbine blades for power generators and drill bits for energy extraction
Aerospace	• Welding titanium • Cladding parts • Percussion drilling of parts • Non-destructive inspection solutions
Semiconductor and electronics	• Wafer inspections • Photovoltaic manufacturing

• Dicing and scribing		
	• Obstacle warning and light detecting and ranging • Special projects and research • Directed energy demonstrations • Laser cinema projection	
	• Short to ultra long reach, 1G to 100G+ DWDM for all network segments • Broadband — fiber to premises, cable video signal transport • Metro and long-haul wire-line DWDM transport • Pluggable optical transceivers	
	• Skin rejuvenation and wrinkle removal • General surgery and urology • Dental • Hair Removal • Treatment of pigmented and vascular lesions	

Our Strategy

Our objective is to maintain and extend our leadership position in our industry by pursuing the following key elements of our strategy:

Leverage Our Technology to Increase Sales. As fiber lasers become more widely accepted, we plan to leverage our position as the leader in fiber lasers and our applications expertise to develop solutions for customers and increase our

position in the market. We believe that our fiber lasers can perform many tasks that have been done with other machine tools in current non-laser applications and will continue to displace other laser technologies. Over the last few years, our high power lasers have become widely accepted in two- and three-dimension cutting, one of the largest laser materials processing applications. We plan to continue to leverage our fiber laser technology by pursuing large-scale laser applications where our fiber lasers offer improved customer value and performance. Some of the more significant applications we intend to target include: (i) joining

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processes including laser welding and brazing, (ii) deposition technology (cladding) and additive manufacturing (also called 3D printing); (iii) ablation processes including cleaning and stripping of materials; and (iv) micro-processing, scribing and marking with high power green lasers, ultrafast pulsed lasers, and UV and IR lasers now under development.

Target New Applications for Lasers and Expand into Broader Markets. We intend to expand the use of fiber lasers into additional applications in which lasers are not widely used. We believe that the advantages of fiber laser technology can overcome many of the limitations that have hindered the broader adoption of laser technology. Using our manufacturing scale and technological innovations, we have been successful in reducing the cost of manufacturing with lasers, which we believe has made fiber lasers a more attractive manufacturing alternative as compared to other laser technologies and many non-laser methods. We target applications where the cost, reliability, mobility, quality of the final process and speed can lead customers to adopt fiber lasers instead of non-laser solutions. Certain industry trends such as the use of high-strength steel and aluminum in automotive manufacturing in order to decrease the weight of vehicles and improve structural rigidity are driving the use of fiber lasers over other manufacturing methods such as stamping, non-laser welding, riveting and adhesives. Other trends, such as increasing automation and miniaturization of parts and electronics, contribute to the use of lasers because no other tools can work as precisely or quickly. Large scale fiber laser applications outside of materials processing are also targeted. We are developing a fiber laser projection technology platform as an alternative to xenon bulb projection platforms in cinemas and other entertainment venues. Through our own manufacturing cost reductions and innovations, we have developed higher power lasers which have been adopted in the market both expanding the capability of existing and enabling new laser processing applications.

Expand Our Product Portfolio. We plan to continue to invest in research and development to produce lasers at additional wavelengths, power levels and more rapid pulse durations as well as new laser-based systems. We are developing and introducing lasers with ultrashort pulse durations (picosecond and femtosecond), UV and mid infra-red lasers. We have introduced a line of optical processing cutting, welding and scanning heads optimized for use with our laser sources. We have also grown our product portfolio through acquisitions. In 2018, we acquired Genesis System Group, LLC ("Genesis"), a leader in the integration of robotic welding and automation solutions, and robot concept, GmbH ("RC"), an integrator of laser-based systems. See footnotes to Financial Statements for description. In 2017, we acquired Innovative Laser Technologies, LLC ("ILT"), a developer of high-precision laser systems for the medical device industry, OptiGrate, a pioneer of chirped volume Bragg grating technologies used in ultrafast lasers for pulse compression, and Laser Depth Dynamics Inc., which develops and manufactures in-process quality monitoring and control solutions for laser-based welding applications.

Lower Our Costs Through Manufacturing Improvements and Innovation. We plan to seek further improvements in component manufacturing processes and device assembly as well as innovation in components and device designs to improve performance and decrease the overall cost per watt for our products. As we increase our production volumes, we improve our internal manufacturing economies of scale and we believe we will be able to better negotiate price reductions with certain suppliers. We intend to leverage our technology and operations expertise to manufacture additional components in order to reduce costs, ensure component quality, ensure supply and improve product performance. We continue to manufacture more of the mechanical parts, printed circuit boards and power supplies we use and redesign certain optical components to improve quality and power capacities. We further decreased the manufacturing cost of our packaged diodes and other key components and sub-assemblies. We seek cost reductions to our integrated systems businesses through economies of scale, vertical integration and manufacturing know how. Additionally, we have developed the capability of growing and processing crystals used in certain of our lasers. By reducing the cost per watt of our lasers and maintaining the lower operating cost of our products, we believe that we can increase the use of fiber lasers in applications for which other laser technologies are not an economical or competitive option.

Expand Global Reach to Attract Customers Worldwide. The acceptance of fiber laser technology has expanded in both developed and emerging markets around the world. As a result, we have increased and continue to increase our international sales and service locations to respond to our customer needs. In 2018, we continued to expand our facilities in Russia, the United States and Germany to increase manufacturing capacity and invest in our sales and service subsidiaries around the world.

Products

We design and manufacture a broad range of high-performance optical fiber-based lasers and amplifiers. We also make packaged diodes, direct diode lasers, laser and non-laser systems and communications components and systems. Many of our products are designed to be used as general-purpose energy or light sources, making them useful in diverse applications and markets.

Our products are based on a common proprietary technology platform using many of the same core components, such as semiconductor diodes and specialty fibers, which we configure to our customers' specifications. Our engineers and scientists

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work closely with OEMs, system integrators and end users to develop and customize our products for their needs. Because of our flexible and modular product architecture, we offer products in different configurations according to the desired application, including modules, rack-mounted units and tabletop units. Our engineers and other technical experts work directly with the customer in our application and development centers to develop and configure the optimal solution for each customer's manufacturing requirements. We also manufacture certain complementary products that are used with our lasers, such as optical delivery cables, fiber couplers, beam switches, optical processing heads and chillers.

Lasers

Our laser products include low (1 to 99 watts), medium (100 to 999 watts) and high (1,000 watts and above) output power lasers from 0.3 to 4.5 microns in wavelength. These lasers may be continuous wave ("CW"), quasi-continuous wave ("QCW") or pulsed. Our pulsed line includes nanosecond, picosecond and femtosecond lasers. We offer several different types of lasers, which are defined by the type of gain medium they use. These are ytterbium, erbium and thulium, as well as Raman and hybrid fiber-crystal lasers. We also sell fiber pigtailed packaged diodes and fiber coupled direct diode laser systems that use semiconductor diodes rather than optical fibers as their gain medium. In addition, we offer high-energy pulsed lasers, multi-wavelength lasers, tunable lasers, single-polarization and single-frequency lasers, as well as other versions of our products.

We believe that we produce the highest power solid-state lasers in the industry. Our ytterbium fiber lasers reach power levels of up to 120,000 watts. We also make single-mode and low-mode output ytterbium fiber lasers with power levels of up to 20,000 watts and single-mode, erbium and thulium fiber lasers with power levels of up to 500 watts. Our compact, durable design and integrated fiber optic beam delivery allow us to offer versatile laser energy sources and simple laser integration for complex production processes without compromising quality, speed or power.

We also sell laser diode chips and packaged laser diodes operating at 8XX to 9XX nanometers. We also make active and passive laser materials and tunable lasers in the mid-IR region.

Accessories

We sell our own family of high power optical fiber delivery cables, fiber couplers, beam switches, chillers, scanners and other accessories for our fiber lasers. We are expanding our line of cutting and welding optical processing heads for use with our fiber lasers, including in-line coherent monitoring for welding.

Systems

Besides selling laser sources, we also offer integrated laser systems for particular geographic markets or custom-developed for a customer's manufacturing requirements. We offer 2D compact flat sheet cutter systems and multi-axis systems for fine welding, cutting and drilling. In 2018, we acquired providers of automated solutions for laser and non-laser technology. In 2018, we acquired Genesis, a leader in the integration of laser and non-laser robotic welding and automation solutions, and RC, an integrator of laser-based systems. Genesis also designs and produces non-destructive inspection systems. In 2017, we acquired ILT, a producer of high precision laser systems for the medical device industry. Also we offer a welding seam stepper and picker, which is an automated and integrated fiber laser welding tool providing customers increased processing speeds, better quality and the elimination of certain clamping tools and laser safety enclosures.

IPG also develops and sells specialized fiber laser systems for unique material processing applications as requested by customers desiring a complete laser-based solution, including orbital welding, pipe welding and remote welding. The platforms include robotic and multi-axis workstations for welding, cutting and cladding, flatbed cutting systems, and diode markers.

Amplifiers

Our amplifier products range from milliwatts to up to 1,500 watts of output power from 1 to 2 microns in wavelength. We offer erbium-doped fiber amplifiers ("EDFAs"), Raman amplifiers and integrated communications systems that incorporate our amplifiers. These products are predominantly deployed in broadband networks such as fiber to the home ("FTTH"), fiber to the curb ("FTTC"), and passive optical networks ("PON"), and dense wavelength division multiplexing ("DWDM") networks. We also offer ytterbium and thulium specialty fiber amplifiers and broadband light sources that are used in advanced applications. In addition, we sell single-frequency, linearly polarized and polarization-maintaining versions of our amplifier products. As with our fiber lasers, our fiber amplifiers offer some of the highest output power levels and highest number of optical outputs in the industry. We believe our line of fiber

amplifiers offers the best commercially available output power and performance.

Transceivers

Our transceivers provide interconnect, coarse wavelength division multiplexing ("CWDM"), DWDM, and tunable-based pluggable interfaces to serve optical transmission needs from 100 meters over multimode fiber to over 1,200 kilometers. A transceiver combines the functions of a transmitter, which uses a laser and modulation to convert electrical signals into optical

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signals for transmission over optical fiber, and a receiver, which uses photo detectors to convert incoming optical signals into electrical signals, within a single device. These optical subsystems provide the interface for interconnecting electronic equipment including Ethernet switches, IP routers and SONET/SDH optical transport modules within telecommunications, cable multi-system operator ("MSO") and data center networks.

The following table lists our principal product lines that generated a substantial majority of our revenues in 2018, and the principal applications markets in which they are used:

Product Line	**Principal Markets**	**Principal Applications**
High Power Ytterbium CW (1,000 — 120,000 Watts)	Automotive Heavy Industry General Manufacturing Natural Resources Aerospace	Cutting Welding Annealing Drilling Cladding Brazing 3D Printing
Medium Power Ytterbium CW (100 — 999 Watts)	General Manufacturing Consumer Medical Devices Printing Electronics	Cutting Welding Scribing Engraving 3D printing
Pulsed Ytterbium (0.1 to 200 Watts)	General Manufacturing Semiconductor Medical Devices Consumer Electronics Panel Displays	Marking Engraving Scribing Drilling Coating removal Cutting
Ultrafast Pulsed Ytterbium	General Manufacturing Semiconductor Medical Scientific Consumer Electronics Panel Displays	Marking Engraving Coating removal Scribing Cutting Drilling Solar
Quasi-CW Ytterbium (100 — 4,500 Watts)	Medical Device Computer Components Fine-Processing	Welding and micro-welding Drilling Cutting metals and crystals
Pulsed and CW Green Lasers	Microprocessing and Semiconductor Solar General Manufacturing	Annealing silicon wafers Thin film ablation Marking plastics
Pulsed Ultraviolet	Consumer Pharmaceutical Semiconductor Consumer Electronics	Marking Engraving Scribing Micro punching

Accessories	Automotive Heavy Industry General Manufacturing Natural Resources Aerospace	Cutting Welding Weld Inspection
Systems	Automotive Aerospace General Manufacturing Medical Device Manufacturing Entertainment	Welding Non-destructive inspection Cutting, drilling, ablation Digital cinema projection
Erbium Amplifiers	Broadband Access Cable TV DWDM Instrumentation Scientific Research	Telephony Video on demand High-speed internet Ultra-long-haul transmission Beam combining
Transceivers	Telecommunications Cable TV Data Center Networking	SONET/SDH optical transport Ethernet switching IP routing

Our products are used in a broad range of applications. The major application is materials processing, comprising approximately 94% of our sales in 2018. Our products also address other applications, including advanced applications (approximately 3% of sales), communications (approximately 2% of sales) and medical (approximately 1% of sales).

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For the fiscal years ended December 31, 2018, 2017 and 2016, high power continuous wave ("CW") lasers accounted for 62.3%, 61.6%, and 57.5%, respectively, of revenue and pulsed lasers accounted for 11.1%, 10.6%, and 12.8%, respectively, of revenues.

Our Markets

Materials Processing

The most significant materials processing applications for fiber lasers are cutting, welding and brazing, marking and engraving, additive manufacturing such as 3D printing and ablation. Other applications include micro-processing, surface treatment, drilling, and annealing.

Cutting and Welding Applications. Laser-based cutting technology has several advantages compared to alternative technologies. Laser cutting is fast, flexible and highly precise and can be used to cut complex contours on flat, tubular or three-dimensional materials. The laser source can be programmed to process many different kinds of materials such as steel, aluminum, brass, copper, glass, ceramic and plastic at various thicknesses. Laser cutting technology is a non-contact process that is easy to integrate into an automated production line and is not subject to wear of the cutting medium. We sell low, mid and high power ytterbium fiber lasers for laser cutting. High electrical efficiency, low maintenance and operating cost, high beam quality, wide operating power range, power stability and small spot size are some of the qualities offered by IPG fiber lasers for many cutting applications, which enable customers to cut a variety of materials faster.

Laser welding offers several important advantages compared to conventional welding technology as it is non-contact, easy to automate, provides high process speed and results in narrow-seamed, high-quality welds that generally require little or no post-processing machining. The high beam quality of our fiber lasers coupled with high CW power offer deep penetration welding as well as shallow conduction mode welding. In addition, fiber lasers can be focused to a small spot with extremely long focal lengths, enabling remote welding "on the fly," a flexible method of three-dimensional welding in which the laser beam is positioned by a robot-guided scanner. Such remote welding stations equipped with fiber lasers are used for welding door panels and seat backs, the multiple welding of spot and lap welds over the entire auto body frame, tailor blank welding and welding "body-in-white," which is welding pieces of metal with different thicknesses for automotive applications. Typically, mid to high power ytterbium fiber lasers and long-pulse QCW ytterbium fiber lasers are used in welding applications. Our products are used also for laser brazing of visible joints in automobiles such as tailgates, roof joints and columns. Brazing is a method of joining sheet metal by using a melted filler material similar to soldering but requiring higher temperatures.

3D Printing. Historically, metalworking has been performed with processes that remove material to produce component parts. The development of 3D printing technology enables the production of three-dimensional objects from digital design data through an additive manufacturing process, which builds up components in layers using materials that are available in fine powder form. 3D printers take advantage of improvements in computing power and motion and process control to deposit a range of materials, including metals, plastics and composite materials, accurately at high speed. Within metal-based 3D printing processes that include laser metal deposition (LMD) and selective laser melting (SLM), a laser beam is used to fuse metallic powder at points defined by computer-generated design data. In many metal-based 3D printers, multiple laser sources are used to fuse the metallic powder more quickly and at multiple angles. 3D printing permits highly complex structures, with a high degree of customization capability and significantly less waste than subtractive manufacturing processes. The trends toward automation and miniaturization, as well as the stability and reliability of our fiber lasers have played important roles in the development of additive manufacturing technology.

Marking and Engraving. With the increasing need for source traceability, component identification and product tracking as a means of reducing product liability and preventing falsification, as well as the demand for modern robotic production systems, manufacturers increasingly demand marking systems capable of applying serialized alphanumeric, graphic or bar code identifications directly onto their manufactured components. Laser engraving is similar to marking but forms deeper grooves in the material. In contrast to conventional acid etching and ink-based technologies, lasers can mark a wide variety of metal and non-metal materials, such as ceramic, glass and plastic surfaces, at high speeds and without contact by changing the surface structure of the material or by engraving. Laser marking systems can be easily integrated into a customer's production process and do not subject the item being marked to mechanical stress. Our ytterbium pulsed fiber lasers are used for these applications. In addition, we make

high powered lasers for ablation and cleaning applications.

In the semiconductor industry, lasers typically are used to mark wafers and integrated circuits. In the electronics industry, lasers typically are used to mark electrical components such as contactors, relays and printed circuit boards. Consumer electronic devices such as mobile phones, computers and handheld computers contain many parts that are laser-marked, including keyboards, logos and labels. With the increase in marking speed in the past few years, the cost of laser marking has decreased. In the photovoltaic or solar panel industry, pulsed lasers increasingly are used to remove materials and to scribe, or

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cut, solar cells. The high beam quality, increased peak output powers, flexible fiber delivery and competitive price of fiber lasers have accelerated the adoption of fiber lasers in these low power applications.

Micro-Processing and Fine Processing. The trend toward miniaturization in numerous industries such as consumer electronics, as well as innovations in materials and structures, is driving end users to utilize lasers in processing and fabrication. The ability of lasers to cut, weld, drill, ablate, etch and add materials on a fine scale is enabling new technologies and products across many industries. Our low power CW and QCW lasers are used to cut medical stents and weld medical batteries. In photovoltaic manufacturing, our lasers etch and perform edge isolation processes. The aerospace industry requires precise manufacturing of engine parts so that cooling is effective and aerospace manufacturers use lasers to conduct percussion drilling. Processing of plastics and semi-conductors require short pulse and high energy lasers, in the green, UV and mid-IR wavelengths.

Advanced Applications

Our fiber lasers and amplifiers are utilized by commercial firms and by academic and government institutions worldwide for manufacturing of commercial systems and for research in advanced technologies and products. These markets may use specialty products developed by us or commercial versions of our products.

Special Projects. Due to the high power, compactness, performance, ruggedness and electrical efficiency of our fiber lasers and amplifiers, we sell our commercial products for government research and projects. These include materials testing, ordnance destruction, coherent beam combining, directed energy demonstrations, advanced communications and research.

Research and Development. Our products are used in a variety of applications for research and development by scientists and industrial researchers, including atom trapping. In addition, our lasers and amplifiers are used to design, test and characterize components and systems in a variety of markets and applications.

Optical Pumping and Harmonic Generation. Several types of our lasers are used to optically pump other solid-state lasers and for harmonic generation and parametric converters to support research in sensing, medical and other scientific research in the IR and visible wavelength domains. Our lasers are used as a power source for these other lasers. Green visible lasers are used to pump titanium sapphire lasers. Visible lasers can be used in cinema projection, amusement parks, planetariums and light shows.

Remote Sensing. Our products are used in light detection and ranging ("LIDAR"), a laser technique for remote sensing. Optical fiber can be used as a sensor for measuring changes in temperature, pressure and gas concentration in oil wells, atmospheric and pollution measurements and seismic exploration.

Obstacle Warning and Mapping. Our products are used for obstacle warning and 3-dimensional mapping of earth surfaces.

Communications

We design and manufacture enhanced optical transmission modules and systems and DWDM transport systems for transmission of multiple wavelength channels over a single optical fiber.

We develop and make optical pluggable system-in-module transponders, based upon proprietary mixed signal ASIC proprietary designs, intended to simplify optical networks and reduce customer capital costs. These software-defined and configurable DWDM transponder modules are designed to operate at 100G direct detection and coherent transmission rates. Higher speed modules are under development. These products are deployed in data center operations and optical network systems.

IPG's fiber amplifiers are deployed in some of the world's largest broadband FTTH networks. In addition, we design and manufacture transceivers for interconnecting electronic equipment within telecommunications, cable MSO, and data center networks.

DWDM. DWDM is a technology that expands the capacity of optical networks, allowing service providers to extend the life of existing fiber networks and reduce operating and capital costs by maximizing bandwidth capacity. We provide a DWDM transport system that offers service providers and private network operators a simple, flexible, optical layer solution scalable to 80 channels that aggregates and multiplexes multiprotocol clients into optical transport network signals operating from 10 to 600 gigabits per second per channel. We also provide both fixed wavelength DWDM transceivers and tunable DWDM transceivers that are capable of dynamically tuning across a range of wavelengths. We provide a broad range of high power products for DWDM applications including EDFAs and Raman lasers.

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Broadband Access. The delivery to subscribers of television programming and Internet-based information and communication services is converging, driven by advances in Internet Protocol ("IP") technology and by changes in the regulatory and competitive environment. Fiber optic lines now offer connection speeds of up to 10 gigabits per second to the subscriber, or 1,000 times faster than digital subscriber lines ("DSL"), or cable links. We offer a series of specialty multi-port EDFAs and cable television ("TV") nodes and transmitters that support different types of passive optical network architectures, enabling high-speed data, voice, video on demand and high-definition TV. We provide an EDFA that supports up to 64 output ports, which allows service providers to support a high number of customers in a small space, reducing overall power consumption and network cost. End users for our products include communications network operators for video wavelength division multiplexing overlay solutions, operators of metro and long-haul networks for DWDM and amplification solutions, as well as cable and multiple system operators for optical amplification solutions.

Medical

We sell our commercial fiber and diode lasers to OEMs that incorporate our products into their medical laser systems. Our ultrafast, CW and QCW ytterbium, erbium and thulium fiber lasers from 1 to 200 watts and diode laser systems can be used in various medical and biomedical applications. Aesthetic applications addressed by lasers include skin rejuvenation, hair removal, and treatment of pigmented and vascular lesions. Purchasers use our diode lasers in dental and skin rejuvenation procedures. Through our medical business, we are developing laser systems for dental (soft tissue and bone surgery) and surgical (benign prostatic hyperplasia and lithotripsy) aesthetic, and veterinary uses. Other medical procedures are also being investigated.

Technology

Our products are based on our proprietary technology platform that we have developed and refined since our formation. The following technologies are key elements in our products.

Specialty Optical Fibers

We have extensive expertise in the disciplines and techniques that form the basis for the multi-clad active and passive optical fibers used in our products. Active optical fibers form the laser cavity or gain medium in which lasing or amplification of light occurs in our products. Passive optical fibers deliver the optical energy created in our products. Our active fibers consist of an inner core that is infused with the appropriate rare earth ion, such as ytterbium, erbium or thulium, and outer cores of un-doped glass having different indices of refraction. We believe that our large portfolio of specialty active and passive optical fibers has a number of advantages as compared to other commercially available optical fibers. These advantages include higher concentrations of rare earth ions, fibers that will not degrade at the high power levels over the useful life of the product, high lasing efficiency, ability to achieve single-mode outputs at high powers, ability to withstand high optical energies and temperatures and scalable side-pumping capability.

Semiconductor Diode Laser Processing and Packaging Technologies

Another key element of our technology platform is that we use multiple multi-mode, or broad area, single-emitter diodes rather than diode bars or stacks as a pump source. We believe that multi-mode single-emitter diodes are the most efficient and reliable pumping source presently available, surpassing diode bars and stacks in efficiency, brightness and reliability. Single-emitter diodes have substantially reduced cooling requirements and typically have long lifetimes at high operating currents, compared to typical lifetimes of diode bars.

We developed advanced molecular beam epitaxy techniques to grow alumina indium gallium arsenide wafers for our diodes. This method yields high-quality optoelectronic material for low-defect density and high uniformity of optoelectronic parameters. In addition, we have developed numerous proprietary wafer processes and testing and qualification procedures in order to create a high energy output in a reliable and high power diode. We package our diodes in hermetically sealed pump modules in which the diodes are combined with an optical fiber output. Characteristics such as the ability of the package to dissipate heat produced by the diode and withstand vibration, shock, high temperature, humidity and other environmental conditions are critical to the reliability and efficiency of the products.

Specialty Components and Combining Techniques

We developed a wide range of advanced optical components that are capable of handling high optical power levels and contribute to the superior performance, efficiency and reliability of our products. In addition to fibers and diodes,

our optical component portfolio includes fiber gratings, couplers, isolators, combiners, and crystals. We also developed special methods and expertise in splicing fibers together with low optical energy loss and on-line loss testing. We believe that our internal development and manufacturing of key optical components allows us to lower our manufacturing costs and improve product performance.

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Side Pumping of Fibers and Fiber Block Technologies

Our technology platform allows us to efficiently combine a large number of multi-mode single-emitter semiconductor diodes with our active optical fibers that are used in all of our products. A key element of this technology is that we pump our fiber lasers through the cladding surrounding the active core. We splice our specialty active optical fibers with other optical components and package them in a sealed box, which we call a fiber block. The fiber blocks are compact and eliminate the risk of contamination or misalignment due to mechanical vibrations and shocks as well as temperature or humidity variations. Our design is scalable and modular, permitting us to make products with high output power by coupling a large number of diodes with fiber blocks, which can be combined in parallel and serially.

High-Stress Testing

We employ high-stress techniques in testing components and final products that help increase reliability and accelerate product development. For example, we test all of our diodes with high current and temperatures to accelerate aging. We also have built a large database of diode test results that allows us to predict the estimated lifetime of our diodes. This testing allows us to eliminate defective diodes prior to further assembly and thus increase reliability.

Customers

We sell our products globally to OEMs, system integrators and end users in a wide range of diverse markets who have the in-house engineering capability to integrate our products into their own systems. We also sell complete laser and non-laser solutions to end users for their production needs. We have thousands of customers worldwide. Our primary end market is materials processing, comprised of general manufacturing, automotive, heavy industry, aerospace, consumer products, medical device manufacturing, natural resources, photovoltaic, semiconductor and electronics. We estimate that in 2018, approximately 57%, 16% and 9% of our net sales were generated from sales for cutting, welding and brazing, and marking and engraving applications, respectively. In 2017, approximately 54%, 20% and 9% and in 2016, approximately 51%, 18% and 11% of our net sales were generated from sales for cutting, welding and brazing, and marking and engraving applications, respectively. These estimates are based upon customer information and when customer information has not been provided, upon our best information and belief. Within each of these applications, the lasers may vary substantially in terms of output powers depending upon the types of materials processed (e.g., thick steel cutting, aluminum cutting and fine metal cutting) and the industry served within the diverse materials processing end market, some of which are listed above. We also sell our products to other end markets, including advanced applications (comprised of commercial companies, universities, research entities and government entities), communications (comprised of system integrators, utilities and municipalities) and medical (comprised of medical laser systems manufacturers and researchers). We believe that our customer, geographic and end market diversification minimizes dependence on any single industry or group of customers.

The following table shows the allocation of our net sales (in thousands) among our principal markets:

	Year Ended December 31,					
	2018		2017		2016	
		% of Total		% of Total		% of Total
Materials processing	$ 1,374,448	94.1%	$ 1,332,607	94.6%	$ 942,119	93.6%
Other applications	85,426	5.9	76,282	5.4	64,054	6.4
Total	$ 1,459,874	100.0%	$ 1,408,889	100.0%	$ 1,006,173	100.0%

One of our customers, Han's Laser, headquartered in China, accounted for 12%, 13% and 9% of our net sales in 2018, 2017 and 2016, respectively. No other customer accounted for 10% or more of our net sales in 2018, 2017 or 2016.

Backlog

At December 31, 2018, our backlog of orders (generally scheduled for shipment within one year) was approximately $712.3 million compared to $743.6 million at December 31, 2017. At December 31, 2018, our backlog included $338.7 million of orders with firm shipment dates and $373.6 million of frame agreements that we expect to ship within one year, compared to $326.1 million of orders with firm shipment dates and $417.4 million of frame agreements at December 31, 2017. Frame agreements are non-binding indications of customer pricing and volume

levels but are not firm customer purchase obligations. Orders used to compute backlog are generally cancellable without substantial penalties. Historically, we have not experienced a significant cancellation rate in ordinary economic conditions. We manage the risk of cancellation by establishing the right to charge a cancellation fee that generally covers a portion of the purchase price, any materials and development costs incurred prior to the order being canceled. Our ability to enforce this right depends on many factors including, but not limited to, the customer's requested length of delay, the number of other outstanding orders with the customer and our ability to quickly convert the canceled order to another sale.

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We anticipate shipping a substantial majority of the present backlog during fiscal year 2019. However, our backlog at any given date is not necessarily indicative of actual sales for any future period.

Sales, Marketing and Support

We market our products internationally primarily through our direct sales force. Our direct sales force sells to end users, OEMs and systems integrators. Once our fiber laser products are designed into an OEMs' system, the OEM's sales force markets its systems, allowing us to take advantage of numerous OEMs' sales forces, each typically having several sales persons in locations other than where our sales offices are located. We have sales offices in the countries in which we have major manufacturing: United States, Germany and Russia.

We also have sales and service offices in the following countries: Brazil, Canada, China, Czech Republic, France, India, Italy, Japan, Mexico, Poland, Singapore, South Korea, Spain, Taiwan, Turkey and the United Kingdom. We have materials processing application centers in the United States, Germany, Russia, China, Italy, Japan and South Korea, which we use to demonstrate our products and develop new applications. Our application centers are fundamental to developing new laser applications for customers and assisting them in integrating lasers into their production processes.

To a lesser extent, we market through agreements with independent sales representatives and distributors. Sales to foreign customers may be priced in non-U.S. currencies and are therefore subject to currency exchange fluctuations.

We maintain a customer support and field service staff in our major markets. We work closely with customers and independent representatives to service equipment and to train customers to use our products. We have expanded our support and field service, particularly in locations where customer concentration or volume requires local service capabilities. We repair products at our facilities or at customer sites.

We typically provide one to three-year parts and service warranties on our lasers and amplifiers. Most of our sales offices provide support to customers in their respective geographic areas. Warranty reserves have generally been sufficient to cover product warranty repair and replacement costs.

Manufacturing

Vertical integration is one of our core business strategies through which we control our proprietary processes and technologies as well as the supply of key components and assemblies. We believe that our vertically integrated business model gives us the following advantages:

•maintaining a technological lead over competitors;
•reducing component and final product costs compared to market prices available to competitors;
•ensuring access to critical components, enabling us to better meet customer demands;
•controlling performance, quality and consistency;
•enabling rapid development and deployment of new products and technologies;
•short lead times for customer deliveries; and
•limiting the spread our trade secrets.

Our vertically integrated manufacturing operations include optical preform making, specialty fiber drawing, semiconductor wafer growth, diode processing and packaging, specialty optical component manufacturing, fiber block and fiber module assembly for different power units, circuit board, software and electronics development and production, crystal growth, cleaning and polishing, machining of metal parts and casings and final assembly of finished product. In addition we make some of the testing, tool manufacturing and automated production systems that we use in our own manufacturing processes. Over the last several years, we added additional production capabilities, including multi-wafer growth reactors, diode test stations, fiber pre-form and fiber drawing equipment and low, mid and high power laser production and testing, in order to increase our capacity as well as reduce the risks associated with our production process.

We operate our own semiconductor foundry for the production of the multi-mode single-emitter diodes. Diodes are the pumps that are used as the light source in each device we make. We also process, package and extensively test all of our diodes. Because pump diodes represent a significant component cost of the final laser or amplifier, we have developed internal manufacturing capabilities for diodes. As a result of our high-volume production levels of pump diodes, proprietary processes and use of a small number of chip designs, we have been able to increase yields, lower component costs and assure high quality. We also design, manufacture and optimize many of our own test instruments, diode test racks, robotic and automated assembly tools and machines.

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We developed proprietary components and accessories, manufacturing tools, equipment and techniques over many years in an effort to address the major issues that had been inhibiting the development of fiber laser technology and to provide products that differentiate us from our competitors. In addition, we have acquired additional components including volume Bragg gratings. We believe that the proprietary components, manufacturing tools, equipment, techniques and software utilized in all of our product lines provide extensive barriers to potential competitors. Generally, we do not sell our proprietary components to third parties in significant quantities. Using our technology platform, we configure standard laser and amplifier products based upon each customer's specifications. Through our vertically integrated manufacturing operations, we believe that we can develop, test and produce new products and configurations with higher performance and reliability and in less time than by working with external vendors. We have developed proprietary testing methodologies that allow us to develop higher power components and products in short periods of time, enable us to introduce products to the market more quickly, capitalize on new opportunities and provide superior service to our customers.

In our materials process systems business, we manufacture standard configuration systems which we also customize for specific customer requirements.

Our in-house manufacturing generally includes those operations and components that are critical to the protection of our intellectual property, the reduction of our costs or the achievement of performance and quality standards. We purchase from vendors common and specialized mechanical, electrical and optical parts and raw materials.

Research and Development

We have extensive research and development experience in laser materials, fiber, optoelectronic and optomechanical components. We have assembled a team of scientists and engineers with specialized experience and extensive knowledge in fiber lasers and amplifiers, materials science, optics, critical components, testing and manufacturing process design, and laser application development.

We focus our research and development efforts on designing and introducing new and improved standard and customized products and complementary products, and the mass production of components for our products. In addition to our cladding-pumped specialty fiber platform, we have core competencies in high power multi-mode and single-mode semiconductor laser diodes, diode packaging, specialty active and passive optical fibers, high-performance optical components, crystal growth and processing, fiber gain blocks and fiber modules, thin film optical coatings, as well as splicing and combining techniques and high-stress test methods. Our research and development efforts are aided by our vertical integration and our proprietary high-stress testing techniques that result in accelerated development cycles. The strategy of developing our proprietary components has allowed us to leverage our optical experience and large volume requirements to lower the cost of our products.

Our research and development efforts are also directed at expanding our product line by increasing power levels, improving beam quality and electrical efficiency, decreasing the size of our products and lowering the cost per watt. We also are engaged in research projects to expand the spectral range of products that we offer, including the development of UV pulsed fiber lasers, ultrafast pulsed fiber lasers, and a mid-IR line of lasers from 2 to 5 microns, with a hybrid fiber and crystal laser design. We are also investing our research and development funds on laser systems, products for medical applications, and telecommunications products and components. Our team of experienced scientists and engineers work closely with many of our customers to develop and introduce custom products and laser processing that address specific applications and performance requirements.

We incurred research and development costs of approximately $122.8 million, $100.9 million and $78.6 million for the years ended December 31, 2018, 2017 and 2016, respectively. We expect to continue our commitment to research and development and to introduce new products, systems and complementary products that would allow us to maintain our competitive position. See Item 7, "Management's Discussion and Analysis of Financial Condition of Results of Operations."

Intellectual Property

We seek to protect our proprietary technology primarily through the U.S. and foreign laws affording protection for trade secrets, and to seek U.S. and foreign patent, copyright and trademark protection of our products and processes where appropriate. Historically, we relied primarily on trade secrets, technical know-how and other unpatented proprietary information relating to our product development and manufacturing activities. We seek to protect our trade secrets and proprietary information, in part, by requiring our employees to enter into agreements providing for the

maintenance of confidentiality and the assignment to us of rights to inventions that they make while we employ them. We also enter into non-disclosure agreements with our consultants and suppliers to protect confidential information delivered to them. We believe that our vertical integration, including our extensive experience in making a wide range of specialty and high power capacity components, as well as our technology platform make it difficult for others to reverse engineer our products.

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We have increased our efforts to expand our patent portfolio globally. As of December 31, 2018, we have over 350 patents issued and over 430 pending patent applications worldwide relating principally to optical fiber lasers, amplifiers, bulk optics, semiconductors, laser and telecommunications systems and applications of fiber lasers. With respect to the United States, we were issued 14 patents and we filed 27 applications containing new subject matter in 2018. Intellectual property rights, including those that we own, those that we license and those of others, involve significant risks. See Item 1A, "Risk Factors-Our Inability to Protect Our Intellectual Property and Proprietary Technologies Could Result in the Unauthorized Use of Our Technologies by Third Parties, Hurt Our Competitive Position and Adversely Affect Our Operating Results."

Competition

Our markets are highly competitive and characterized by rapidly changing technology, continuously evolving customer requirements, and reduced average selling prices over time. We believe that the primary competitive factors in our markets are:

•product performance and reliability;
•quality and service support;
•price and value to the customer;
•ability to manufacture and deliver products on a timely basis;
•ability to achieve qualification for and integration into OEM systems;
•ability to meet customer specifications; and
•ability to respond quickly to market demand and technological developments.

We believe we compete favorably with respect to these criteria. In the materials processing market, the competition is fragmented and includes a large number of competitors. We compete with makers of fiber lasers, solid-state lasers, direct diode lasers, high power CO_2, YAG and disc lasers. These include public and private companies such as Coherent, Inc., Laserline GmbH, Lumentum Holdings Inc., Maxphotonics Co., Ltd., nLight, Inc., Raycus Fiber Laser Technologies Co. Ltd., and Trumpf GmbH + Co. KG, as well as other smaller competitors. Our current or potential customers may determine to develop and produce products for their own use which are competitive to our products. Such vertical integration could reduce the market opportunity for our products. Many of our fiber laser competitors are increasing the output powers of their fiber lasers to compete with our products.

We also compete in the materials processing, advanced and medical applications markets with end users that produce their own solid-state and gas lasers as well as with manufacturers of non-laser methods and tools, such as traditional non-laser welding and cutting dies in the materials processing market and scalpels in the medical market.

Some of our competitors are larger than we are and have substantially greater financial, managerial and technical resources, more extensive distribution and service networks, greater sales and marketing capacity, and larger installed customer bases than we do.

Employees

As of December 31, 2018, we had approximately 6,220 full-time employees, including 670 in research and development, 4,820 in manufacturing operations, 300 in sales, service and marketing, and 430 in general and administrative functions. Of our total full-time employees at our principal facilities, approximately 2,340 were in the United States, 1,300 were in Germany, 1,740 were in Russia and 220 were in China. We have never experienced a work stoppage, and none of our employees are subject to a collective bargaining agreement. We believe that our current relations with our employees are good. We also have approximately 245 independent contractors worldwide who are principally used in manufacturing operations.

Seasonality

Our net sales have historically fluctuated from quarter to quarter. The increase or decrease in sales from a prior quarter can be affected by the timing of orders received from customers, the shipment, installation and acceptance of products at our customers' facilities, the mix of OEM orders and one-time orders for products with large purchase prices, competitive pressures, acquisitions, economic and political conditions in a certain country or region and seasonal factors such as the purchasing patterns and levels of activity throughout the year in the regions where we operate. Historically, our net sales have been higher in the second half of the year than in the first half of the year, although that trend did not occur in 2018 due to a decrease in capital equipment spending in Europe and China caused by slower macro-economic growth and uncertainty caused by the trade war between the United States and China. Net

sales can be affected by the time taken to qualify our products for use in new applications in the end markets that we serve. The adoption of our products by a new customer or qualification in a new

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application can lead to an increase in net sales for a period, which may then slow until we penetrate new markets or obtain new customers.

Government Regulation

Regulatory Compliance

The majority of our laser and amplifier products sold in the United States are classified as Class IV Laser Products under the applicable rules and regulations of the Center for Devices and Radiological Health ("CDRH") of the U.S. Food and Drug Administration ("FDA"). The same classification system is applied in the European markets. Safety rules are formulated with "Deutsche Industrie Norm" (i.e., German Industrial Standards) or International Organization for Standardization ("ISO") standards, which are internationally harmonized.

CDRH regulations generally require a self-certification procedure pursuant to which a manufacturer must submit a filing to the CDRH with respect to each product incorporating a laser device, make periodic reports of sales and purchases and comply with product labeling standards, product safety and design features and informational requirements. The CDRH is empowered to seek fines and other remedies for violations of their requirements. We believe that our products are in material compliance with applicable laws and regulations relating to the manufacture of laser devices.

Environmental Regulation

Our operations are subject to various federal, state, local and international laws governing the environment, including those relating to the storage, use, discharge, disposal, product composition and labeling of, human exposure to and hazardous and toxic materials. We believe that our operations are in material compliance with applicable environmental protection laws and regulations. Although we believe that our safety procedures for using, handling, storing and disposing of such materials comply with the standards required by federal and state laws and regulations, we cannot completely eliminate the risk of accidental contamination or injury from these materials. In the event of such an accident involving such materials, we could be liable for damages and such liability could exceed the amount of our liability insurance coverage and the resources of our business.

We face increasing complexity in our product design and procurement operations due to the evolving nature of environmental compliance regulations and standards, as well as specific customer compliance requirements. These regulations and standards have an impact on the material composition of our products entering specific markets. Such legislation has gone into effect at various times across worldwide markets. For example, in the European Union ("EU"), the Restriction of the use of Certain Hazardous Substances in Electrical and Electronic Equipment (RoHS) went into effect in 2006, and was subsequently revised in 2011 (as RoHS 2) and again in 2015 (as RoHS 2 amended) and will be in effect in 2019. The Registration, Evaluation, Authorization and Restriction of Chemicals (REACH) went into effect in 2007, and is updated with additional substances every 6 months. China enacted the Management Methods for Controlling Pollution Caused by Electronic Information Products Regulation (China-RoHS) in 2007, which was revised and renamed in 2016 as the Administrative Measures for the Restriction of the Use of Hazardous Substances in Electrical and Electronic Products (known as China RoHS 2). Another example is the US Dodd-Frank Wall Street Reform and Consumer Protection Act of 2010 (Conflict Minerals Act) which requires manufacturers to provide disclosures about the use of specified conflict minerals emanating from the DRC and nine adjoining countries (Covered Countries). In addition to these regulations and directives, we may face costs and liabilities in connection with product take-back legislation. For example, beginning in 2006 (with several subsequent revisions), the EU Waste Electrical and Electronic Equipment Directive 2012/19/EU made producers of electrical goods financially responsible for specified collection, recycling, recovery, treatment and disposal of past and future covered products. Similar laws are now pending in various jurisdictions around the world, including the United States.

Availability of Reports

Our annual reports on Form 10-K, quarterly reports on Form 10-Q, current reports on Form 8-K and any amendments to such reports are available free of charge on our web site at www.ipgphotonics.com as soon as reasonably practicable after such reports are electronically filed with, or furnished to, the Securities and Exchange Commission ("SEC"). The SEC maintains an internet site that contains reports, proxy and information statements and other information regarding issuers that file electronically with the SEC at www.sec.gov. We will also provide electronic or paper copies of such reports free of charge, upon request made to our Corporate Secretary. The information included on our website is not a part of, nor is it incorporated by reference into, this annual report on Form 10-K.

ITEM 1A. ***RISK FACTORS***

The factors described below are the principal risks that could materially adversely affect our operating results and financial condition. Other factors may exist that we do not consider significant based on information that is currently available.

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In addition, new risks may emerge at any time, and we cannot predict those risks or estimate the extent to which they may affect us.

Downturns in the markets we serve, particularly materials processing, could have a material adverse effect on our sales and profitability.

Our business depends substantially upon capital expenditures by our customers, particularly by manufacturers in the materials processing market, which includes general manufacturing, automotive, aerospace, other transportation, heavy industry, electronics and photovoltaic industries. Approximately 94% of our revenues in 2018 were from customers in the materials processing market. Although applications in this market are broad, sales for these applications are cyclical and have historically experienced sudden and severe downturns and periods of oversupply, resulting in significantly reduced demand for capital equipment, including the products that we manufacture and market. For example, our sales decreased by 25% in the materials processing market in 2009 as a result of the global economic recession. For the foreseeable future, our operations will continue to depend upon capital expenditures by customers in these industries or markets, which, in turn, depend upon the demand for their products or services. Decreased demand for products and services from customers for these applications during an economic downturn may lead to decreased demand for our products, which would reduce our sales and margins. We may not be able to respond by decreasing our expenses quickly enough or sufficiently, due in part, to our fixed overhead structure related to our vertically integrated operations and our commitments to continuing investment in research and development and infrastructure for long term growth.

Uncertainty and adverse changes in the general economic conditions of markets in which we participate negatively affect our business.

Current and future conditions in the economy have an inherent degree of uncertainty. As a result, it is difficult to estimate the level of growth or contraction for the economy as a whole. It is even more difficult to estimate growth or contraction in various parts, sectors and regions of the economy, including the materials processing, telecommunications, advanced and medical markets and applications in which we participate. Because all components of our budgeting and forecasting are dependent upon estimates of growth or contraction in the markets and applications we serve and demand for our products, the prevailing economic uncertainties render estimates of future income and expenditures very difficult to make. A significant portion of our sales are to customers in China, which accounted for 43%, 44% and 36% in 2018, 2017 and 2016, respectively. A slowing of economic growth or recession, other adverse economic developments or uncertainty in any of our key markets, including in China, would slow our growth rates or may result in a decrease in our sales. Adverse changes have occurred and may occur in the future as a result of declining or flat global or regional economic conditions, fluctuations in currency and commodity prices, wavering confidence, capital expenditure reductions, unemployment, declines in stock markets, contraction of credit availability, declines in real estate values, or other factors affecting economic conditions generally. These changes may negatively affect the sales of our lasers and amplifiers, increase exposure to losses from bad debts, increase the cost and decrease the availability of financing, increase the risk of loss on investments, or increase costs associated with manufacturing and distributing products. An economic downturn could have a material adverse effect on our business, financial condition and results of operations.

The markets for our products are highly competitive and increased competition could result in reduced sales, reduced gross margins or the loss of market share.

The industries in which we operate are characterized by significant price and technological competition. We compete with makers of fiber lasers, solid-state lasers, direct diode lasers, high power CO_2, YAG and disc lasers. These include public and private companies such as Coherent, Inc., Laserline GmbH, Lumentum Holdings Inc., Maxphotonics Co., Ltd., nLight, Inc., Raycus Fiber Laser Technologies Co. Ltd., and Trumpf GmbH + Co. KG, as well as other smaller competitors. Several of these are larger and have substantially greater financial, managerial and technical resources, more extensive distribution and service networks, greater sales and marketing capacity, and larger installed customer bases than we do. Also, we compete with widely used non-laser production methods, such as water-jet cutting and resistance welding. Our current or potential customers may determine to develop and produce products for their own use which are competitive to our products. Such vertical integration could reduce the market opportunity for our products. Many of our fiber laser competitors are increasing the output powers of their fiber lasers to compete with our products. We also compete in the materials processing, advanced and medical applications markets with end users

that produce their own solid-state and gas lasers as well as with manufacturers of non-laser methods and tools, such as traditional non-laser welding and cutting dies in the materials processing market and scalpels in the medical market. We may not be able to successfully differentiate our current and proposed products from our competitors' products and current or prospective customers may not consider our products to be superior to competitors' products. To maintain our competitive position, we believe that we will be required to continue a high level of investment in research and development,

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application development, manufacturing facilities and customer service and support, and to react to market pricing conditions. As a result of the foregoing factors, we expect that competitive pressures may result in price reductions, reduced margins, loss of sales and loss of market share.

The laser and amplifier industries are experiencing declining average selling prices, which could cause our gross margins to decline and harm our operating results.

Our products are experiencing and may in the future continue to experience a significant decline in average selling prices ("ASPs") as a result of new product and technology introductions, increased competition and price pressures from significant customers. If the ASPs of our products decline further and we are unable to increase our unit volumes, introduce new or enhanced products with higher margins or reduce manufacturing costs to offset anticipated decreases in the prices of our existing products, our operating results may be adversely affected. In addition, because of our significant fixed costs, we are limited in our ability to reduce total costs quickly in response to any revenue shortfalls. Because of these factors, we have experienced and we may experience in the future material adverse fluctuations in our operating results on a quarterly or annual basis if the ASPs of our products continue to decline.

Our sales growth depends upon our ability to penetrate new applications and end markets for fiber lasers and increase our market share in existing applications.

Our level of sales will depend on our ability to generate sales of fiber lasers in applications where conventional lasers, such as CO_2 and YAG lasers, have been used or in new and developing markets and applications for lasers where they have not been used previously. To date, a significant portion of our revenue growth has been derived from sales of fiber lasers primarily for applications where CO_2 and YAG lasers historically have been used. We have made significant sales into the cutting, welding and marking and engraving applications, three large applications where other laser technologies are used. As fiber lasers reach higher levels of penetration in core materials processing applications, the development of new applications, end markets and products outside our core applications becomes more important to our growth. In order to maintain or increase market demand for our fiber laser products, we will need to devote substantial resources to:

- demonstrate the effectiveness of fiber lasers in new applications for materials processing, medical, communications or other applications such as cinema and projection;
- successfully develop new product lines, such as UV, visible and ultrafast fiber lasers, that extend our product line to address different applications than our current products;
- increase our direct and indirect sales efforts;
- effectively service and support our installed product base on a global basis;
- effectively meet growing competition and pricing pressures; and
- continue to reduce our manufacturing costs and enhance our competitive position.

Potential customers may have substantial investments and know-how related to their existing laser and non-laser technologies. They may perceive risks relating to the reliability, quality, usefulness and profitability of integrating of fiber lasers in their systems when compared to other laser or non-laser technologies available in the market or that they manufacture themselves. Despite fiber lasers having better performance and prices compared to other lasers or tools, OEM customers may be reluctant to switch incumbent suppliers or we may miss the design cycles of our customers. Many of our target markets, such as the automotive, machine tool and other manufacturing, communications and medical industries, have historically adopted new technologies slowly. These markets often require long test and qualification periods or lengthy government approval processes before adopting new technologies.

If we are unable to implement our strategy to develop new applications and end markets for our products or develop new products, our revenues, operating results and financial condition could be adversely affected. We cannot assure you that we will be able to successfully implement our business strategy in part or whole. In addition, any newly developed or enhanced products may not achieve market acceptance or may be rendered obsolete or less competitive by the introduction of new products by other companies.

Our vertically integrated business results in high levels of fixed costs and inventory levels that may adversely impact our gross profits and our operating results in the event that demand for our products declines or we maintain excess inventory levels.

We have a high fixed cost base due to our vertically integrated business model, including the fact that approximately 77% of our approximately 6,220 employees as of December 31, 2018 were employed in our manufacturing operations. We may not

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adjust these fixed costs quickly enough or sufficiently to adapt to rapidly changing market conditions. Our gross profit, in absolute dollars and as a percentage of net sales, is impacted by our sales volume, the corresponding absorption of fixed manufacturing overhead expenses and manufacturing yields. In addition, because we are a vertically integrated manufacturer and design and manufacture our key specialty components, insufficient demand for our products may subject us to the risks of high inventory carrying costs and increased inventory obsolescence. If our capacity and production levels are not properly sized in relation to expected demand, we may need to record write-downs for excess or obsolete inventory. Because we are vertically integrated, the rate at which we turn inventory has historically been low when compared to our cost of sales. We do not expect this to change significantly in the future and believe that we will have to maintain a relatively high level of inventory compared to our cost of sales. As a result, we expect to have a significant amount of working capital invested in inventory. Changes in our level of inventory lead to an increase in cash generated from our operations when inventory is sold or a decrease in cash generated from our operations at times when the amount of inventory increases.

Our manufacturing capacity and operations may not be appropriate for future levels of demand and may adversely affect our gross margins.

We have added and are continuing to add substantial manufacturing capacity at our facilities in the United States, Germany and Russia. A significant portion of our manufacturing facilities and production equipment, such as our semiconductor production and processing equipment, diode packaging equipment and diode burn-in stations, are special-purpose in nature and cannot be adapted easily to make other products. If the demand for fiber lasers or amplifiers does not increase or if our revenue decreases from current levels, we may have significant excess manufacturing capacity and under-absorption of our fixed costs, which could in turn adversely affect our gross margins and profitability.

To maintain our competitive position as the leading developer and manufacturer of fiber lasers and to meet anticipated demand for our products, we invest significantly in the expansion of our manufacturing and operations throughout the world and may do so in the future. We incurred in the past and will incur in the future significant costs associated with the acquisition, build-out and preparation of our facilities. We had capital expenditures of $160.3 million and $126.5 million in 2018 and 2017, respectively, and we expect to incur approximately $170 million to $180 million in capital expenditures, excluding acquisitions, in 2019. In connection with these projects, we may incur cost overruns, construction delays, labor difficulties or regulatory issues which could cause our capital expenditures to be higher than what we currently anticipate, possibly by a material amount, which would in turn adversely impact our operating results. Moreover, we may experience higher costs due to yield loss, production inefficiencies and equipment problems until any operational issues associated with the opening of new manufacturing facilities are resolved.

A few customers account for a significant portion of our sales, and if we lose any of these customers or they significantly curtail their purchases of our products, our results of operations could be adversely affected.

We rely on a few customers for a significant portion of our sales. In the aggregate, our top five customers accounted for 26%, 28% and 22% of our consolidated net sales in 2018, 2017 and 2016, respectively. Our largest customer is located in China and accounted for 12%, 13% and 9% of sales in 2018, 2017 and 2016, respectively. A few of our larger customers are making fiber lasers or announced plans to develop fiber lasers. We generally do not enter into agreements with our customers obligating them to purchase our fiber lasers or amplifiers. Our business is characterized by short-term purchase orders and shipment schedules. If any of our principal customers discontinues its relationship with us, replaces us as a vendor for certain products or suffers downturns in its business, our business and results of operations could be adversely affected.

Foreign currency risk may negatively affect our net sales, cost of sales and operating margins and could result in exchange losses.

We conduct our business and incur costs in the local currency of most countries in which we operate. In 2018, our net sales outside the United States represented a substantial majority of our total sales. We incur currency transaction risk whenever one of our operating subsidiaries enters into either a purchase or a sales transaction using a different currency from the currency in which it operates or holds assets or liabilities in currencies different than their functional currency. Changes in exchange rates can also affect our results of operations when the value of sales and expenses of foreign subsidiaries are translated to U.S. dollars. We cannot accurately predict the impact of future exchange rate fluctuations on our results of operations. Further, given the volatility of exchange rates, we may not be

able to effectively manage our currency risks, and any volatility in currency exchange rates may increase the price of our products in local currency to our foreign customers or increase the manufacturing cost of our products, which may have an adverse effect on our financial condition, cash flows and profitability.

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Our inability to manage risks associated with our international customers and operations could adversely affect our business.

We have significant facilities in and our products are sold in numerous countries. Our principal markets include China, the United States, Germany, Turkey, Switzerland, Italy, Japan, Korea and Russia. A substantial majority of our revenues are derived from customers outside the United States. In addition we have substantial tangible assets outside of the United States. We anticipate that foreign sales will continue to account for a significant portion of our revenues in the foreseeable future. Our operations and sales in these markets are subject to risks inherent in international business activities, including:

•fluctuations in the values of foreign currencies;
•general economic uncertainties in the macroeconomic and local economic communities in which we our customers operate or serve;
•impact of government economic policies on macroeconomic conditions, including recently instituted changes in trade policies by the U.S. and any corresponding retaliatory actions by affected countries, including China;
•longer accounts receivable collection periods and less developed credit assessment and collection procedures;
•changes in a specific country's or region's economic conditions, such as recession;
•compliance with a wide variety of domestic and foreign laws and regulations and unexpected changes in those laws and regulatory requirements, including uncertainties regarding taxes, tariffs, quotas, export controls, export licenses and other trade barriers;
•certification requirements;
•environmental regulations;
•less effective protection of intellectual property rights in some countries;
•potentially adverse tax consequences;
•different capital expenditure and budget cycles for our customers, which affect the timing of their spending;
•political, legal and economic instability, foreign conflicts, labor unrest and the impact of regional and global infectious illnesses in the countries in which we and our customers, suppliers, manufacturers and subcontractors are located;
•preference for locally produced products;
•difficulties and costs of staffing and managing international operations across different geographic areas and cultures;
•seasonal reductions in business activities;
•fluctuations in freight rates and transportation disruptions;
•investment restrictions or requirements;
•repatriation restrictions or requirements;
•export and import restrictions; and
•limitations on the ability of our employees to travel without restriction to certain countries in which we operate.

Political, economic and monetary instability and changes in governmental regulations or policies, including trade tariffs and protectionism, could adversely affect both our ability to effectively operate our foreign sales offices and the ability of our foreign suppliers to supply us with required materials or services. Any interruption or delay in the supply of our required components, products, materials or services, or our inability to obtain these components, materials, products or services from alternate sources at acceptable prices and within a reasonable amount of time, could impair our ability to meet scheduled product deliveries to our customers and could cause customers to cancel orders.

We are subject to risks of doing business in Russia through our subsidiary, NTO IRE-Polus, which provides components and test equipment to us and sells finished fiber devices to customers in Russia and neighboring countries as well as finished lasers to China. Further, approximately 43% of our sales are to customers in China. The results of our operations, business prospects and facilities in these two countries are subject to the economic and political environment in Russia and China. In recent years, both countries have undergone substantial political, economic and social change. As is typical of an emerging economy, neither China nor Russia possesses a well-developed business, financial, legal and regulatory infrastructure that would generally exist in a more mature free market economy. In addition, tax, currency and customs legislation is subject to varying interpretations and changes, which can occur frequently. The future economic direction of these two emerging market

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countries remains largely dependent upon the effectiveness of economic, financial and monetary measures undertaken by the government, together with tax, legal, regulatory and political developments. Our failure to manage the risks associated with our operations in Russia and China and our other existing and potential future international business operations could have a material adverse effect upon our results of operations.

We must comply with and could be impacted by various export controls and trade and economic sanctions laws and regulations that are fluid and may change due to diplomatic and political considerations outside of our control.

Our business activities are subject to various export controls and trade and economic sanctions laws and regulations, including, without limitation, the U.S. Commerce Department's Export Administration Regulations, the U.S. Treasury Department's Office of Foreign Assets Control's trade and economic sanctions programs, and the U.S. Department of State's Nonproliferation Sanctions, which we collectively refer to as Trade Controls.

We have a large manufacturing facility and research and development operations in Russia which supplies components to our U.S. and German manufacturing facilities and finished lasers to our subsidiary in China. In addition, we supply components from our U.S. and German manufacturing facilities to our Russian facility. Should there be any disruption of our supplies from or to our Russian operations, or should the United States, the European Union or Russia implement new or broad-based Trade Controls, our production and/or deliveries as well as results of operations would be affected. Although we have implemented compliance measures designed to prevent transactions prohibited by current or future Trade Controls, our failure to successfully comply with applicable Trade Controls may expose us to negative legal and business consequences, including civil or criminal penalties, government investigations, and reputational harm.

In addition, Trade Controls and their implementation are fluid and may change due to diplomatic and political considerations outside of our control. Such changes, including the potential expansion of sanctions and sanctions designations, as well as public statements by government officials, could be significant, require us to take certain actions to be in compliance, adversely affect prevailing market prices of our common stock, have a reputational impact, or otherwise have a material adverse impact on us, our business, and our ability to raise capital.

We have experienced, and expect to experience in the future, fluctuations in our quarterly operating results. These fluctuations may increase the volatility of our stock price and may be difficult to predict.

We have experienced, and expect to continue to experience, fluctuations in our quarterly operating results. We believe that fluctuations in quarterly results may cause the market price of our common stock to fluctuate, perhaps substantially. Factors which may have an influence on our operating results in a particular quarter include:

•general economic conditions and uncertainties in the macroeconomic and local economies in which we or our customers operate and serve;
•the increase, decrease, cancellation or rescheduling of significant customer orders;
•compliance with applicable import/export regulations, tariffs and trade barriers, including recently instituted or proposed changes in trade policies by the U.S. and any corresponding retaliatory actions by affected countries, in particular with respect to China;
•the timing of revenue recognition based on the installation or acceptance of certain products shipped to our customers;
•seasonality attributable to different purchasing patterns and levels of activity throughout the year in the areas where we operate;
•the timing of customer qualification of our products and commencement of volume sales of systems that include our products;
•our ability to obtain export licenses for our products on a timely basis or at all;
•the rate at which our present and future customers and end users adopt our technologies;
•the gain or loss of a key customer;
•product or customer mix;
•competitive pricing pressures and new market entrants;
•our ability to design, manufacture and introduce new products on a cost-effective and timely basis;
•our ability to manage our inventory levels and any provisions for excess or obsolete inventory;
•our ability to collect outstanding accounts receivable balances;

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•incurring expenses to develop and improve application and support capabilities, the benefits of which may not be realized until future periods, if at all;
•incurring expenses related to impairment of values for goodwill, intangibles and other long-lived assets;
•different capital expenditure and budget cycles for our customers, which affect the timing of their spending;
•our ability to successfully and fully integrate acquisitions into our operation and management;
•expenses associated with acquisition-related activities;
•foreign currency fluctuations; and
•our ability to control expenses.

These factors make it difficult for us to accurately predict our operating results. In addition, our ability to accurately predict our operating results is complicated by the fact that many of our products have long sales cycles, some lasting as long as twelve months or more. Once a sale is made, our delivery schedule typically ranges from four weeks to four months, and therefore our sales will often reflect orders shipped in the same quarter that they are received and will not enhance our ability to predict our results for future quarters. In addition, long sales cycles may cause us to incur significant expenses without offsetting revenues since customers typically expend significant effort in evaluating, testing and qualifying our products before making a decision to purchase them. Moreover, customers may cancel or reschedule shipments, and production difficulties could delay shipments. Accordingly, our results of operations are subject to significant fluctuations from quarter to quarter, and we may not be able to accurately predict when these fluctuations will occur.

Because we lack long-term purchase commitments from our customers, our sales can be difficult to predict, which could lead to excess or obsolete inventory and adversely affect our operating results.

We generally do not enter into long-term agreements with our customers obligating them to purchase our fiber lasers or amplifiers. Our business is characterized by short-term purchase orders and shipment schedules and, in some cases, orders may be canceled or delayed without significant penalty. As a result, it is difficult to forecast our revenues and to determine the appropriate levels of inventory required to meet future demand. In addition, due to the absence of long-term volume purchase agreements, we forecast our revenues and plan our production and inventory levels based upon the demand forecasts of our OEM customers, end users and distributors, which are highly unpredictable and can fluctuate substantially. This could lead to increased inventory levels and increased carrying costs and risk of excess or obsolete inventory due to unanticipated reductions in purchases by our customers. In addition, provisions have been recorded as a result of changes in market prices of certain components, the value of those inventories that was realizable through finished product sales due to declines in certain end market demand and uncertainties related to the recoverability of the value of inventories due to technological and product changes, and excess quantities. In this regard, we recorded provisions for slow-moving, obsolete or excess inventory totaling $13.0 million, $16.9 million and $22.8 million in 2018, 2017 and 2016, respectively. If our OEM customers, end users or distributors fail to accurately forecast the demand for our products, fail to accurately forecast the timing of such demand, or are unable to consistently negotiate acceptable purchase order terms with customers, our results of operations may be adversely affected.

We pursue acquisitions and investments in new businesses, products, patents or technologies. These involve risks which could disrupt our business and may harm our financial results and condition.

We make acquisitions of and investments in new businesses, products, patents and technologies and expand into new geographic areas, or we may acquire operations, products or technologies that expand our current capabilities. Although we have pursued acquisitions small in size in the past, we may pursue larger transactions in the future. Acquisitions present a number of potential risks and challenges that could, if not met, disrupt our business operations, increase our operating costs, reduce consolidated margins, cause us to incur impairment charges and reduce the value of the acquired company, asset or technology to us. For example, if we identify an acquisition candidate, we may not be able to successfully negotiate or finance the acquisition on favorable terms. Even if we are successful, we may not be able to complete the transaction after signing definitive agreements, integrate the acquired businesses, business cultures, products, patents or technologies into our existing business and products, or retain key employees. As a result of the rapid pace of technological change in our industry, we may misjudge the long-term potential of an acquired business, product, patent or technology, or the acquisition may not be complementary to our existing business. Furthermore, potential acquisitions and investments, whether or not consummated, may divert our management's

attention, require considerable cash outlays at the expense of our existing operations, incur unanticipated costs or liabilities, including the costs associated with improving the internal controls of the acquired company. In addition, to complete future acquisitions, we may issue equity securities, incur debt, assume contingent liabilities or have amortization expenses and write-downs of acquired assets, which could adversely affect our profitability and result in dilution to our existing and future stockholders.

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We may incur impairments to goodwill or long-lived assets, which would negatively affect our results of operations

We review our long-lived assets, including goodwill and intangible assets identified in business combinations and other intangible assets, for impairment annually or whenever events or changes in circumstances indicate that the carrying amount of these assets may not be recoverable. Negative industry or economic trends, including reduced estimates of future cash flows, disruptions to our business, slower growth rates, lack of growth in our relevant business units or differences in the estimated product acceptance rates could lead to impairment charges against our long-lived assets, including goodwill and other intangible assets.

Our valuation methodology for assessing impairment requires management to make significant judgments and assumptions based on historical experience and to rely heavily on projections of future operating performance at many points during the analysis. Also, the process of evaluating the potential impairment of goodwill is subjective. We operate in a highly competitive environment and projections of future operating results and cash flows may vary significantly from actual results. Additionally, if our analysis indicates potential impairment to goodwill in one or more of our business units, we may be required to record additional charges to earnings in our financial statements, which could negatively affect our results of operations.

We rely on the significant experience and specialized expertise of our senior management and scientific staff and if we are unable to retain these key employees and attract other highly skilled personnel necessary to grow our business successfully, our business and results of operations could suffer.

Our future success is substantially dependent on the continued service of our executive officers, particularly our founder and chief executive officer, Dr. Valentin P. Gapontsev, age 79, and the chief operating officer, Dr. Eugene Scherbakov, age 70, our highly trained team of scientists, many of whom have numerous years of experience and specialized expertise in optical fibers, semiconductors and optical component technology, and other key engineering, sales, marketing, manufacturing and support personnel, any of whom may leave, which could harm our business. The members of our scientific staff who are expected to make significant individual contributions to our business are also members of our executive management team. Furthermore, our business requires scientists and engineers with experience in several disciplines, including physics, optics, materials sciences, chemistry and electronics. We will need to continue to recruit and retain highly skilled scientists and engineers for certain functions. Our future success also depends on our ability to identify, attract, hire, train, retain and motivate highly skilled research and development, managerial, operations, sales, marketing and customer service personnel. If we fail to attract, integrate and retain the necessary personnel, our ability to extend and maintain our scientific expertise and grow our business could suffer significantly.

We are subject to litigation alleging that we are infringing third-party intellectual property rights. Intellectual property claims could result in costly litigation and harm our business.

In recent years, there has been significant litigation involving intellectual property rights in many technology-based industries, including our own. We face risks and uncertainties in connection with such litigation, including the risk that patents issued to others may harm our ability to do business; that there could be existing patents of which we are unaware that could be pertinent to our business; and that it is not possible for us to know whether there are patent applications pending that our products might infringe upon, since patent applications often are not disclosed until a patent is issued or published. Moreover, the frequency with which new patents are granted and the diversity of jurisdictions in which they are granted make it impractical and expensive for us to monitor all patents that may be relevant to our business.

From time to time, we have been notified of allegations and claims that we may be infringing patents or intellectual property rights owned by third parties. For instance, we were named a defendant in an action filed November 2015 in the United States District Court for the Eastern District of Texas for patent infringement relating to an apparatus for coupling radiation beams into optical waveguides. This matter was settled. Following a federal jury trial in 2011, we won a patent infringement lawsuit asserted by IMRA America, Inc. IMRA America has also informed us that it has patents and applications directed to fiber lasers and fiber amplifiers, but has not asserted them against us. We were previously engaged in opposition proceedings in Japan and Germany with respect to several related IMRA patents. There can be no assurance that we will be able to dispose without a material effect any claims or other allegations made or asserted in the future. The outcome of any litigation is uncertain. Even if we ultimately are successful on the

merits of any such litigation or re-examination, legal and administrative proceedings related to intellectual property are typically expensive and time-consuming, generate negative publicity and divert financial and managerial resources. Some litigants may have greater financial resources than we have and may be able to sustain the costs of complex intellectual property litigation more easily than we can.

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If we do not prevail in any intellectual property litigation brought against us, it could affect our ability to sell our products and materially harm our business, financial condition and results of operations. These developments could adversely affect our ability to compete for customers and increase our revenues. Plaintiffs in intellectual property cases often seek, and sometimes obtain, injunctive relief. Intellectual property litigation commenced against us could force us to take actions that could be harmful to our business, competitive position, results of operations and financial condition, including the following:

•stop selling our products or using the technology that contains the allegedly infringing intellectual property;

•pay actual monetary damages, royalties, lost profits or increased damages and the plaintiff's attorneys' fees, which individually or in the aggregate may be substantial; and

•attempt to obtain a license to use the relevant intellectual property, which may not be available on reasonable terms or at all.

In addition, intellectual property lawsuits can be brought by third parties against OEMs and end users that incorporate our products into their systems or processes. In some cases, we indemnify OEMs against third-party infringement claims relating to our products and we often make representations affirming, among other things, that our products do not infringe the intellectual property rights of others. As a result, we may incur liabilities in connection with lawsuits against our customers. Any such lawsuits, whether or not they have merit, could be time-consuming to defend, damage our reputation or result in substantial and unanticipated costs.

Our inability to protect our intellectual property and proprietary technologies could result in the unauthorized use of our technologies by third parties, hurt our competitive position and adversely affect our operating results.

We rely on patents, trade secret laws, contractual agreements, technical know-how and other unpatented proprietary information to protect our products, product development and manufacturing activities from unauthorized copying by third parties. Our patents do not cover all of our technologies, systems, products and product components and may not prevent third parties from unauthorized copying of our technologies, products and product components. We seek to protect our proprietary technology under laws affording protection for trade secrets. We also seek to protect our trade secrets and proprietary information, in part, by requiring employees to enter into agreements providing for the maintenance of confidentiality and the assignment of rights to inventions made by them while employed by us. We have significant international operations and we are subject to foreign laws which differ in many respects from U.S. laws. Policing unauthorized use of our trade secret technologies throughout the world and proving misappropriation of our technologies are particularly difficult, especially due to the number of our employees and operations in numerous foreign countries. The steps that we take to acquire ownership of our employees' inventions and trade secrets in foreign countries may not have been effective under all such local laws, which could expose us to potential claims or the inability to protect intellectual property developed by our employees. Furthermore, any changes in, or unexpected interpretations of, the trade secret and other intellectual property laws in any country in which we operate may adversely affect our ability to enforce our trade secret and intellectual property positions. Costly and time-consuming litigation could be necessary to determine the scope of our confidential information and trade secret protection. We also enter into confidentiality agreements with our consultants and other suppliers to protect our confidential information that we deliver to them. However, there can be no assurance that our confidentiality agreements will not be breached, that we will be able to effectively enforce them or that we will have adequate remedies for any breach. Given our reliance on trade secret laws, others may independently develop similar or alternative technologies or duplicate our technologies and commercialize discoveries that we have made. Therefore, our intellectual property efforts may be insufficient to maintain our competitive advantage or to stop other parties from commercializing similar products or technologies. Many countries outside of the United States afford little or no protection to trade secrets and other intellectual property rights. Intellectual property litigation can be time-consuming and expensive, and there is no guarantee that we will have the resources to fully enforce our rights. If we are unable to prevent misappropriation or infringement of our intellectual property rights, or the independent development or design of similar technologies, our competitive position and operating results could suffer.

We depend upon internal production and on outside single or limited-source suppliers for many of our key components and raw materials, including cutting-edge optics and materials. Any interruption in the supply of these key components and raw materials could adversely affect our results of operations.

We rely exclusively on our own production capabilities to manufacture certain of our key components, such as semiconductor diodes, specialty optical fibers and optical components. We do not have redundant production lines for some of our components, such as our diodes, specialty optical fibers and some other components, which are made at a single manufacturing facility. These are not readily available from other sources at our current costs. If our manufacturing activities were obstructed or hampered significantly, it could take a considerable length of time, or it could increase our costs, for us to resume manufacturing or find alternative sources of supply. Many of the tools and equipment we use are custom-designed, and

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it could take a significant period of time to repair or replace them. Our three major manufacturing facilities are located in Oxford, Massachusetts; Burbach, Germany; and Fryazino, Russia. Despite our efforts to mitigate the impact of any flood, fire, natural disaster, political unrest, act of terrorism, war, outbreak of disease or other similar event, our business could be adversely affected to the extent that we do not have redundant production capabilities if any of our three major manufacturing facilities or equipment should become inoperable, inaccessible, damaged or destroyed. Also, we purchase certain raw materials used to manufacture our products and other components, such as semiconductor wafer substrates, diode packages, modulators, micro-optics, bulk optics and high power beam delivery products, from single or limited-source suppliers. We typically purchase our components and materials through purchase orders or agreed-upon terms and conditions and we do not have guaranteed supply arrangements with many of these suppliers. These suppliers are relatively small private companies that may discontinue their operations at any time and may be particularly susceptible to prevailing economic conditions. Some of our suppliers are also our competitors. Some of our suppliers may not be able to meet demand from our growing business or because of global demand for their components. As a result, we experienced and may in the future experience longer lead times or delays in fulfillment of our orders. Furthermore, other than our current suppliers, there are a limited number of entities from whom we could obtain these supplies. We do not anticipate that we would be able to purchase these components or raw materials that we require in a short period of time or at the same cost from other sources in commercial quantities or that have our required performance specifications. Any interruption or delay in the supply of any of these components or materials, or the inability to obtain these components and materials from alternate sources at acceptable prices and within a reasonable amount of time, could adversely affect our business. If our suppliers face financial or other difficulties, if our suppliers do not maintain sufficient inventory on hand or if there are significant changes in demand for the components and materials we obtain from them, they could limit the availability of these components and materials to us, which in turn could adversely affect our business.

We depend on our OEM customers and system integrators to incorporate our products into their systems.

Our sales depend in part on our ability to maintain existing and secure new OEM customers. Our revenues also depend in part upon the ability of our current and potential OEM customers and system integrators to incorporate our laser and amplifier products. The commercial success of these systems depends to a substantial degree on the efforts of these OEM customers and system integrators to develop and market products that incorporate our technologies. Relationships and experience with traditional laser makers, limited marketing resources, reluctance to invest in research and development and other factors affecting these OEM customers and third-party system integrators could have a substantial impact upon our financial results. If OEM customers or integrators are not able to adapt existing tools or develop new systems to take advantage of the features and benefits of fiber lasers or if they perceive us to be an actual or potential competitor, then the opportunities to increase our revenues and profitability may be severely limited or delayed. In addition, some of our OEM customers are developing their own fiber laser sources. If they are successful, this may reduce our sales to these customers. Furthermore, if our OEM customers or third-party system integrators experience financial or other difficulties that adversely affect their operations, our financial condition or results of operations may also be adversely affected.

Changes in tax rates, tax liabilities or tax accounting rules could affect future results.

As a global company, we are subject to taxation in the United States and various other countries and jurisdictions. Significant judgment is required to determine worldwide tax liabilities. Our future tax rates could be affected by changes in the composition of earnings in countries or states with differing tax rates, transfer pricing rules, changes in the valuation of our deferred tax assets and liabilities, or changes in the tax laws. In addition, we are subject to regular examination of our income tax returns by the Internal Revenue Service ("IRS") and other tax authorities. From time to time the United States, foreign and state governments make substantive changes to tax rules and the application of rules to companies, including various announcements from the United States government potentially impacting our ability to defer taxes on international earnings. We regularly assess the likelihood of favorable or unfavorable outcomes resulting from these examinations to determine the adequacy of our provision for income taxes. Although we believe our tax estimates are reasonable, there can be no assurance that any final determination will not be materially different than the treatment reflected in our historical income tax provisions and accruals, which could materially and adversely affect our operating results and financial condition.

Failure to effectively maintain and expand our direct field service and support organization could have an adverse effect on our business.

It is important for us to provide rapid, responsive service directly to our customers throughout the world and to maintain and expand our own personnel resources to provide these services. Any actual or perceived lack of direct field service in the locations where we sell or try to sell our products may negatively impact our sales efforts and, consequently, our revenues. This requires us to recruit and train additional qualified field service and support personnel as well as maintain effective and highly trained organizations that can provide service to our customers in various countries. We may not be able to attract and train

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additional qualified personnel to expand our direct support operations successfully. We may not be able to find and engage additional qualified third-party resources to supplement and enhance our direct support operations. Further, we may incur significant costs in providing these direct field and support services. Failure to implement and manage our direct support operation effectively could adversely affect our relationships with our customers, and our operating results may suffer.

Our products could contain defects, which may reduce sales of those products, harm market acceptance of our fiber laser products or result in claims against us.

The manufacture of our fiber lasers and amplifiers involves highly complex and precise processes. Despite testing by us and our customers, errors have been found, and may be found in the future, in our products. These defects may cause us to incur significant warranty, support and repair costs, incur additional costs related to a recall, divert the attention of our engineering personnel from our product development efforts and harm our relationships with our customers. These problems could result in, among other things, loss of revenues or a delay in revenue recognition, loss of market share, harm to our reputation or a delay or loss of market acceptance of our fiber laser products. Defects, integration issues or other performance problems in our fiber laser and amplifier products could also result in personal injury or financial or other damages to our customers, which in turn could damage market acceptance of our products. Our customers could also seek damages from us for their losses. A product liability claim brought against us, even if unsuccessful, could be time-consuming and costly to defend.

We may experience lower than expected manufacturing yields, which would adversely affect our gross margins.

The manufacture of semiconductor diodes and the packaging of them is a highly complex process. Manufacturers often encounter difficulties in achieving acceptable product yields from diode and packaging operations. We have from time to time experienced lower than anticipated manufacturing yields for our diodes and packaged diodes. This occurs during the production of new designs and the installation and start-up of new process technologies and new equipment. If we do not achieve planned yields, our product costs could increase resulting in lower gross margins, and key component availability would decrease.

Failure to maintain effective internal controls may cause a loss of investor confidence in the reliability of our financial statements or to cause us to delay filing our periodic reports with the SEC and adversely affect our stock price.

The SEC, as directed by Section 404 of the Sarbanes-Oxley Act of 2002, adopted rules requiring public companies to include a report of management on internal control over financial reporting in their annual reports on Form 10-K that contain an assessment by management of the effectiveness of our internal control over financial reporting. In addition, our independent registered public accounting firm must attest to and report on the effectiveness of our internal control over financial reporting. We have experienced rapid growth and have extensive and complex international manufacturing and sales and service locations which may make us more vulnerable to weaknesses in our internal controls. Although we test our internal control over financial reporting in order to ensure compliance with the Section 404 requirements, our failure to maintain adequate internal controls over financial reporting could result in an adverse reaction in the financial marketplace due to a loss of investor confidence in the reliability of our financial statements or a delay in our ability to timely file our periodic reports with the SEC, which ultimately could negatively impact our stock price.

Our information systems are subject to cyber-attacks, interruptions and failures. If unauthorized access is obtained to our information systems, we may incur significant legal and financial exposure and liabilities.

Like many multinational corporations, we maintain several information technology systems, including software products licensed from third parties. These systems vary from country to country. Any system, network or internet failures, misuse by system users, the hacking into or disruption caused by the unauthorized access by third parties or loss of license rights could disrupt our ability to timely and accurately manufacture and ship products or to report our financial information in compliance with the timelines mandated by the SEC. Any such failure, misuse, hacking, disruptions or loss would likely cause a diversion of management's attention from the underlying business and could harm our operations. In addition, a significant failure of our various information technology systems could adversely affect our ability to complete an evaluation of our internal controls and attestation activities pursuant to Section 404 of the Sarbanes-Oxley Act of 2002 under the updated framework issued in 2013.

As part of our day-to-day business, we store our data and certain data about our customers, employees and service providers in our information technology system. While our system is designed with access security, if a third party gains unauthorized access to our data or technology, including information regarding our customers, employees and service providers, such security breach could expose us to a risk of loss of this information, loss of business, litigation and possible liability. Our security measures may be breached as a result of third-party action, including intentional misconduct by computer hackers, employee error, malfeasance or otherwise. Additionally, third parties may attempt to fraudulently induce employees or customers into disclosing sensitive information such as user names, passwords or other information in order to gain access to our customers' data or our data, including our intellectual property and other confidential business information, employee

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information or our information technology systems. Because the techniques used to obtain unauthorized access, or to sabotage systems, change frequently and generally are not recognized until launched against a target, we may be unable to anticipate or detect these techniques or to implement adequate preventative measures. Any unauthorized access could result in a loss of confidence by our customers, damage our reputation, disrupt our business, result in a misappropriation of our assets (including cash), lead to legal liability and negatively impact our future sales. Additionally, such actions could result in significant costs associated with loss of our intellectual property, impairment of our ability to conduct our operations, rebuilding our network and systems, prosecuting and defending litigation, responding to regulatory inquiries or actions, paying damages or taking other remedial steps. In addition, we may incur significant costs designed to prevent or mitigate the damage related to cybersecurity incidents. For instance, we may retain additional employees or consultants, implement new policies and procedures, and install information technology to detect and prevent identity theft, data breaches, or system disruptions. We would incur any such costs with the intent that proactively preventing a cybersecurity incident ultimately helps to mitigate potential cybersecurity liability.

The costs to address the foregoing security problems and security vulnerabilities before or after a cyber-incident could be significant. Our remediation efforts may not be successful and could result in interruptions, delays, a cessation of service, and a loss of existing or potential customers, impeding our sales, manufacturing, distribution, and other critical functions.

We may face particular privacy, data security and data protection risks due to laws and regulations regulating the protection or security of personal and other sensitive data.

We may face particular privacy, data security and data protection risks due to laws and regulations regulating the protection or security of personal and other sensitive data, including in particular several laws and regulations that have recently been enacted or adopted or are likely to be enacted or adopted in the future. For instance, effective May 25, 2018, the European General Data Protection Regulation ("GDPR") imposes additional obligations and risk upon our business and increases substantially the penalties to which we could be subject in the event of any non-compliance. GDPR requires companies to satisfy new requirements regarding the handling of personal data (generally, of EU residents), including its use, protection and the rights of affected persons regarding their data. Failure to comply with GDPR requirements could result in penalties of up to 4% of worldwide revenue. In addition, several other jurisdictions around the world have recently enacted privacy laws or regulations similar to GDPR. For instance, California enacted the California Consumer Privacy Act ("CCPA"), which is effective January 1, 2020 and which gives consumers many of the same rights as those available under GDPR. Several laws similar to the CCPA have been proposed in the United States at both the federal and state level. GDPR and other similar laws and regulations, as well as any associated inquiries or investigations or any other government actions, may be costly to comply with, result in negative publicity, increase our operating costs, require significant management time and attention, and subject us to remedies that may harm our business. We are evaluating its processes and taking measures to ensure compliance with all applicable privacy and data protection-related laws and regulations. Due to the lack of experience with the interpretation and enforcement of many of these laws and regulations, some measures initially might not satisfy standard or best practices that will be established in the coming years.

We are subject to government regulations, including tariffs, duties and export control regulations, that could restrict our international sales and negatively affect our business.

A significant part of our business involves the export and import of components and products among many countries, including the U.S., Germany, Russia and China. The U.S. government has in place a number of laws and regulations that control the export, re-export or transfer of U.S.-origin products, software and technology. The governments of other countries in which we do business have similar regulations regarding products, software and technology originating in those countries. These laws and regulations may require that we obtain a license before we can export, re-export or transfer certain products, software or technology. The requirement to obtain a license could put us at a competitive disadvantage by restricting our ability to sell products to customers in certain countries or by giving rise to delays or expenses related to obtaining a license. In applying for a license and responding to questions from

licensing authorities, we have experienced and, in the future, may experience delays in obtaining export licenses based on issues solely within the control of the applicable government agency. Under the discretion of the issuing government agency, an export license may permit the export of one unit to a single customer or multiple units to one or more customers. Licenses may also include conditions that limit the use, resale, transfer, re-export, modification, disassembly, or transfer of a product, software or technology after it is exported without first obtaining permission from the relevant government agency. Failure to comply with these laws and regulations could result in government sanctions, including substantial monetary penalties, denial of export privileges, debarment from government contracts and a loss of revenues. Delays in obtaining or failure to obtain required export licenses may require us to defer shipments for substantial periods or cancel orders. Any of these circumstances could adversely affect our operations and, as a result, our financial results could suffer.

In January 2018, the U.S. Treasury Department presented the U.S. Congress with a report on “oligarchs” as required under the Countering America’s Adversaries through Sanctions Act of 2017. Our founder, CEO and Chairman is one of nearly 100 persons on the list of “oligarchs” on the basis of his reported net worth and birth in Russia. Uncertainties and reputational

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damage from his naming in the Treasury report, the imposition of trade sanctions and/or future legislation relying on the Treasury Department's list of so-called "oligarchs" could negatively affect our business, financial condition and results of operation.

The United States, Germany, the European Union, China, Japan, South Korea and many other foreign governments impose tariffs and duties on the import and export of products, including some of those which we sell. The U.S. has recently instituted or proposed changes in trade policies that include the negotiation or termination of trade agreements, the imposition of higher tariffs on imports into the United States, including, in particular, on Chinese goods, economic sanctions on individuals, corporations or countries and other government regulations affecting trade between the United States and other countries where we conduct our business. For example, in September 2018, the Office of the U.S. Trade Representative announced that the current U.S. administration would impose a 10% tariff on approximately $200 billion worth of imports from China into the United States, effective September 24, 2018, which is expected to increase to 25% in the first half of 2019. We have recently seen a drop in demand for our Chinese customers, particularly in the materials processing market. As a result, some of our customers are reevaluating expansion plans and delaying and, in limited cases, canceling orders.

These policy changes and proposals could require time-consuming and expensive alterations to our business operations and may result in greater restrictions and economic disincentives on international trade, which could negatively impact our competitiveness in jurisdictions around the world as well as lead to an increase in costs in our supply chain. We are a multinational corporation, with manufacturing located both in the United States and internationally and with approximately 85% of our net sales arising from foreign customers. As such, we may be more susceptible to negative impacts from these tariffs or change in trade policies than other less internationally focused enterprises. In addition, new tariffs and other changes in U.S. trade policy could trigger retaliatory actions by affected countries, and certain foreign governments, including the Chinese government (which has imposed retaliatory tariffs on a range of U.S. goods including certain photonics products), have instituted or are considering imposing trade sanctions on certain U.S. manufactured goods. Such changes by the United States and other countries have the potential to adversely impact U.S. and worldwide economic conditions, our industry and the global demand for our products, and as a result, could negatively affect our business, financial condition and results of operations.

We are subject to various environmental laws and regulations that could impose substantial costs upon us and may adversely affect our business, operating results and financial condition.

Some of our operations use substances regulated under various federal, state, local and international laws governing the environment, including those relating to the storage, use, discharge, disposal, product composition and labeling of, and human exposure to, hazardous and toxic materials. We could incur costs, fines and civil or criminal sanctions, third-party property damage or personal injury claims, or could be required to incur substantial investigation or remediation costs, if we were to violate or become liable under environmental laws. Liability under environmental laws can be joint and several and without regard to comparative fault. Compliance with current or future environmental laws and regulations could restrict our ability to expand our facilities or require us to acquire additional expensive equipment, modify our manufacturing processes, or incur other significant expenses in order to remain in compliance with such laws and regulations. At this time, we do not believe the costs to maintain compliance with current environmental laws to be material. Although we do not currently anticipate that such costs will become material, if such costs were to become material in the future, whether due to unanticipated changes in environmental laws, unanticipated changes in our operations or other unanticipated changes, we may be required to dedicate additional staff or financial resources in order to maintain compliance. There can be no assurance that violations of environmental laws or regulations will not occur in the future as a result of the lack of, or failure to obtain, permits, human error, accident, equipment failure or other causes.

We are exposed to credit risk and fluctuations in the market values of our cash, cash equivalents and marketable securities.

Given the global nature of our business, we have both domestic and international investments. At December 31, 2018, 71% of our cash, cash equivalents and marketable securities were in the United States and 29% were outside the United States. Credit ratings and pricing of our investments can be negatively affected by liquidity, credit deterioration, prevailing interest rates, financial results, economic risk, political risk, sovereign risk or other factors. Also, our investments may be negatively affected by events that impact the banks or depositories that hold our

investments. As a result, the value and liquidity of our cash, cash equivalents and marketable securities may fluctuate substantially. Therefore, although we have not realized any significant losses on our cash, cash equivalents and marketable securities, future fluctuations in their value could result in a significant realized loss.

Our ability to access financial markets to raise capital or finance a portion of our working capital requirements and support our liquidity needs may be adversely affected by factors beyond our control and could negatively impact our ability to finance our operations, meet certain obligations, implement our operating strategy or complete acquisitions.

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We occasionally borrow under our existing credit facilities to fund operations, including working capital investments. Our major credit lines in the United States and Germany expire in April 2020 and July 2020, respectively. In the past, market disruptions experienced in the United States and abroad have materially impacted liquidity in the credit and debt markets, making financing terms for borrowers less attractive, and, in certain cases, have resulted in the unavailability of certain types of financing. Uncertainty in the financial markets may negatively impact our ability to access additional financing or to refinance our existing credit facilities or existing debt arrangements on favorable terms or at all, which could negatively affect our ability to fund current and future expansion as well as future acquisitions and development. These disruptions may include turmoil in the financial services industry, unprecedented volatility in the markets where our outstanding securities trade, and general economic downturns in the areas where we do business. If we are unable to access funds at competitive rates, or if our short-term or long-term borrowing costs increase, our ability to finance our operations, meet our short-term obligations and implement our operating strategy could be adversely affected.

We also may in the future be required to raise capital through public or private financing or other arrangements. Such financing may not be available on acceptable terms, or at all, and our failure to raise capital when needed could harm our business. Additional equity financing may be dilutive to the holders of our common stock, and debt financing, if available, may involve restrictive covenants and could reduce our profitability. If we cannot raise funds on acceptable terms, we may not be able to grow our business or respond to competitive pressures.

Substantial sales of our common stock, including shares issued upon the exercise of currently outstanding options, restricted stock units and performance stock units could cause our stock price to decline.

Sales of a substantial number of shares of common stock, or the perception that sales could occur, could adversely affect the market price of our common stock. As of December 31, 2018, we had 52,941,607 shares of common stock outstanding and 2,207,750 shares subject to outstanding options, restricted stock units and performance stock units. We have registered all shares of common stock that we may issue under our stock option plans and our employee stock ownership plan. In addition, all of the unregistered shares of our common stock are now eligible for sale under Rule 144 or Rule 701 under the Securities Act. As these shares are issued, they may be freely sold in the public market subject, in the case of any awards under our stock-based compensation plans, to applicable vesting requirements.

We currently have the ability to file a registration statement and immediately offer and sell common stock, preferred stock, warrants, debt and convertible securities because of our current status a well-known seasoned issuer. In the future, we may issue additional options, warrants or other securities convertible into our common stock. Sales of substantial amounts of shares of our common stock or other securities under any future registration statement that we may file covering newly issued shares or shares held by affiliates or others could lower the market price of our common stock and impair our ability to raise capital through the sale of equity securities.

Dr. Valentin P. Gapontsev, our Chairman and Chief Executive Officer, and three trusts he created collectively control approximately 31% of our voting power and have a significant influence on the outcome of director elections and other matters requiring stockholder approval, including a change in corporate control.

Dr. Valentin P. Gapontsev, our Chairman and Chief Executive Officer, and IP Fibre Devices (UK) Ltd., of which Dr. Gapontsev is the managing director, together with three trusts he created beneficially own approximately 31% of our common stock. Trustees of the trusts are officers or employees of the Company.

Dr. Gapontsev and the trusts have a significant influence on the outcome of matters requiring stockholder approval, including:

•election of our directors;

•amendment of our certificate of incorporation or by-laws; and

•approval of mergers, consolidations or the sale of all or substantially all of our assets.

Dr. Gapontsev and the trusts may vote their shares of our common stock in ways that are adverse to the interests of other holders of our common stock. These significant ownership interests could delay, prevent or cause a change in control of the Company, any of which could adversely affect the market price of our common stock.

Provisions in our charter documents and Delaware law, and our severance arrangements, could prevent or delay a change in control of our company, even if a change in control would be beneficial to our stockholders.

Provisions of our certificate of incorporation and by-laws, including certain provisions that will take effect when Dr. Valentin P. Gapontsev (together with his affiliates and associates) ceases to beneficially own an aggregate of 25% or more of

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our outstanding voting securities, may discourage, delay or prevent a merger, acquisition or change of control, even if it would be beneficial to our stockholders. The existence of these provisions could also limit the price that investors might be willing to pay in the future for shares of our common stock. These provisions include:

•authorizing the issuance of "blank check" preferred stock;
•establishing a classified board;
•providing that directors may only be removed for cause;
•prohibiting stockholder action by written consent;
•limiting the persons who may call a special meeting of stockholders;
•establishing advance notice requirements for nominations for election to the board of directors and for proposing matters to be submitted to a stockholder vote; and
•supermajority stockholder approval to change these provisions.

Provisions of Delaware law may also discourage, delay or prevent someone from acquiring or merging with the Company or obtaining control of our company. Specifically, Section 203 of the Delaware General Corporation Law, which will apply to the Company following such time as Dr. Gapontsev (together with his affiliates and associates) ceases to beneficially own 25% or more of the total voting power of our outstanding shares, may prohibit business combinations with stockholders owning 15% or more of our outstanding voting stock. The terms of our agreements with executives include change-of-control severance provisions which provide for the payment of cash following a termination of employment following a change of control. These provisions may discourage, delay or prevent a merger or acquisition, make a merger or acquisition more costly for a potential acquirer, or make removal of incumbent directors or officers more difficult.

If securities analysts stop publishing research or reports about our business, or if they downgrade our stock, the price of our stock could decline.

The trading market for our common stock relies in part on the research and reports that industry or financial analysts publish about us. If one or more of these analysts who cover us downgrade our stock, our stock price would likely decline. Further, if one or more of these analysts cease coverage of the Company, we could lose visibility in the market, which in turn could cause our stock price to decline.

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ITEM 1B. ***UNRESOLVED STAFF COMMENTS***

None.

ITEM 2. ***PROPERTIES***

Our facilities consisting of 20,000 or more square feet at December 31, 2018 include the following:

Location	Owned or Leased	Lease Expiration	Approximate Size (sq. ft.)	Primary Activity
Fryazino, Russia	Owned	—	473,700	Manufacturing, R&D, administration
	Leased	September 2019	78,200	Components, complete device manufacturing
Oxford, Massachusetts	Owned	—	427,300	Diodes, components, complete device manufacturing, R&D, administration
Burbach, Germany	Owned	—	417,000	Optical fiber, components, final assembly, complete device manufacturing, R&D administration
Marlborough, Massachusetts	Owned	—	227,000	Components, manufacturing, applications, sales, R&D, administration
Davenport, Iowa	Owned	—	160,300	Manufacturing, administration
	Leased	March 2020	96,200	Manufacturing, sales, administration
Moscow, Russia	Owned	—	51,500	Components, complete device manufacturing
Webster, MA	Leased	April 2020	43,100	Manufacturing
Cerro Maggiore, Italy	Owned	—	40,400	Complete device manufacturing, administration
Birmingham, Alabama	Owned	—	39,000	Administration, service
Munich, Germany	Owned	—	36,800	Manufacturing, administration
Beijing, China	Owned	—	34,500	

				Administration, service
	Leased	April 2019	28,700	Service
Shenzhen, China	Leased	March 2019	34,100	Administration, service
Minneapolis, MN	Leased	March 2022	32,800	Manufacturing, administration
Shanghai, China	Leased	April 2019	29,700	Administration, service
San Juan del Rio, Mexico	Leased	June 2021	29,100	Manufacturing, administration
Daejeon, South Korea	Owned	—	24,400	Administration, service
Total square feet occupied:			2,303,800	

We maintain our corporate headquarters in Oxford, Massachusetts, and we operate four principal manufacturing facilities for lasers, laser systems, amplifiers and components, which are located in the United States, Germany, Russia and Italy. We are committed to meeting internationally recognized manufacturing standards. Our facilities in the United States and Germany are ISO 9001 certified, and we have ISO certification in Russia for specific products. We conduct our major research and development activities in Oxford and Marlborough, Massachusetts; Burbach, Germany; and Fryazino, Russia, and at several other facilities in the United States. We have sales personnel at each of our manufacturing facilities, and at the countries in which we operate.

We plan to continue our expansion of our operations in Russia, Germany and the United States, and to build manufacturing in Belarus, the United Kingdom, and Italy to meet the demand for our products and our sales and support needs. The additional expansion for the United States, Russia, Germany, Belarus, the United Kingdom, and Italy will provide an approximately additional 371,600 square feet, 13,500 square feet, 236,800 square feet, 136,100 square feet, 56,000 square feet, and 25,000 square feet respectively once these additions are completed and occupied in 2019. With the amount occupied as of December 31, 2018, once all expansions are completed in 2019, we will have over approximately 3.1 million square feet of occupied space to continue to execute on our planned strategies.

ITEM 3. ***LEGAL PROCEEDINGS***

From time to time, we are party to various legal claims and legal proceedings and other disputes incidental to our business, such as employment, intellectual property or product issues. For a discussion of the risks associated with intellectual property legal proceedings and other disputes, see Item 1A. "Risk Factors — We are subject to litigation alleging that we are

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infringing third-party intellectual property rights. Intellectual property claims could result in costly litigation and harm our business."

ITEM 4. ***MINE SAFETY DISCLOSURES***

Not applicable.

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PART II

ITEM 5. ***MARKET FOR THE REGISTRANT'S COMMON EQUITY, RELATED STOCKHOLDER MATTERS AND ISSUER PURCHASES OF EQUITY SECURITIES***

Our common stock is quoted on the Nasdaq Global Select Market under the symbol "IPGP". As of February 24, 2019, there were 52,962,009 shares of our common stock outstanding held by approximately 35 holders of record, which does not include beneficial owners of common stock whose shares are held in the names of various securities brokers, dealers and registered clearing agencies.

Stock Price Performance Graph

The following Stock Price Performance Graph and related information includes comparisons required by the SEC. The graph does not constitute "soliciting material" and should not be deemed "filed" or incorporated by reference into any other filings under the Securities Act of 1933, as amended, or the Securities Exchange Act of 1934, as amended, except to the extent that we specifically incorporate this information by reference into such filing.

The following graph presents the cumulative shareholder returns for our Common Stock compared with the Nasdaq Composite Index and the Russell 3000 Index. We selected these comparative groups due to industry similarities and the fact that they contain several direct competitors.

	5-Year Cumulative Total Return					
	12/31/2013	**12/31/2014**	**12/31/2015**	**12/31/2016**	**12/31/2017**	**12/31/2018**
IPG Photonics Corporation	$ 100.00	$ 96.53	$ 114.88	$ 127.19	$ 275.91	$ 145.97
Nasdaq Composite (U.S. & Foreign)	$ 100.00	$ 113.40	$ 119.89	$ 128.89	$ 165.29	$ 158.87
Russell 3000 Index	$ 100.00	$ 110.45	$ 108.83	$ 120.16	$ 142.81	$ 132.83

The above graph represents and compares the value, through December 31, 2018, of a hypothetical investment of $100 made at the closing price on December 31, 2013 in each of (i) our common stock, (ii) the Nasdaq Composite Stock Index and (iii) the Russell 3000 Index, in each case assuming the reinvestment of dividends. The stock price performance shown in this graph is not necessarily indicative of, and not is intended to suggest, future stock price performance.

Dividends

We anticipate that we will retain future earnings to support operations, fund acquisitions and to finance the growth and development of our business. Therefore, we do not expect to pay cash dividends in the foreseeable future. Our payment of any future dividends will be at the discretion of our Board of Directors after taking into account any business conditions, any

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contractual and legal restrictions on our payment of dividends, and our financial condition, operating results, cash needs, growth plans and other factors. In addition, a current agreement with one lender contains a restrictive covenant that prohibits us from paying cash dividends, making any distribution on any class of stock or making stock repurchases if a breach of a financial covenant or an event of default exists or would result from the dividend, distribution or repurchase.

Recent Sales of Unregistered Securities; Use of Proceeds from Registered Securities

There have been no sales of unregistered securities during the past year.

Issuer Purchases of Equity Securities

The following table shows repurchases of our common stock in the fiscal quarter ended December 31, 2018:

Date	Total Number of Shares (or Units) Purchased		Average Price Paid per Share (or Unit)		Total Number of Shares (or Units) Purchased as Part of Publicly Announced Plans or Programs		Maximum Number (or Approximate Dollar Value) of Shares (or Units) that May Yet Be Purchased Under the Plans or Programs	
October 1, 2018 — October 31, 2018	285,076	(1),(2)	$	137.51	$	—	$	25,005
November 1, 2018 — November 30, 2018	182,114	(1),(2)	137.84		—		—	
December 1, 2018 — December 31, 2018	—	—	—		—		—	
Total	467,190		$	137.64	$	—	$	—

1.In 2012, our Board of Directors approved "withhold to cover" as a tax payment method for vesting of restricted stock awards for certain employees. Pursuant to the "withhold to cover" method, we withheld from such employees the shares noted in the table above to cover tax withholding related to the vesting of their awards. For the fourth quarter of 2018, the Company withheld 28,870 shares at an average price of $234.94.

2.In July 2018, the Board of Directors authorized a share repurchase program (the "2018 Program"). Under the 2018 Program, the Company's management is authorized to repurchase shares of common stock in an amount not to exceed the greater of the number of shares issued to employees and directors under its various employee and director equity compensation and employee stock purchase plans from January 1, 2018 through March 30, 2019 or $125 million, exclusive of any fees, commissions or other expenses. The 2018 Program limits aggregate share repurchases to no more than $125 million over a period ending June 30, 2019. The Company has purchased $125.0 million in shares pursuant to the 2018 Program.

Information Regarding Equity Compensation Plans

The following table sets forth information with respect to securities authorized for issuance under our equity compensation plans as of December 31, 2018:

Equity Compensation Plan Information

Plan Category	Number of Securities to be Issued upon Exercise of Outstanding	Weighted-Average Exercise Price of Outstanding Options, RSUs and PSUs	Number of Securities Remaining Available for Future Issuance under Equity Compensation

	Options, RSUs and PSUs (a)	(b)		Plans (Excluding Securities Reflected in Column (a)) (c)
Equity Compensation Plans Approved by Security Holders	2,207,750	$	105.77	3,680,071
Equity Compensation Plans Not Approved by Security Holders[1]	—			387,498
Total	2,207,750			4,067,569

[1] As of December 31, 2018, there were 387 shares available for issuance under the employee stock purchase plan, including 45,184 shares subject to purchase during the current purchase period. Shares subject to purchase were calculated following plan guidelines using the December 31, 2018 closing stock price. Shares available for issuance including the shares subject to purchase, are subject to approval of the employee stock purchase plan at the 2019 annual meeting of stockholders.

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ITEM 6. ***SELECTED FINANCIAL DATA***

The following selected consolidated financial data should be read in conjunction with, and is qualified by reference to, our consolidated financial statements and related notes and Item 7, "Management's Discussion and Analysis of Financial Condition and Results of Operations" included elsewhere in this Annual Report on Form 10-K. The data as of December 31, 2018 and 2017, and for the years ended December 31, 2018, 2017 and 2016, is derived from our audited consolidated financial statements and related notes included elsewhere in this Annual Report on Form 10-K. The data as of December 31, 2016, 2015 and 2014, and for the years ended December 31, 2015 and 2014, is derived from our audited consolidated financial statements and related notes not included in this Annual Report on Form 10-K. Our historical results are not necessarily indicative of the results for any future period.

	Year Ended December 31,				
	2018	2017	2016	2015	2014
	(In thousands, except per share data)				
Consolidated Statement of Income Data:					
Net sales	$ 1,459,874	$ 1,408,889	$ 1,006,173	$ 901,265	$ 769,832
Cost of sales	659,606	611,978	453,933	409,388	353,314
Gross profit	800,268	796,911	552,240	491,877	416,518
Operating expenses:					
Sales and marketing	57,815	49,801	38,393	31,868	30,637
Research and development	122,769	100,870	78,552	63,334	53,403
General and administrative	102,429	80,668	66,486	57,192	55,338
Loss (gain) on foreign exchange	(6,150)	14,460	4,496	(2,560)	(6,618)
Total operating expenses	276,863	245,799	187,927	149,834	132,760
Operating income	523,405	551,112	364,313	342,043	283,758
Interest income (expense), net	9,057	737	1,304	(301)	(77)
Other income (expense), net	1,933	22	948	(125)	793
Income before provision for income taxes	534,395	551,871	366,565	341,617	284,474
Provision for income taxes	(130,226)	(204,283)	(105,849)	(99,590)	(84,029)
Net income	404,169	347,588	260,716	242,027	200,445
Less: Net (loss) income attributable to noncontrolling interests	142	(26)	(36)	(127)	—
Net income attributable to IPG Photonics Corporation	404,027	347,614	260,752	242,154	200,445
	$ 404,027	$ 347,614	$ 260,752	$ 242,154	$ 200,445

Net income attributable to common shareholders					
Net income per share:					
Basic	$ 7.55	$ 6.50	$ 4.91	$ 4.60	$ 3.85
Diluted	$ 7.38	$ 6.36	$ 4.85	$ 4.53	$ 3.79
Weighted-average shares outstanding:					
Basic	53,522	53,495	53,068	52,676	52,104
Diluted	54,726	54,699	53,797	53,427	52,824
Dividends per common share	$ —	$ —	$ —	$ —	$ —

	As of December 31,				
	2018	**2017**	**2016**	**2015**	**2014**
	(In thousands)				
Consolidated Balance Sheet Data:					
Cash and cash equivalents	$ 544,358	$ 909,900	$ 623,855	$ 582,532	$ 522,150
Short-term investments	500,432	206,257	206,779	106,584	—
Working capital, excluding cash and cash equivalents and short-term investments	514,860	438,950	312,053	271,683	237,546
Total assets	2,574,450	2,367,255	1,789,999	1,453,429	1,210,887
Revolving line-of-credit facilities	—	—	—	—	2,631
Long-term debt, including current portion	45,378	48,982	40,823	19,667	33,000
Noncontrolling interests and redeemable noncontrolling interests	687	—	166	1,137	—
IPG Photonics Corporation equity	2,205,548	2,022,322	1,557,558	1,259,528	1,046,561

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

The following discussion and analysis of our financial condition and results of operations should be read in conjunction with Item 6, "Selected Financial Data" and our consolidated financial statements and related notes included in this Annual Report on Form 10-K. This discussion contains forward-looking statements that involve risks and uncertainties. Our actual results could differ materially from those anticipated in these forward-looking statements as a result of certain factors including, but not limited to, those discussed under Item 1A, "Risk Factors."

Overview

We develop and manufacture a broad line of high-performance fiber lasers, fiber amplifiers and diode lasers that are used in numerous applications, primarily in materials processing. We also manufacture certain complementary products used with our lasers, including optical delivery cables, fiber couplers, beam switches, optical processing heads and chillers. In addition, we offer laser-based systems for certain markets and applications. Following the acquisition of Genesis, we also offer non-laser-based customized robotic systems primarily for welding applications. We sell our products globally to OEMs, system integrators and end users. We market our products internationally primarily through our direct sales force. We are vertically integrated such that we design and manufacture most of our key components used in our finished products, from semiconductor diodes to optical fiber preforms, finished fiber lasers and amplifiers.

Description of Our Net Sales, Costs and Expenses

Net sales. We derive net sales primarily from the sale of fiber lasers and amplifiers. We also sell diode lasers, communications systems, laser systems, customized robotic systems and complementary products. We sell our products through our direct sales organization and our network of distributors and sales representatives, as well as system integrators. We sell our products to OEMs that supply materials processing laser systems, communications systems, medical laser systems and other laser systems for advanced applications to end users. We also sell our products to end users that build their own systems which incorporate our products or use our products as an energy or light source. Our scientists and engineers work closely with OEMs, systems integrators and end users to analyze their system requirements and match appropriate fiber laser, amplifier or system specifications to those requirements. Our sales cycle varies substantially, ranging from a period of a few weeks to as long as one year or more, but is typically several months.

Sales of our products are, in general, recognized upon shipment, provided that no obligations remain and collection of the receivable is reasonably assured. Our sales typically are made on a purchase order basis rather than through long-term purchase commitments. Revenue from sales of customized robotic systems is recognized over time.

We develop our products to standard specifications and use a common set of components within our product architectures. Our major products are based upon a common technology platform. We continually enhance these and other products by improving their components and developing new components and new product designs.

The average selling prices of our products generally decrease as the products mature. These decreases result from factors such as decreased manufacturing costs and increases in unit volumes, increased competition, the introduction of new products and market share considerations. In the past, we have lowered our selling prices in order to penetrate new markets and applications or to meet competition. Furthermore, we may negotiate discounted selling prices from time to time with certain customers that purchase multiple units or large volumes.

Cost of sales. Our cost of sales consists primarily of the cost of raw materials and components, direct labor expenses and manufacturing overhead. We are vertically integrated and currently manufacture all critical components for our products as well as assemble finished products. We believe our vertical integration allows us to increase efficiencies, leverage our scale and lower our cost of sales. Cost of sales also includes personnel costs and overhead related to our manufacturing, engineering and service operations, related occupancy and equipment costs, shipping costs and reserves for inventory obsolescence and for warranty obligations. Inventories are written off and charged to cost of sales when identified as excess or obsolete.

Due to our vertical integration strategy and ongoing investment in plant and machinery, we maintain a relatively high fixed manufacturing overhead. We may not be able to or choose not to adjust these fixed costs to adapt to rapidly changing market conditions. Our gross margin is therefore significantly affected by our sales volume and the corresponding utilization of capacity and absorption of fixed manufacturing overhead expenses.

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Sales and marketing. Our sales and marketing expense consists primarily of costs related to compensation, trade shows, professional and technical conferences, travel, facilities, depreciation of equipment used for demonstration purposes and other marketing costs.

Research and development. Our research and development expense consists primarily of compensation, development expenses related to the design of our products and certain components, the cost of materials and components to build prototype devices for testing and facilities costs. Costs related to product development are recorded as research and development expenses in the period in which they are incurred.

General and administrative. Our general and administrative expense consists primarily of compensation and associated costs for executive management, finance, legal, human resources, information technology and other administrative personnel, outside legal and professional fees, insurance premiums and fees, allocated facilities costs and other corporate expenses such as charges and benefits related to the change in allowance for doubtful debt.

Factors and Trends That Affect Our Operations and Financial Results

In reading our financial statements, you should be aware of the following factors and trends that our management believes are important in understanding our financial performance.

Net sales. Our net sales grew from $901.3 million in 2015 to $1,459.9 million in 2018, representing a three year compound annual growth rate of approximately 17%. Net sales growth was driven by (i) increasing demand for our products, fueled by their superior performance and decreasing average cost per watt of output power which has resulted in a substantial improvement in their competitiveness and increased market share compared not only to other laser technologies including CO_2 and YAG lasers but also to compared to non-laser machine tools and processes such as punches, presses, dies and traditional welding technologies, (ii) increased sales of fiber lasers for cutting and welding applications and the development of OEM customers in these applications, (iii) the introduction of new products, including our high power lasers with higher output power levels, quasi-continuous wave ("QCW") lasers, laser systems, high power pulsed lasers and optical heads and other accessories and (iv) the development of new applications for our products some of which displace non-laser technologies. Our annual revenue growth rates have varied. Net sales increased by 4%, 40% and 12% in 2018, 2017 and 2016, respectively.

Our business depends substantially upon capital expenditures by our customers, particularly by manufacturers using our products for materials processing, which includes general manufacturing, automotive, other transportation, aerospace, heavy industry, consumer, semiconductor and electronics. Approximately 94% of our revenues in 2018 were from customers using our products for materials processing. Although applications within materials processing are broad, the capital equipment market in general is cyclical and historically has experienced sudden and severe downturns. For the foreseeable future, our operations will continue to depend upon capital expenditures by customers for materials processing and will be subject to the broader fluctuations of capital equipment spending.

Our net sales have historically fluctuated from quarter to quarter. The increase or decrease in sales from a prior quarter can be affected by the timing of orders received from customers, the shipment, installation and acceptance of products at our customers' facilities, the mix of OEM orders and one-time orders for products with large purchase prices, competitive pressures, acquisitions, economic and political conditions in a certain country or region and seasonal factors such as the purchasing patterns and levels of activity throughout the year in the regions where we operate. Historically, our net sales have been higher in the second half of the year than in the first half of the year, although that trend did not occur in 2018 due to a decrease in capital equipment spending in Europe and China caused by slower macro-economic growth and uncertainty caused by the trade war between the United States and China. Net sales can be affected by the time taken to qualify our products for use in new applications in the end markets that we serve. The adoption of our products by a new customer or qualification in a new application can lead to an increase in net sales for a period, which may then slow until we penetrate new markets or obtain new customers. Sales in the telecom business may tend to be driven by large projects and technology upgrades, which can be uneven and result in material increases or decreases over prior periods. The revenues from such projects and upgrades also are subject to risks greater than our core materials processing business

Gross margin. Our total gross margin in any period can be significantly affected by total net sales in any period, by product mix, by sales mix between OEM customers who purchase devices from us in high unit volumes and other customers, by mix of sales in different geographies, by competitive factors and by other factors such as changes in foreign exchange rates relative to the U.S. Dollar, some of which are not under our control.

Our gross margin can be significantly affected by product mix. Within each of our product categories, the gross margin is generally higher for devices with greater average power. These higher power products often have better performance, more difficult specifications to attain and fewer competing products in the marketplace. Higher power lasers also use a greater number of optical components, improving absorption of fixed overhead costs and enabling economies of scale in manufacturing. The gross margin for certain specialty products may be higher because there are fewer or sometimes no

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equivalent competing products. Customers that purchase devices in greater unit volumes generally receive lower prices per device than customers that purchase fewer units. These lower selling prices to high unit volume customers may be partially offset by the improved absorption of fixed overhead costs associated with larger product volumes, which drive economies of scale in manufacturing. Finally, gross margin on systems and communication components can be lower than margins for our laser and amplifier sources, depending on the configuration, volume and competitive forces, among other factors.

We believe our strategy to maintain and extend our leadership position will result in industry-leading revenue growth and profitability. Although our fiber laser technology has a leading market position within select materials processing applications, our share within many other laser applications is significantly smaller and non-existent in many other applications. We estimate fiber lasers comprise less than 35% of total laser source sales and that laser-based machine tools comprise less than 25% of all machine tools used for cutting and welding of metals. Given the potential for our fiber laser technology to gain deeper penetration within the broader markets we serve and plan to target, we continue to introduce and acquire new technologies, products and systems to expand our market presence. We expect that some new technologies, products and systems will have returns above our cost of capital but may have gross margins below our corporate average. If we are able to develop opportunities that are significant in size, competitively advantageous or leverage our existing technology base and leadership, our current gross margin levels may not be maintained. Instead, we aim to deliver industry-leading levels of gross and operating margins by growing our market position across the broader markets we serve.

The mix of sales between OEM customers and other customers can affect gross margin because we provide sales price discounts on products based on the number of units ordered. As the number of OEM customers increase and the number of units ordered increases, the average sales price per unit will be reduced. We expect that the impact of reduced sales price per unit will be offset by the manufacturing efficiency provided by high unit volume orders, but the timing and extent of achieving these efficiencies may not always match the mix of sales in any given time period or be realized at all.

We invested $160.3 million, $126.5 million and $127.0 million in capital expenditures in 2018, 2017 and 2016, respectively. Most of this investment relates to expansion of our manufacturing capacity and, to a lesser extent, research and development and sales-related facilities.

A high proportion of our costs is fixed so costs are generally difficult to adjust or may take time to adjust in response to changes in demand. In addition, our fixed costs increase as we expand our capacity. If we expand capacity faster than is required by sales growth, gross margins could be negatively affected. Gross margins generally decline if production volumes are lower as a result of a decrease in sales or a reduction in inventory because the absorption of fixed manufacturing costs will be reduced. Gross margins generally improve when the opposite occurs. If both sales and inventory decrease in the same period, the decline in gross margin may be greater if we cannot reduce fixed costs or choose not to reduce fixed costs to match the decrease in the level of production. If we experience a decline in sales that reduces absorption of our fixed costs, or if we have production issues, our gross margins will be negatively affected.

We also regularly review our inventory for items that are slow-moving, have been rendered obsolete or are determined to be excess. Any provision for such slow-moving, obsolete or excess inventory affects our gross margins. For example, we recorded provisions for slow-moving, obsolete or excess inventory totaling $13.0 million, $16.9 million and $22.8 million in 2018, 2017 and 2016, respectively.

Sales and marketing expense. We expect to continue to expand our worldwide direct sales organization, build and expand applications centers, hire additional sales and marketing personnel at our existing and new geographic locations as well as to support sales of new product lines, increase the number of units for demonstration purposes and otherwise increase expenditures on sales and marketing activities in order to support the growth in our net sales. As such, we expect that our sales and marketing expenses will increase in the aggregate.

Research and development expense. We plan to continue to invest in research and development to improve our existing components and products and develop new components, products, systems and applications technology. The amount of research and development expense we incur may vary from period to period. In general, if net sales continue to increase we expect research and development expense to increase in the aggregate.

General and administrative expense. We expect our general and administrative expenses to increase as we continue to invest in systems and resources in management, finance, legal, information technology, human resources and administration to support our worldwide operations and our acquisition strategy. Legal expenses vary from quarter to quarter based primarily upon the level of transaction activities and litigation.

Major customers. While we have historically depended on a few customers for a large percentage of our annual net sales, the composition of this group can change from year to year. Net sales derived from our five largest customers as a percentage of our annual net sales were 26%, 28% and 22% in 2018, 2017 and 2016, respectively. Our largest customer accounted for 12%,

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13% and 9% of our net sales in 2018, 2017 and 2016, respectively. We seek to add new customers and to expand our relationships with existing customers. We anticipate that the composition of our significant customers will continue to change. We generally do not enter into agreements with our customers obligating them to purchase a fixed number or large volume of our fiber lasers or amplifiers. If any of our significant customers were to substantially reduce their purchases from us, our results would be adversely affected.

Critical Accounting Policies and Estimates

The preparation of financial statements in conformity with accounting principles generally accepted in the United States ("GAAP") requires management to make estimates and assumptions that affect the reported amounts of assets and liabilities and disclosure of contingent assets and liabilities at the date of the financial statements and the reported amounts of net sales and expenses. By their nature, these estimates and judgments are subject to an inherent degree of uncertainty. We base our estimates and judgments on our historical experience and on other assumptions that we believe are reasonable under the circumstances, the results of which form the basis for making the judgments about the carrying values of assets and liabilities that are not readily apparent from other sources. Actual results could differ from those estimates, which may materially affect our operating results and financial position. We have identified the following items that require the most significant judgment and often involve complex estimation: revenue recognition, inventory valuation, warranty, and accounting for income taxes.

Revenue Recognition — Revenue is recognized when transfer of control to the customer occurs in an amount reflecting the consideration that we expect to be entitled. In order to achieve this core principle, we apply the following five step approach: (1) identify the contract with a 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, and (5) recognize revenue when a performance obligation is satisfied.

We allocate the transaction price to each distinct product based on its relative standalone selling price, as more fully described in Note 1, "Nature of Business and Summary of Significant Accounting Policies - Revenue Recognition," in our consolidated financial statements. Revenue is generally recognized when control of the product is transferred to the customer (i.e., when our performance obligation is satisfied), which typically occurs at shipment but which can occur over time for certain of our systems contracts. When goods or services have been delivered to the customer, but all conditions for revenue recognition have not been met, deferred revenue and deferred costs are recorded on our consolidated balance sheet. With the acquisition of Genesis in December 2018, we enter into contracts to sell customized robotic systems, for which revenue is generally recognized over time, depending on the terms of the contract. Recognizing revenue over time for these contracts is based on our judgment that the customized robotic system does not have an alternative use and we have an enforceable right to payment for performance completed to date. Recognizing revenue over time also estimation of the progress towards completion based on the projected costs for the contract.

Inventory — Inventory is stated at the lower of cost (first-in, first-out method) or market value. Inventory includes parts and components that may be specialized in nature and subject to rapid obsolescence. We maintain a reserve for excess or obsolete inventory items. The reserve is based upon a review of inventory materials on hand, which we compare with historic usage, estimated future usage and age. In addition, we review the inventory and compare recorded costs with estimates of current market value. Write-downs are recorded to reduce the carrying value to the net realizable value with respect to any part with costs in excess of current market value. Estimating demand and current market values is inherently difficult, particularly given that we make highly specialized components and products. We determine the valuation of excess and obsolete inventory by making our best estimate considering the current quantities of inventory on hand and our forecast of the need for this inventory to support future sales of our products. We often have limited information on which to base our forecasts. If future sales differ from these forecasts, the valuation of excess and obsolete inventory may change and additional inventory provisions may be required. Because of our vertical integration, a significant or sudden decrease in sales could result in a significant change in the estimates of excess or obsolete inventory valuation.

Warranty — We maintain an accrual for warranty claims for units sold that are subject to warranty. We estimate this accrual considering past claims experience, the number of units still carrying warranty coverage and the average life of the remaining warranty period. A change in the rate of warranty repairs or when warranty is generally incurred during the warranty period could change our estimated warranty accrual and associated warranty expense.

Income Taxes and Deferred Taxes — Our annual tax rate is based on our income, statutory tax rates and tax planning opportunities available to us in the various jurisdictions in which we operate. We file federal and state income tax returns in the United States and tax returns in numerous international jurisdictions. We must estimate our income tax expense after considering, among other factors, if inter-company transactions have been made on an arm's length basis, differing tax rates between jurisdictions, allocation factors, tax credits, nondeductible items and changes in enacted tax rates. Significant judgment is required in determining our annual tax expense and in evaluating our tax positions. As we continue to expand globally, there

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is a risk that, due to complexity within and diversity among the various jurisdictions in which we do business, a governmental agency may disagree with the manner in which we have computed our taxes. Additionally, due to the lack of uniformity among all of the foreign and domestic taxing authorities, there may be situations where the tax treatment of an item in one jurisdiction is different from the tax treatment in another jurisdiction or that the transaction causes a tax liability to arise in another jurisdiction.

We provide reserves for potential payments of tax to various tax authorities related to uncertain tax positions and other issues. Reserves recorded are based on a determination of whether and how much of a tax benefit taken by us in our tax filings or positions is "more likely than not" to be realized following resolution of any potential contingencies present related to the tax benefit, assuming that the matter in question will be raised by the tax authorities. Potential interest and penalties associated with such uncertain tax positions is recorded as a component of income tax expense. At December 31, 2018, we had unrecognized tax benefits of approximately $11.2 million that, if recognized, would be recorded as a reduction in income tax expense.

Results of Operations

The following table sets forth selected statement of operations data for the periods indicated in dollar amounts and expressed as a percentage of net sales:

	Year Ended December 31,					
	2018		**2017**		**2016**	
	(In thousands, except percentages and per share data)					
Net sales	$ 1,459,874	100.0	$ 1,408,889	100.0	$ 1,006,173	100.0
Cost of sales	659,606	45.2	611,978	43.4	453,933	45.1
Gross profit	800,268	54.8	796,911	56.6	552,240	54.9
Operating expenses:						
Sales and marketing	57,815	4.0	49,801	3.5	38,393	3.8
Research and development	122,769	8.4	100,870	7.2	78,552	7.8
General and administrative	102,429	7.0	80,668	5.7	66,486	6.6
Loss (gain) on foreign exchange	(6,150)	(0.4)	14,460	1.0	4,496	0.4
Total operating expenses	276,863	19.0	245,799	17.4	187,927	18.7
Operating income	523,405	35.9	551,112	39.1	364,313	36.2
Interest income (expense), net	9,057	0.6	737	0.1	1,304	0.1
Other income (expense), net	1,933	0.1	22	—	948	0.1
Income before provision for income taxes	534,395	36.6	551,871	39.2	366,565	36.4
Provision for	(130,226)	(8.9)	(204,283)	(14.5)	(105,849)	(10.5)

income taxes						
Net income	404,169	27.7	347,588	24.7	260,716	25.9
Less: Net loss attributable to noncontrolling interest	142	—	(26)	—	(36)	—
Net income attributable to IPG Photonics Corporation	$ 404,027	27.7	$ 347,614	24.7	$ 260,752	25.9
Net income attributable to IPG Photonics Corporation per share:						
Basic	$ 7.55		$ 6.50		$ 4.91	
Diluted	$ 7.38		$ 6.36		$ 4.85	
Weighted-average shares outstanding:						
Basic	53,522		53,495		53,068	
Diluted	54,726		54,699		53,797	

Comparison of Year Ended December 31, 2018 to Year Ended December 31, 2017

Net sales. Net sales increased by $51.0 million, or 3.6%, to $1,459.9 million in 2018 from $1,408.9 million in 2017. The table below sets forth sales by application (in thousands, except for percentages):

Sales by application	**Year Ended December 31,**					
	2018		**2017**		**Change**	
		% of Total				