

UNITED STATES SECURITIES AND EXCHANGE COMMISSION
Washington, DC 20549
Form 10-K

(Mark One)

☒ 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

☐ 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

(State or other jurisdiction of
incorporation or organization)

50 Old Webster Road, Oxford, Massachusetts

(Address of principal executive offices)

04-3444218

(IRS Employer
Identification No.)

01540

(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 ☒ No ☐

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 ☐ No ☒

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

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

Indicate by check mark if disclosure of delinquent filers pursuant to Item 405 of Regulation S-K is not contained herein, and will not be contained, to the best of registrant's knowledge, in definitive proxy or information statements incorporated by reference in Part III of this Form 10-K or any amendment to this Form 10-K. ☐

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				Smaller reporting company
☒	Accelerated filer ☐	Non-accelerated filer ☐	Emerging growth company ☐	☐

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. ☐

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

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.

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 ("CO₂") 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 CO₂ laser produces light by electrically stimulating a gas-filled tube and delivers the beam through free space using mirrors to provide direction. A

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 CO₂ 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.

- *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, CO₂ 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:

Materials Processing	
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
Advanced Applications	• Obstacle warning and light detecting and ranging • Special projects and research • Directed energy demonstrations • Laser cinema projection
Communications	• 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
Medical	• 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

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

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

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).

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

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.

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.

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			
Materials processing	\$	1,374,448	94.1 %	\$	1,332,607	94.6 %
Other applications		85,426	5.9		76,282	5.4
Total	\$	1,459,874	100.0 %	\$	1,408,889	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.

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.

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.

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 CO₂, 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

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.

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 CO₂, 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,

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

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.

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

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;

- incurr ing expenses to develop and improve application and support capabilities, the benefits of which may not be realized until future periods, if at all;
- incurr ing 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 a ssociated 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.

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.

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

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

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

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

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.

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 as 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

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.

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

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.

PART II

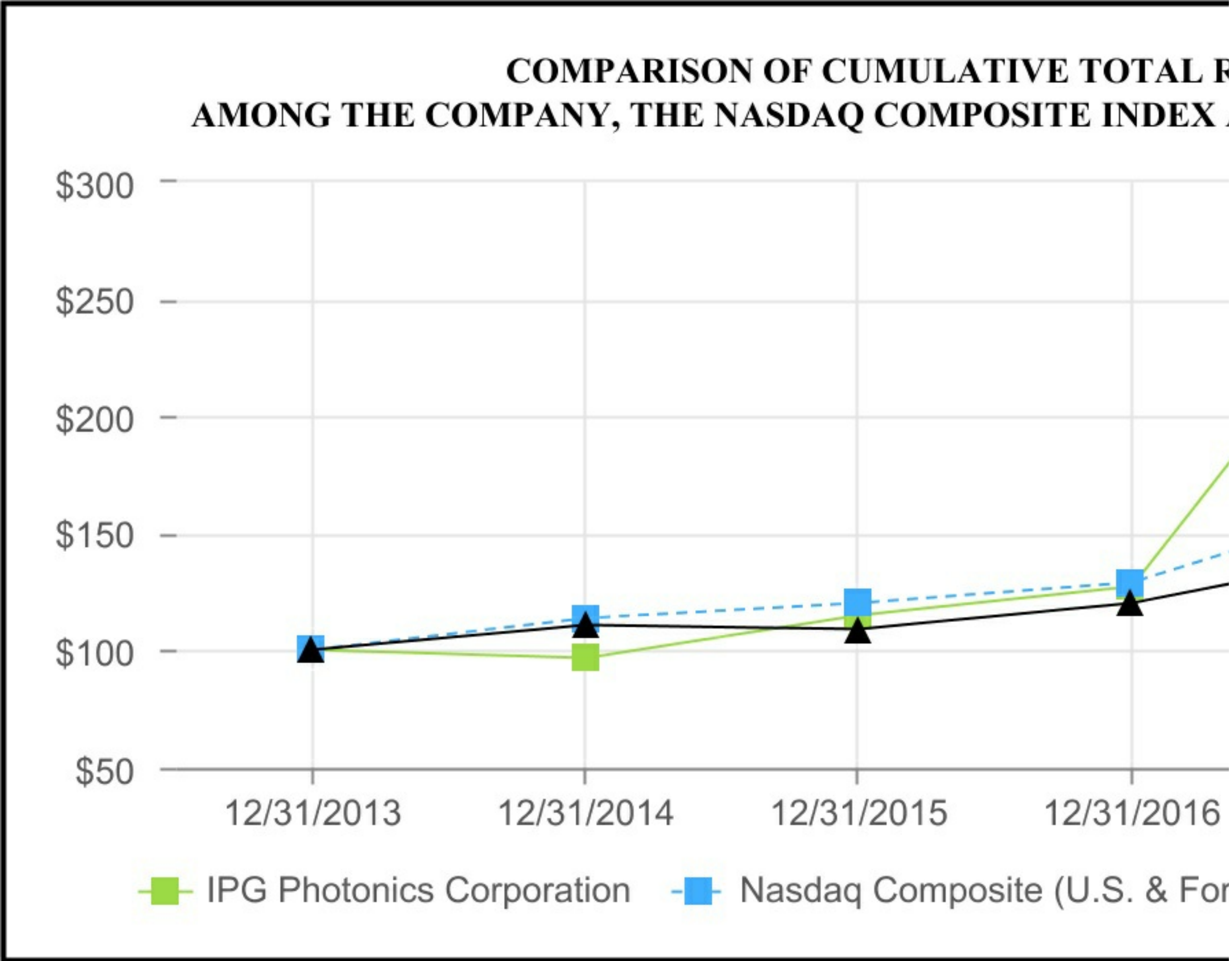
ITEM 5. MARKET FOR THE REGISTRANT'S COMMON EQUITY, RELATED STOCKHOLDER MATTERS AND ISSUER PURCHASES OF EQUITY SECURITIES

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

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 Options, RSUs and PSUs (a)	Weighted-Average Exercise Price of Outstanding Options, RSUs and PSUs (b)	Number of Securities Remaining Available for Future Issuance under Equity Compensation Plans (Excluding Securities Reflected in Column (a)) (c)
Equity Compensation Plans Approved by Security Holders	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.

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
Net income attributable to common shareholders	\$ 404,027	\$ 347,614	\$ 260,752	\$ 242,154	\$ 200,445
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

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.

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 CO₂ 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

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%,

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

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 %
Cost of sales		659,606	45.2		611,978	43.4
Gross profit		800,268	54.8		796,911	56.6
Operating expenses:						
Sales and marketing		57,815	4.0		49,801	3.5
Research and development		122,769	8.4		100,870	7.2
General and administrative		102,429	7.0		80,668	5.7
Loss (gain) on foreign exchange		(6,150)	(0.4)		14,460	1.0
Total operating expenses		276,863	19.0		245,799	17.4
Operating income		523,405	35.9		551,112	39.1
Interest income (expense), net		9,057	0.6		737	0.1
Other income (expense), net		1,933	0.1		22	—
Income before provision for income taxes		534,395	36.6		551,871	39.2
Provision for income taxes		(130,226)	(8.9)		(204,283)	(14.5)
Net income		404,169	27.7		347,588	24.7
Less: Net loss attributable to noncontrolling interest		142	—		(26)	—
Net income attributable to IPG Photonics Corporation	\$	404,027	27.7 %	\$	347,614	24.7 %
Net income attributable to IPG Photonics Corporation per share:						
Basic	\$	7.55		\$	6.50	\$
Diluted	\$	7.38		\$	6.36	\$
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		% of Total			
Materials Processing	\$	1,374,448	94.1 %	\$	1,332,607	94.6 %
Other Applications		85,426	5.9 %		76,282	5.4 %
Total	\$	1,459,874	100.0 %	\$	1,408,889	100.0 %
					\$	50,985
						3.6 %

The table below sets forth sales by type of product and other revenue (in thousands, except for percentages):

Sales by product

Sales by product	Year Ended December 31,								
	2018			2017		Change			
	% of Total		% of Total						
High Power Continuous Wave ("CW") Lasers	\$	909,726	62.3 %	\$	867,464	61.6 %	\$	42,262	4.9 %
Medium and Low Power CW Lasers		95,764	6.6 %		118,705	8.4 %		(22,941)	(19.3)%
Pulsed Lasers		162,048	11.1 %		148,701	10.6 %		13,347	9.0 %
Quasi-Continuous Wave ("QCW") Lasers		66,700	4.6 %		88,329	6.3 %		(21,629)	(24.5)%
Laser Systems		59,330	4.1 %		40,410	2.9 %		18,920	46.8 %
Other Revenue including Amplifiers, Service, Parts, Accessories and Change in Deferred Revenue		166,306	11.3 %		145,280	10.2 %		21,026	14.5 %
Total	\$	1,459,874	100.0 %	\$	1,408,889	100.0 %	\$	50,985	3.6 %

Sales for materials processing applications increased due to higher sales of high power and pulsed lasers and laser systems, partially offset by a decrease in sales of medium and low power lasers and QCW lasers.

- H igh power laser sales increased primarily due to growth in sales for cutting applications offset by declines in sales in welding applications. Within cutting applications, we continue to see a migration to lasers with higher output powers which improve processing speeds and enable processing of thicker materials. The shift towards lasers with higher output powers has also benefited sales due to their higher average selling prices.
- M edium and low power sales decreased due to lower sales for cutting and laser sintering applications partially offset by higher sales for welding applications. The decline in sales for cutting applications is largely due to the use of high power lasers instead of medium power lasers for these applications as the low cost cutting systems market has gravitated to higher power lasers as their selling price per watt has decreased.
- Pulsed laser sales increased due to growth in sales of high power pulsed lasers used for cutting, marking and engraving and cleaning applications partially offset by decreases in pulsed lasers used for ablation.
- QCW laser sales decreased due to lower sales for welding applications. Welding applications for QCW lasers are largely related to consumer electronics manufacturing and the investment cycle for this application was weaker in 2018 and 2017.
- Laser systems sales increased due to increase s in sales for cutting systems, as well as incremental sales from the acquisition of ILT in July 2017 and the acquisition of Genesis in December 2018.

Sales for other applications increased due to higher sales of high power lasers and high power amplifiers used for advanced applications as well as increased sales of telecommunication components, including pluggable transceivers used in data transmission.

Our net sales (in thousands) were derived from customers in the following geographic regions:

	Year Ended December 31,						
	2018			2017		Change	
	% of Total			% of Total			
North America ⁽¹⁾	\$	202,743	13.9 %	\$	165,363	11.8 %	\$ 37,380 22.6 %
Europe:							
Germany		111,259	7.6 %		114,608	8.1 %	(3,349) (2.9)%
Other including Eastern Europe/CIS		296,917	20.3 %		290,067	20.6 %	6,850 2.4 %
Asia and Australia:							
China		629,079	43.1 %		621,283	44.1 %	7,796 1.3 %
Japan		87,619	6.0 %		80,612	5.7 %	7,007 8.7 %
Other		127,251	8.7 %		131,511	9.3 %	(4,260) (3.2)%
Rest of World		5,006	.4 %		5,445	.4 %	(439) (8.1)%
Total	\$	1,459,874	100.0 %	\$	1,408,889	100.0 %	\$ 50,985 3.6 %

1. The substantial majority of sales in North America are to customers in the United States.

Cost of sales and gross margin. Cost of sales increased by \$47.6 million, or 7.8%, to \$659.6 million in 2018 from \$612.0 million in 2017. Our gross margin decreased to 54.8% in 2018 from 56.6% in 2017. Gross margin decreased due to lower absorption of manufacturing costs, decreases in average selling prices and changes in product sales mix. The impact to gross margin primarily occurred in the second half of the year in conjunction with the slowdown in sales and increased competition for certain products in China. Expenses related to provisions for excess or obsolete inventory and other valuation adjustments decreased by \$3.9 million to \$13.0 million, or 0.9% of sales, for the year ended December 31, 2018, as compared to \$16.9 million, or 1.2% of sales, for the year ended December 31, 2017.

Sales and marketing expense. Sales and marketing expense increased by \$8.0 million, or 16.1%, to \$57.8 million in 2018 from \$49.8 million in 2017, primarily as a result of an increase in personnel, depreciation, trade show and exhibitions, and travel expense. As a percentage of sales, sales and marketing expense increased to 4.0% in 2018 from 3.5% in 2017. As we continue to expand our worldwide sales organization, we expect sales and marketing expenses to increase in the aggregate.

Research and development expense. Research and development expense increased by \$21.9 million, or 21.7%, to \$122.8 million in 2018 from \$100.9 million in 2017, primarily as a result of an increase in personnel, materials, contractors, consultants, depreciation and other research and development expense. Research and development continues to focus on developing new products, enhancing performance of existing components, improving production processes and developing manufacturing of new components such as crystals and refining production processes to improve manufacturing yields and productivity. New products include lasers that operate at different wavelengths such as UV, visible and mid-IR, lasers with ultrafast pulses, laser based systems for material processing, projection, display and medical as well as accessories such as welding and cutting heads and components such as ASICs used in pluggable transceivers in the telecom industry. In addition to new products research and development is focused on enhancing the performance of our existing products by improving their electrical efficiency and increasing their average power. As a percentage of sales, research and development expense increased to 8.4% in 2018 from 7.2% in 2017. We expect to continue to invest in research and development and that research and development expense will increase in the aggregate.

General and administrative expense. General and administrative expense increased by \$21.7 million, or 26.9%, to \$102.4 million in 2018 from \$80.7 million in 2017, primarily as a result of increased expenses for personnel, stock-based compensation, professional services expenses related to acquisitions, accounting legal and information technology expenses, and depreciation expense. As a percentage of sales, general and administrative expense increased to 7.0% in 2018 from 5.7% in 2017. We expect general and administrative expenses to increase as we invest to support the expected growth in net sales.

Effect of exchange rates on sales, gross margin and operating expenses. We estimate that if exchange rates had been the same as one year ago, sales in 2018 would have been \$35.8 million lower, gross margin would have been \$23.3 million lower and operating expenses in total would have been \$1.3 million higher. These estimates assume constant exchange rates between fiscal year 2018 and fiscal year 2017 and are calculated using the average exchange rates for the twelve-month period ended December 31, 2017 for the respective currencies, which were US\$1=Euro 0.89, US\$1=Japanese Yen 112, US\$1=Chinese Yuan 6.76 and US\$1=Russian Ruble 58.

Loss (gain) on foreign exchange. We incurred a foreign exchange gain of \$6.2 million in 2018 as compared to a loss of \$14.5 million in 2017. The change was primarily attributable to the depreciation of the Euro as compared to the U.S. Dollar, which was partially offset by depreciation of the Chinese Yuan as compared to the U.S. Dollar.

Interest income (expense), net. Interest income (expense), net increased to \$9.1 million of income in 2018 compared to \$0.7 million of income in 2017. The increase of interest income was the result of the repatriation of \$522 million of cash during the year from Germany to the United States and improved rate of return on U.S. Dollar denominated investments as compared to Euro denominated investments.

Other income (expense), net. Other income (expense), net increased to approximately \$2 million in 2018 while in 2017 it was an insignificant amount.

Provision for income taxes . Provision for income taxes was \$130.2 million in 2018 compared to \$204.3 million in 2017, representing an effective tax rate of 24.4% in 2018 and 37.0% in 2017. The decreased effective tax rate was primarily due to changes in the statutory tax rate in the United States from 35% to 21% resulting from the Tax Cuts and Jobs Act (the "Tax Act"). Discrete adjustments in 2018 include (i) a decrease to tax expense of \$13.3 million related to equity based compensation deductions for tax in excess of the deductions reflected in book income; (ii) an increase to tax expense of \$6.6 million related to U.S. tax on profits earned in 2017 calculated at the prior year federal rate of 35% flowing through consolidated income in 2018; and, (iii) an increase in the valuation allowance of \$7.4 million primarily for state credits. Discrete adjustments in 2017 include (i) a decrease to tax expense of \$14.0 million related to equity based compensation deductions for tax in excess of the deductions reflected in book income and (ii) an increase to tax expense of \$48.1 million for a U.S. tax on cumulative foreign earnings as a result of the Tax Act.

On December 22, 2017, the U.S. government enacted the Tax Act. The Tax Act makes broad and complex changes to the U.S. tax code including, but not limited to: (i) reducing the U.S. federal corporate tax rate from 35% to 21%; (ii) requiring companies to pay a one-time transition tax on certain un-repatriated earnings of foreign subsidiaries; (iii) generally eliminating U.S. federal income taxes on dividends from foreign subsidiaries; (iv) providing an incentive benefit for U.S. income from intangibles (Foreign Derived Intangible Income); (v) increasing U.S. taxable income to include all income earned by foreign subsidiaries in excess of ten percent of the fixed assets in those entities (Global Intangible Low-taxed Income) and (vi) providing for bonus depreciation that will allow for full expensing of qualified property.

Our final calculation of the Deemed Repatriation Transition Tax ("Transition Tax") element of the Tax Act is a \$43.4 million increase to the tax expense. At December 31, 2017, we calculated a provisional amount of tax for this at \$48.1 million and have included a benefit of \$4.7 million in 2018 income tax expense to reflect the impact of the decrease in liability. The federal Transition Tax is payable over eight years and \$30.3 million of the liability is included in other long-term liabilities at December 31, 2018.

Net income. Net income attributable to IPG Photonics Corporation increased by \$56.4 million to \$404.0 million in 2018 from \$347.6 million in 2017. Net income attributable to IPG Photonics Corporation as a percentage of our net sales increased by 3.0% to 27.7% in 2018 from 24.7% in 2017 due to the factors described above.

Comparison of Year Ended December 31, 2017 to Year Ended December 31, 2016

Net sales. Net sales increased by \$402.7 million, or 40.0%, to \$1,408.9 million in 2017 from \$1,006.2 million in 2016. The table below sets forth sales by application (in thousands, except for percentages):

<u>Sales by application</u>	Year Ended December 31,					
	2017		2016		Change	
	% of Total		% of Total			
Materials Processing	\$ 1,332,607	94.6 %	\$ 942,119	93.6 %	\$ 390,488	41.4 %
Other Applications	76,282	5.4 %	64,054	6.4 %	12,228	19.1 %
Total	\$ 1,408,889	100.0 %	\$ 1,006,173	100.0 %	\$ 402,716	40.0 %

The table below sets forth sales by type of product and other revenue (in thousands, except for percentages):

	Year Ended December 31,								
Sales by product	2017		2016		Change				
		% of Total		% of Total					
High Power Continuous Wave ("CW") Lasers	\$	867,464	61.6 %	\$	578,668	57.5 %	\$	288,796	49.9 %
Medium and Low Power CW Lasers		118,705	8.4 %		111,643	11.1 %		7,062	6.3 %
Pulsed Lasers		148,701	10.6 %		128,971	12.8 %		19,730	15.3 %
Quasi-Continuous Wave ("QCW") Lasers		88,329	6.3 %		48,612	4.8 %		39,717	81.7 %
Laser Systems		40,410	2.9 %		22,943	2.3 %		17,467	76.1 %
Other Revenue including Amplifiers, Service, Parts, Accessories and Change in Deferred Revenue		145,280	10.2 %		115,336	11.5 %		29,944	26.0 %
Total	\$	1,408,889	100.0 %	\$	1,006,173	100.0 %	\$	402,716	40.0 %

Sales for materials processing applications increased due to higher sales of high power lasers, medium power lasers, pulsed lasers, QCW lasers and laser systems.

- The increase in high power laser sales related to growth in cutting and welding. High power lasers continue to displace CO2 lasers. We believe our revenue growth has benefited from an accelerated replacement cycle for older CO2 based cutting systems and also from displacement of non-laser technologies, which has resulted in higher demand for the fiber based cutting and welding systems sold by our OEM customers. Within cutting applications, we continue to see a migration to lasers with higher output powers which improve processing speeds and enable processing of thicker materials. The shift towards lasers with higher output powers has also benefited sales due to their higher average selling prices.
- Medium and low power sales increased due to growth in laser sintering and fine welding applications, which was partially offset by decreases in sales for fine cutting applications because fine cutting systems using medium power lasers migrated to using high power 1 to 2 kilowatt lasers. Average selling prices for medium power lasers also declined.
- Pulsed laser sales increased due to growth in marking and engraving, cleaning and stripping, solar cell manufacturing and cutting applications. Within the pulsed laser category, the rate of sales increases was larger for high power pulsed lasers than for pulsed lasers with lower average power.
- The increase in laser systems sales was mainly driven by the July 2017 acquisition of ILT.
- QCW laser sales increased due to the demand for welding and drilling applications. Welding applications for QCW lasers are primarily related to consumer electronics.
- Materials processing sales also increased as a result of parts and service sales, which are included in Other Revenue in the Sales by Product chart above.

Sales for other applications increased due to higher sales for telecom and advanced applications. Telecom sales benefited from an increase in sales of pluggable transceivers used in data transmission and an increase in amplifier sales used for last mile fiber access to the home applications. For 2017, the rate of growth of telecom sales benefited from the contribution of sales by Menara, which we acquired in May 2016. Sales of telecom products are included in Other Revenue in the Sales by Product chart above. Advanced application sales are typically uneven from quarter to quarter. The increase in advanced applications sales was driven by increase in demand from defense, semiconductor and scientific applications across various product lines.

Our net sales (in thousands) were derived from customers in the following geographic regions:

	Year Ended December 31,							
	2017			2016		Change		
	% of Total			% of Total				
North America ⁽¹⁾	\$	165,363	11.8 %	\$	141,184	14.0 %	\$ 24,179	17.1 %
Europe:								
Germany		114,608	8.1 %		90,893	9.1 %	23,715	26.1 %
Other including Eastern Europe/CIS		290,067	20.6 %		224,836	22.3 %	65,231	29.0 %
Asia and Australia:								
China		621,283	44.1 %		358,476	35.7 %	262,807	73.3 %
Japan		80,612	5.7 %		88,592	8.8 %	(7,980)	(9.0)%
Other		131,511	9.3 %		100,052	9.9 %	31,459	31.4 %
Rest of World		5,445	.4 %		2,140	0.2 %	3,305	154.4 %
Total	\$	1,408,889	100.0 %	\$	1,006,173	100.0 %	\$ 402,716	40.0 %

1. The substantial majority of sales in North America are to customers in the United States.

Sales for China increased year over year driven by high power CW lasers for cutting and welding (including electric vehicle battery welding) and QCW lasers for consumer electronics. China cutting sales were also driven by strong growth in the ultra high power market at 6 kilowatts or greater power and the lower cost cutting market for power levels at 1 to 3 kilowatts.

Cost of sales and gross margin. Cost of sales increased by \$158.0 million, or 34.8%, to \$612.0 million in 2017 from \$453.9 million in 2016. Our gross margin increased to 56.6% in 2017 from 54.9% in 2016. Gross margin increased due to a decrease in the cost of internally manufactured components, increased manufacturing efficiency and product mix which included increased sales of high power, QCW and pulsed lasers with higher average powers. These increases in gross margin were partially offset by lower average selling prices. Expenses related to provisions for excess or obsolete inventory and other valuation adjustments decreased by \$5.9 million to \$16.9 million, or 1.2% of sales, for the year ended December 31, 2017, as compared to \$22.8 million, or 2.3% of sales, for the year ended December 31, 2016.

Sales and marketing expense. Sales and marketing expense increased by \$11.4 million, or 29.7%, to \$49.8 million in 2017 from \$38.4 million in 2016, primarily as a result of an increase in personnel, trade show and exhibitions, travel and depreciation expense. As a percentage of sales, sales and marketing expense decreased to 3.5% in 2017 from 3.8% in 2016. As we continue to expand our worldwide sales organization, we expect sales and marketing expenses to increase in the aggregate.

Research and development expense. Research and development expense increased by \$22.3 million, or 28.4%, to \$100.9 million in 2017 from \$78.6 million in 2016, primarily as a result of an increase in personnel, contractors, consultants, materials, depreciation and other research and development expense. Research and development continues to focus on developing new products, enhancing performance of existing components, improving production processes and developing manufacturing of new components such as crystals and refining production processes to improve manufacturing yields and productivity. New products include lasers that operate at different wavelengths such as UV, visible and mid-IR, lasers with ultrafast pulses, laser based systems for material processing, projection, display and medical as well as accessories such as welding and cutting heads. In addition to new products research and development is focused on enhancing the performance of our existing products by improving their electrical efficiency and increasing their average power. As a percentage of sales, research and development expense decreased to 7.2% in 2017 from 7.8% in 2016. We expect to continue to invest in research and development and that research and development expense will increase in the aggregate.

General and administrative expense. General and administrative expense increased by \$14.2 million, or 21.3%, to \$80.7 million in 2017 from \$66.5 million in 2016, primarily as a result of increased expenses for personnel, stock-based compensation, accounting, subscription fees, recruitment, information technology, travel and depreciation expense. In 2016, general and administrative expense also includes a non-cash impairment charge of \$2.9 million related to our corporate aircraft. As a percentage of sales, general and administrative expense decreased to 5.7% in 2017 from 6.6% in 2016. We expect general and administrative expenses to increase as we invest to support the expected growth in net sales.

Effect of exchange rates on sales, gross margin and operating expenses. We estimate that if exchange rates had been the same as one year ago, sales in 2017 would have been \$2.0 million higher, gross margin would have been \$4.3 million higher and operating expenses in total would have been \$3.7 million lower. These estimates assume constant exchange rates between fiscal year 2017 and fiscal year 2016 and are calculated using the average exchange rates for the twelve-month period ended December 31, 2016 for the respective currencies, which were US\$1=Euro 0.90, US\$1=Japanese Yen 109, US\$1=Chinese Yuan 6.65 and US\$1=Russian Ruble 67.

Loss (gain) on foreign exchange. We incurred a foreign exchange loss of \$14.5 million in 2017 as compared to a loss of \$4.5 million in 2016. The change was primarily attributable to the appreciation of the Euro and Russian Ruble as compared to the U.S. Dollar, which was partially offset by appreciation of the Chinese Yuan as compared to the U.S. Dollar.

Interest income (expense), net. Interest income (expense), net decreased to \$0.7 million of income in 2017 compared to \$1.3 million of income in 2016.

Other income (expense), net. Other income (expense), net decreased to approximately \$0 in 2017 compared to \$0.9 million of income in 2016 as a result of the loss incurred upon sale of available-for-sale-securities being partially offset by increases in net rental income from a building in the United States purchased in the second quarter of 2016 that is partially leased to third parties.

Provision for income taxes. Provision for income taxes was \$204.3 million in 2017 compared to \$105.8 million in 2016, representing an effective tax rate of 37.0% in 2017 and 28.9% in 2016. The increase in the effective tax rate was primarily driven by the amounts recorded upon adoption of the Tax Act including \$47.0 million of accrued federal Transition Taxes for undistributed earnings of foreign subsidiaries with an associated \$1.1 million state tax liability and a \$1.3 million write down of deferred tax assets as a result of the rate reductions in the Tax Act. In addition, the provision for income taxes includes a \$4.4 million provision for uncertain tax positions. These increases in the provision for income taxes were partially offset by \$14.6 million of excess tax benefits related to exercise of stock options and release of restricted stock units which vested during the period.

Effective as of the beginning of 2017, the accounting standard related to excess tax benefits and deficits changed, and these items are now recognized in the provision for income taxes whereas previously they were accounted for within additional paid-in capital. The tax effects of the accounting for share-based compensation will increase or decrease our effective rate based upon the difference between our share-based compensation expense and the benefits taken on our tax return which will depend upon the quantity and intrinsic value of RSUs that vest and options that are exercised in the period. Additionally, we recognize excess tax benefits on a discrete basis and we anticipate that our effective rate will vary from quarter to quarter depending upon the factors described above.

Net income. Net income attributable to IPG Photonics Corporation increased by \$86.8 million to \$347.6 million in 2017 from \$260.8 million in 2016. Net income attributable to IPG Photonics Corporation as a percentage of our net sales decreased by 1.2% to 24.7% in 2017 from 25.9% in 2016 due to the factors described above.

Liquidity and Capital Resources

Our principal sources of liquidity as of December 31, 2018 consisted of cash and cash equivalents of \$544.4 million, short-term investments of \$500.4 million, unused credit lines and overdraft facilities of \$107.4 million and working capital (excluding cash and cash equivalents and short-term investments) of \$514.9 million. This compares to cash and cash equivalents of \$909.9 million, short-term investments of \$206.3 million, unused credit lines and overdraft facilities of \$111.0 million and working capital (excluding cash and cash equivalents and short-term investments) of \$439.0 million as of December 31, 2017. The decrease in cash and cash equivalents and short-term investments of \$71.4 million from \$1,116.2 million to \$1,044.8 million relates primarily to cash provided by operating activities in 2018 of \$393.3 million, which was offset by cash used in investing activities of \$563.0 million and cash used in financing activities of \$166.6 million.

Short-term investments at December 31, 2018, consist of liquid investments including U.S. government and government agency notes, corporate notes, commercial paper and certificates of deposit with original maturities of greater than three months but less than one year. We also hold long-term investments, included in other assets on the consolidated balance sheets, which consist of the corporate bonds detailed above with maturities of less than two years and auction rate securities totaling \$4.7 million.

Our long-term debt consists of two long-term notes with a combined total outstanding balance at December 31, 2018 of \$45.4 million of which \$3.7 million is the current portion. We have an unsecured note with an outstanding balance at December 31, 2018 of \$20.8 million of which \$1.2 million is the current portion. The interest on this unsecured note is variable at 1.20% above LIBOR and is fixed using an interest rate swap at 2.85% per annum. The unsecured note matures in May 2023, at which time the outstanding debt balance will be \$15.4 million. We have another note that is secured by our corporate aircraft. The outstanding balance on this secured note at December 31, 2018 was \$24.6 million of which \$2.5 million is the current portion. The interest rate on this secured note is fixed at 2.74% per annum and it matures in July 2022, at which time the outstanding debt balance will be \$15.4 million.

We believe that our existing cash and cash equivalents, short-term investments, our cash flows from operations and our existing lines of credit provide us with the financial flexibility to meet our liquidity and capital needs, as well as to complete

certain acquisitions of businesses and technologies. We intend to continue to pursue acquisition opportunities based upon market conditions and the strategic importance and valuation of the target company. We may consider issuing debt to finance acquisitions depending on the timing and size of the acquisition among other reasons. Our future long-term capital requirements will depend on many factors including our level of sales, the impact of economic environment on our sales levels, the timing and extent of spending to support development efforts, the expansion of the global sales and marketing activities, government regulation including trade sanctions, the timing and introduction of new products, the need to ensure access to adequate manufacturing capacity and the continuing market acceptance of our products.

The following table details our line-of-credit facilities as of December 31, 2018:

Description	Available Principal	Interest Rate	Maturity	Security
U.S. Revolving Line of Credit ⁽¹⁾	\$50.0 million	LIBOR plus 0.80% to 1.20%, depending on our performance	April 2020	Unsecured
Euro Credit Facility (Germany) ⁽²⁾	Euro 50.0 million (\$57.2 million)	Euribor plus 0.75% or EONIA 1.00%	July 2020	Unsecured, guaranteed by parent company and German subsidiary
Other Euro Facilities ⁽³⁾	Euro 2.0 million (\$2.3 million)	Euribor plus 0.89% to 1.10%	May 2019	Common pool of assets of Italian subsidiary

1. This facility is available to certain foreign subsidiaries in their respective local currencies. At December 31, 2018, there were no amounts drawn on this line, however, there were \$0.9 million of guarantees issued against the line which reduces total availability.
2. This facility is available to certain foreign subsidiaries in their respective local currencies. At December 31, 2018, there were no drawings, however, there were \$1.2 million of guarantees issued against the line which reduces total availability.
3. At December 31, 2018, there were no drawings.

Our largest committed credit lines are with Bank of America N.A. and Deutsche Bank AG in the amounts of \$50.0 million and \$57.2 million (or 50 million Euro as described above), respectively, and neither of them is syndicated.

We are required to meet certain financial covenants associated with our U.S. revolving line of credit and long-term debt facilities. These covenants, tested quarterly, include a debt service coverage ratio and a funded debt to earnings before interest, taxes, depreciation and amortization ("EBITDA") ratio. The debt service coverage covenant requires that we maintain a trailing twelve month ratio of cash flow to debt service that is greater than 1.5:1. Debt service is defined as required principal and interest payments during the period. Debt service in the calculation is decreased by our cash held in the U.S.A. in excess of \$50 million up to a maximum of \$250 million. Cash flow is defined as EBITDA less unfunded capital expenditures. The funded debt to EBITDA covenant requires that the sum of all indebtedness for borrowed money on a consolidated basis be less than two times our trailing twelve months EBITDA. We were in compliance with all such financial covenants as of and for the three months ended December 31, 2018.

The financial covenants in our loan documents may cause us to not take or to delay investments and actions that we might otherwise undertake because of limits on capital expenditures and amounts that we can borrow or lease. In the event that we do not comply with any one of these covenants, we would be in default under the loan agreement or loan agreements, which may result in acceleration of the debt, cross-defaults on other debt or a reduction in available liquidity, any of which could harm our results of operations and financial condition.

Operating activities. Net cash provided by operating activities decreased by \$12.1 million to \$393.3 million in 2018 from \$405.4 million in 2017. In 2018, net sales and net income grew by 4% and 16%, respectively. As the business and net income has grown, cash provided by net income after adding back non-cash charges has increased. This increase has been partially offset by continued increases in working capital to support the growth of the business. Our largest working capital items are inventory and accounts receivable. Items such as accounts payable to third parties, prepaid expenses and other current assets and accrued expenses and other liabilities are not as significant as our working capital investment in accounts receivable and inventory because of the amount of value added within IPG due to our vertically integrated structure. Accruals and payables for personnel costs including bonuses and income and other taxes payable are largely dependent on the timing of payments for those items. The increase in cash flow from operating activities in 2018 primarily resulted from:

- An increase in cash provided by net income after adding back non-cash charges of \$540.5 million in 2018 as compared to \$512.0 million in 2017; and
- An increase in cash due to an increase in income and other taxes payable of \$35.2 million in 2018 compared with a decrease of \$16.7 million in 2017; and
- A decrease in cash used by accounts receivable of \$18.8 million in 2018 as compared to \$63.2 million in 2017; and
- An increase in cash used by inventory of \$135.4 million in 2018 as compared to \$71.1 million in 2017 due to an increase in inventory.

Given our vertical integration, rigorous and time-consuming testing procedures for both internally manufactured and externally purchased components and the lead time required to manufacture components used in our finished products, the rate at which we turn inventory has historically been comparatively low when compared to our cost of sales. Also, our historic growth rates required investment in inventories to support future sales and enable us to quote short delivery times to our customers, providing what we believe is a competitive advantage. Furthermore, if there was a disruption to the manufacturing capacity of any of our key technologies, our inventories of components should enable us to continue to build finished products for a reasonable period of time. We believe that we will continue 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. A reduction in our level of net sales or the rate of growth of our net sales from their current levels would mean that the rate at which we are able to convert our inventory into cash would decrease.

Investing activities. Net cash used in investing activities was \$563.0 million and \$170.8 million in 2018 and 2017, respectively. The cash used in investing activities in 2018 related to \$295.0 million of net purchases of investments after the repatriation of cash from our German subsidiary, \$160.3 million for property, plant and equipment and \$109.1 million for the acquisition of three businesses during 2018, net of cash acquired. The cash used in investing activities in 2017 related to \$126.5 million for property, plant and equipment, including the purchase of a new corporate aircraft, and \$60.5 million for the acquisition of two businesses, net of cash acquired. These cash uses were partially offset by \$15.9 million of cash generated by the sale of fixed assets, primarily the previous corporate aircraft.

In 2019, we expect to incur approximately \$170 million to \$180 million in capital expenditures, excluding acquisitions. Capital expenditures include investments in property, facilities and equipment to add capacity worldwide to support anticipated revenue growth. The timing and extent of any capital expenditures in and between periods can have a significant effect on our cash flow. If we obtain financing for certain projects, our cash expenditures would be reduced in the year of expenditure. Many of the capital expenditure projects that we undertake have long lead times and are difficult to cancel or defer to a later period.

Financing activities. Net cash used in financing activities was \$166.6 million and \$3.4 million in 2018 and 2017, respectively. The cash used in financing activities in 2018 was primarily related to the purchase of treasury stock of \$176.1 million and payments on our long-term borrowings of \$3.6 million. These cash uses were partially offset by net proceeds from the exercise of stock options and shares issued under our employee stock purchase plan of \$12.2 million. The cash used in financing activities in 2017 was primarily related to the purchase of treasury stock of \$40.0 million and payments on our long-term borrowings of \$19.8 million, the majority of which related to repayment of the long-term note secured by our previous corporate aircraft. These cash uses were partially offset by net proceeds from the exercise of stock options and shares issued under our employee stock purchase plan of \$28.7 million and proceeds of debt issued to fund the new corporate aircraft purchase of \$28.0 million.

Contractual Obligations and Off-Balance Sheet Arrangements

As of December 31, 2018, we had no off-balance sheet arrangements that have, or are reasonably likely to have, a current or future material effect on our consolidated financial condition, results of operations, liquidity, capital expenditures or capital resources. The following summarizes our contractual obligations at December 31, 2018 and the effect such obligations are expected to have on our liquidity and cash flow in future periods (in thousands):

	Payments Due in				
	Total	Less Than 1 Year	1-3 Years	3-5 Years	More Than 5 Years
Operating lease obligations	\$ 30,289	\$ 6,314	\$ 7,961	\$ 4,674	\$ 11,340
Purchase obligations	114,396	113,823	382	191	—
Long-term debt obligations (including interest) ⁽¹⁾	46,593	3,722	26,383	16,488	—
Contingent consideration	898	610	288	—	—
Total ⁽²⁾	<u>\$ 192,176</u>	<u>\$ 124,469</u>	<u>\$ 35,014</u>	<u>\$ 21,353</u>	<u>\$ 11,340</u>

1. Interest for long-term debt obligations was calculated including the effect of our fixed rate amounts. The weighted average fixed rate amount was 2.79%
2. Excludes obligations related to ASC 740, reserves for uncertain tax positions, because we are unable to provide a reasonable estimate of the timing of future payments relating to the remainder of these obligations. See Note 14, "Income Taxes" to the consolidated financial statements.

Recent Accounting Pronouncements

See Note 1, "Nature of Business and Summary of Significant Accounting Policies" in the notes to the consolidated financial statements for a full description of recent accounting pronouncements, including the respective dates of adoption or expected adoption and effects on our consolidated financial statements contained in Part IV of this Annual Report.

ITEM 7A. *QUANTITATIVE AND QUALITATIVE DISCLOSURES ABOUT MARKET RISK*

We are exposed to market risk in the ordinary course of business, which consists primarily of interest rate risk associated with our cash and cash equivalents and our debt and foreign exchange rate risk.

Interest rate risk . Our investments have limited exposure to market risk. We maintain a portfolio of cash, cash equivalents and short-term investments, consisting primarily of bank deposits, money market funds, certificates of deposit, corporate notes and government and agency securities. None of these investments have a maturity date in excess of one year. The interest rates are variable and fluctuate with current market conditions. Because of the short-term nature of these instruments, a sudden change in market interest rates would not be expected to have a material impact on our financial condition or results of operations.

We are also exposed to market risk as a result of increases or decreases in the amount of interest expense we must pay on our bank debt and borrowings on our bank credit facilities. Our interest obligations on our long-term debt are fixed. Although our U.S. revolving line of credit and our Euro credit facility have variable rates, we do not believe that a 10% change in market interest rates would have a material impact on our financial position or results of operations.

Exchange rates. Due to our international operations, a significant portion of our net sales, cost of sales and operating expenses are denominated in currencies other than the U.S. Dollar, principally the Euro, the Russian Ruble, the Chinese Yuan and the Japanese Yen. As a result, our international operations give rise to transactional market risk associated with exchange rate movements of the U.S. Dollar, the Euro, the Chinese Yuan, the Japanese Yen, and the Russian Ruble. In 2018 we incurred a loss on foreign exchange transactions of \$6.2 million as compared to a loss of \$14.5 million in 2017. Management attempts to minimize these exposures by partially or fully off-setting foreign currency denominated assets and liabilities at our subsidiaries that operate in different functional currencies. The effectiveness of this strategy can be limited by the volume of underlying transactions at various subsidiaries and by our ability to accelerate or delay inter-company cash settlements. As a result, we are unable to create a perfect offset of the foreign currency denominated assets and liabilities. Furthermore, if we expect a currency movement to be beneficial to us in the short or medium term, we have, on occasions, chosen not to hedge or otherwise off-set the underlying assets or liabilities. However, it is difficult to predict foreign currency movements accurately. At December 31, 2018, our material foreign currency exposure is net U.S. Dollar denominated assets at subsidiaries where the Euro or the Russian Ruble is the functional currency and U.S. Dollar denominated liabilities where the Chinese Yuan is the functional currency. The net U.S. Dollar denominated assets are comprised of cash, third party receivables, inter-company receivables and inter-company notes offset by third party and inter-company U.S. Dollar denominated payables. The U.S. Dollar denominated liabilities are comprised of inter-company payables. A 5% change in the relative exchange rate of the U.S. Dollar to the Euro applied to the net U.S. Dollar asset balances as of December 31, 2018, would result in a foreign exchange gain of \$0.5 million if the U.S. Dollar appreciated and a \$0.5 million foreign exchange loss if the U.S. Dollar depreciated.

In addition we are exposed to foreign currency translation risk for those subsidiaries whose functional currency is not the U.S. Dollar as changes in the value of their functional currency relative to the U.S. Dollar can adversely affect the translated amounts of our revenue, expenses, net income, assets and liabilities. As discussed in our Results of Operations, this can, in turn, affect the reported value and relative growth of sales and net income from one period to the next. In addition changes in the translated value of assets and liabilities due to changes in functional currency exchange rates relative to the U.S. Dollar result in foreign currency translation adjustments that are a component of other comprehensive income or loss.

Foreign currency derivative instruments can also be used to hedge exposures and reduce the risks of certain foreign currency transactions; however, these instruments provide only limited protection and can carry significant cost. We have no foreign currency derivative instrument hedges as of December 31, 2018. We will continue to analyze our exposure to currency exchange rate fluctuations and may engage in financial hedging techniques in the future to attempt to minimize the effect of these potential fluctuations. Exchange rate fluctuations may adversely affect our financial results in the future.

ITEM 8. *FINANCIAL STATEMENTS AND SUPPLEMENTARY DATA*

This information is incorporated by reference from pages F-1 through F-32 of this report.

ITEM 9. *CHANGES IN AND DISAGREEMENTS WITH ACCOUNTANTS ON ACCOUNTING AND FINANCIAL DISCLOSURE*

None.

ITEM 9A. CONTROLS AND PROCEDURES

Evaluation of Disclosure Controls and Procedures

Under the supervision of our Chief Executive Officer and our Chief Financial Officer, our management has evaluated the effectiveness of the design and operation of our "disclosure controls and procedures" (as defined in Rules 13a-15(e) and 15d-15(e) promulgated under the Securities Exchange Act of 1934, as amended (the "Exchange Act")), as of the end of the period covered by this Annual Report on Form 10-K (the "Evaluation Date") utilizing the Committee of Sponsoring Organizations of the Treadway Commission's Internal Control - Integrated Framework ("COSO") Updated Framework issued in 2013. Based upon that evaluation, our Chief Executive Officer and our Chief Financial Officer have concluded that, as of the Evaluation Date, our disclosure controls and procedures are effective to ensure that information we are required to disclose in reports that we file or submit under the Exchange Act is recorded, processed, summarized and reported within the time periods specified in the SEC's rules and forms. Disclosure controls and procedures include, without limitation, controls and procedures designed to ensure that information required to be disclosed by an issuer in the reports that it files or submits under the Exchange Act is accumulated and communicated to the issuer's management, including its principal executive and principal financial officers, or persons performing similar functions, as appropriate to allow timely decisions regarding required disclosure.

Management's Annual Report on Internal Control Over Financial Reporting

Our management, including our Chief Executive Officer and Chief Financial Officer, is responsible for establishing and maintaining adequate internal control over financial reporting (as defined in Exchange Act Rules 13a-15(f) and 15d-15(f)) for the Company and its subsidiaries. Internal control over financial reporting is a process designed to provide reasonable assurance regarding the reliability of financial reporting and the preparation of financial statements for external purposes in accordance with generally accepted accounting principles. Our management conducted an assessment of the effectiveness of our internal control over financial reporting as of the Evaluation Date based on criteria established in COSO utilizing the Updated Framework issued in 2013. Based on this assessment, our management concluded that, as of the Evaluation Date, our internal control over financial reporting was effective.

The Company closed the acquisition of Genesis Systems Group, LLC ("Genesis") on December 3, 2018. Genesis' total assets and net sales constituted 5.6% and 0.6% respectively, of the Company's consolidated total assets and revenues as shown on our consolidated financial statements as of and for the year ended December 31, 2018. As the acquisition occurred in the fourth quarter of 2018, we excluded the internal control over financial reporting related to Genesis from the scope of our assessment of the effectiveness of the Company's internal control over financial reporting. This exclusion is in accordance with the general guidance issued by the Staff of the Securities and Exchange Commission that an assessment of a recently-acquired business may be omitted from our scope in the year of acquisition, if specified conditions are satisfied.

Our independent registered public accounting firm, Deloitte & Touche LLP, has audited our internal control over financial reporting, as stated in their report below.

Changes in Internal Controls

There was no change in our internal control over financial reporting (as defined in Rule 13a-15(f) under the Exchange Act) that occurred during the last fiscal quarter that has materially affected, or is reasonably likely to materially affect, our internal control over financial reporting.

Limitations on Effectiveness of Controls

Our management, including our Chief Executive Officer and Chief Financial Officer, does not expect that the disclosure controls and procedures or internal control over financial reporting will prevent or detect all error and all fraud. A control system, no matter how well designed and operated, can provide only reasonable, not absolute, assurance that the objectives of the control system are met. Further, the design of a control system must reflect the fact that there are resource constraints, and the benefits of controls must be considered relative to their costs. Due to the inherent limitations in all control systems, no evaluation of controls can provide absolute assurance that all control issues, errors and instances of fraud, if any, within the company have been or will be detected.

REPORT OF INDEPENDENT REGISTERED PUBLIC ACCOUNTING FIRM

To the Shareholders and the Board of Directors of
IPG Photonics Corporation
Oxford, Massachusetts

Opinion on Internal Control over Financial Reporting

We have audited the internal control over financial reporting of IPG Photonics Corporation and subsidiaries (the "Company") as of December 31, 2018, based on criteria established in *Internal Control - Integrated Framework (2013)* issued by the Committee of Sponsoring Organizations of the Treadway Commission (COSO). In our opinion, the Company maintained, in all material respects, effective internal control over financial reporting as of December 31, 2018, based on criteria established in *Internal Control - Integrated Framework (2013)* issued by COSO.

We have also audited, in accordance with the standards of the Public Company Accounting Oversight Board (United States) (PCAOB), the consolidated financial statements as of and for the year ended December 31, 2018, of the Company and our report dated February 27, 2019, expressed an unqualified opinion on those financial statements.

As described in "Management's Annual Report on Internal Control over Financial Reporting", management excluded from its assessment the internal control over financial reporting at Genesis Systems Group, LLC, which was acquired on December 3, 2018. The assets acquired from Genesis Systems Group, LLC represented approximately 5.6% of the Company's total assets as of December 31, 2018 and 0.6% of the Company's net sales for the year ended December 31, 2018. Accordingly, our audit did not include the internal control over financial reporting at Genesis Systems Group, LLC.

Basis for Opinion

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

We conducted our audit in accordance with the standards of the PCAOB. Those standards require that we plan and perform the audit to obtain reasonable assurance about whether effective internal control over financial reporting was maintained in all material respects. Our audit included obtaining an understanding of internal control over financial reporting, assessing the risk that a material weakness exists, testing and evaluating the design and operating effectiveness of internal control based on the assessed risk, and performing such other procedures as we considered necessary in the circumstances. We believe that our audit provides a reasonable basis for our opinion.

Definition and Limitations of Internal Control over Financial Reporting

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

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

/s/ DELOITTE & TOUCHE LLP

Boston, Massachusetts
February 27, 2019

ITEM 9B. CONTROLS AND PROCEDURES

None.

PART III

ITEM 10. DIRECTORS, EXECUTIVE OFFICERS AND CORPORATE GOVERNANCE

The information required hereunder is incorporated herein by reference to our definitive Proxy Statement to be filed pursuant to Regulation 14A, which Proxy Statement is anticipated to be filed with the SEC within 120 days after December 31, 2018.

ITEM 11. EXECUTIVE COMPENSATION

The information required hereunder is incorporated herein by reference to our definitive Proxy Statement to be filed pursuant to Regulation 14A, which Proxy Statement is anticipated to be filed with the SEC within 120 days after December 31, 2018.

ITEM 12. SECURITY OWNERSHIP OF CERTAIN BENEFICIAL OWNERS AND MANAGEMENT AND RELATED STOCKHOLDER MATTERS

The information required hereunder is incorporated herein by reference to our definitive Proxy Statement to be filed pursuant to Regulation 14A, which Proxy Statement is anticipated to be filed with the SEC within 120 days after December 31, 2018, with the exception of the information regarding securities authorized for issuance under our equity compensation plans, which is set forth in Item 5, "Market for the Registrant's Common Equity, Related Stockholder Matters and Issuer Purchases of Equity Securities Information Regarding Equity Compensation Plans" and is incorporated herein by reference.

ITEM 13. CERTAIN RELATIONSHIPS AND RELATED TRANSACTIONS, AND DIRECTOR INDEPENDENCE

The information required hereunder is incorporated herein by reference to our definitive Proxy Statement to be filed pursuant to Regulation 14A, which Proxy Statement is anticipated to be filed with the SEC within 120 days after December 31, 2018.

ITEM 14. PRINCIPAL ACCOUNTING FEES AND SERVICES

The information required hereunder is incorporated herein by reference to our definitive Proxy Statement to be filed pursuant to Regulation 14A, which Proxy Statement is anticipated to be filed with the SEC within 120 days after December 31, 2018.

PART IV

ITEM 15. EXHIBITS AND FINANCIAL STATEMENT SCHEDULES

- a. The following documents are filed as part of this Annual Report on Form 10-K:
 1. Financial Statements.
See Index to Financial Statements on page F-1.
 2. Financial Statement Schedules.
All schedules are omitted because they are not applicable or the required information is shown on the financial statements or notes thereto.
 3. The exhibits listed in the "Index to Exhibits" preceding the Exhibits attached hereto are filed with this Form 10-K or incorporated by reference as set forth therein.
- b. Exhibits.
See (a)(3) above.
- c. Additional Financial Statement Schedules.

All schedules are omitted because they are not applicable or the required information is shown on the financial statements or notes thereto.

ITEM 16. *FORM 10-K SUMMARY*

None.

SIGNATURES

Pursuant to the requirements of Section 13 or 15(d) of the Securities Exchange Act of 1934, the Registrant has duly caused this report to be signed on its behalf by the undersigned, thereunto duly authorized, on February 27, 2019.

IPG P HOTONICS C ORPORATION

By: /s/ Valentin P. Gapontsev
Valentin P. Gapontsev
Chief Executive Officer and
Chairman of the Board

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

Signature	Title	
<u>/s/ Valentin P. Gapontsev</u> Valentin P. Gapontsev	Chief Executive Officer, Chairman of the Board and Director (Principal Executive Officer)	February 27, 2019
<u>/s/ Timothy P.V. Mammen</u> Timothy P.V. Mammen	Senior Vice President, Chief Financial Officer (Principal Financial Officer)	February 27, 2019
<u>/s/ Thomas J. Burgomaster</u> Thomas J. Burgomaster	Vice President, Corporate Controller (Principal Accounting Officer)	February 27, 2019
<u>/s/ Michael C. Child</u> Michael C. Child	Director	February 27, 2019
<u>/s/ Gregory P. Dougherty</u> Gregory P. Dougherty	Director	February 27, 2019
<u>/s/ Henry E. Gauthier</u> Henry E. Gauthier	Director	February 27, 2019
<u>/s/ Catherine P. Lego</u> Catherine P. Lego	Director	February 27, 2019
<u>/s/ Eric Meurice</u> Eric Meurice	Director	February 27, 2019
<u>/s/ John R. Peeler</u> John Peeler	Director	February 27, 2019
<u>/s/ Igor Samartsev</u> Igor Samartsev	Director	February 27, 2019
<u>/s/ Eugene A. Scherbakov</u> Eugene Scherbakov	Director	February 27, 2019
<u>/s/ Thomas J. Seifert</u> Thomas J. Seifert	Director	February 27, 2019

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REPORT OF INDEPENDENT REGISTERED PUBLIC ACCOUNTING FIRM

To the Shareholders and the Board of Directors of
IPG Photonics Corporation
Oxford, Massachusetts

Opinion on the Financial Statements

We have audited the accompanying consolidated balance sheets of IPG Photonics Corporation and subsidiaries (the "Company") as of December 31, 2018 and 2017, the related consolidated statements of income, comprehensive income, equity, and cash flows for each of the three years in the period ended December 31, 2018, and the related notes (collectively referred to as the "financial statements"). In our opinion, the financial statements present fairly, in all material respects, the financial position of the Company as of December 31, 2018 and 2017, and the results of its operations and its cash flows for each of the three years in the period ended December 31, 2018, in conformity with accounting principles generally accepted in the United States of America.

We have also audited, in accordance with the standards of the Public Company Accounting Oversight Board (United States) (PCAOB), the Company's internal control over financial reporting as of December 31, 2018, based on criteria established in *Internal Control - Integrated Framework (2013)* issued by the Committee of Sponsoring Organizations of the Treadway Commission and our report dated February 27, 2019, expressed an unqualified opinion on the Company's internal control over financial reporting.

Basis for Opinion

These financial statements are the responsibility of the Company's management. Our responsibility is to express an opinion on the Company's financial statements based on our audits. We are a public accounting firm registered with the PCAOB and are required to be independent with respect to the Company in accordance with the U.S. federal securities laws and the applicable rules and regulations of the Securities and Exchange Commission and the PCAOB.

We conducted our audits in accordance with the standards of the PCAOB. Those standards require that we plan and perform the audit to obtain reasonable assurance about whether the financial statements are free of material misstatement, whether due to error or fraud. Our audits included performing procedures to assess the risks of material misstatement of the financial statements, whether due to error or fraud, and performing procedures that respond to those risks. Such procedures included examining, on a test basis, evidence regarding the amounts and disclosures in the financial statements. Our audits also included evaluating the accounting principles used and significant estimates made by management, as well as evaluating the overall presentation of the financial statements. We believe that our audits provide a reasonable basis for our opinion.

/s/ DELOITTE & TOUCHE LLP

Boston, Massachusetts
February 27, 2019

We have served as the Company's auditor since 1999.

IPG PHOTONICS CORPORATION
CONSOLIDATED BALANCE SHEETS

	December 31,	
	2018	2017
	(In thousands, except share and per share data)	
ASSETS		
CURRENT ASSETS:		
Cash and cash equivalents	\$ 544,358	\$ 909,900
Short-term investments	500,432	206,257
Accounts receivable, net	255,509	237,278
Inventories	403,579	307,712
Prepaid income taxes	43,782	44,944
Prepaid expenses and other current assets	57,764	47,919
Total current assets	1,805,424	1,754,010
DEFERRED INCOME TAXES, NET	19,165	26,976
GOODWILL	100,722	55,831
INTANGIBLE ASSETS, NET	87,139	51,223
PROPERTY, PLANT AND EQUIPMENT, NET	543,068	460,206
OTHER ASSETS, NET	18,932	19,009
TOTAL ASSETS	\$ 2,574,450	\$ 2,367,255
LIABILITIES AND EQUITY		
CURRENT LIABILITIES:		
Current portion of long-term debt	\$ 3,671	\$ 3,604
Accounts payable	36,302	35,109
Accrued expenses and other liabilities	154,640	144,417
Income taxes payable	51,161	15,773
Total current liabilities	245,774	198,903
DEFERRED INCOME TAXES AND OTHER LONG-TERM LIABILITIES	80,734	100,652
LONG-TERM DEBT, NET OF CURRENT PORTION	41,707	45,378
Total liabilities	368,215	344,933
COMMITMENTS AND CONTINGENCIES (NOTE 11)		
IPG PHOTONICS CORPORATION EQUITY:		
Common stock, \$0.0001 par value, 175,000,000 shares authorized; 54,371,701 and 52,941,607 shares issued and outstanding, respectively, at December 31, 2018; 54,007,708 and 53,629,439 shares issued and outstanding, respectively, at December 31, 2017	5	5
Treasury stock, at cost (1,430,094 and 378,269 shares held)	(224,998)	(48,933)
Additional paid-in capital	744,937	704,727
Retained earnings	1,848,500	1,443,867
Accumulated other comprehensive loss	(162,896)	(77,344)
Total IPG Photonics Corporation stockholders' equity	2,205,548	2,022,322
NONCONTROLLING INTERESTS	687	—
Total equity	2,206,235	2,022,322
TOTAL LIABILITIES AND EQUITY	\$ 2,574,450	\$ 2,367,255

See notes to consolidated financial statements.

IPG PHOTONICS CORPORATION
CONSOLIDATED STATEMENTS OF INCOME

	Year Ended December 31,		
	2018	2017	2016
	(In thousands, except per share data)		
NET SALES	\$ 1,459,874	\$ 1,408,889	\$ 1,006,173
COST OF SALES	659,606	611,978	453,933
GROSS PROFIT	800,268	796,911	552,240
OPERATING EXPENSES:			
Sales and marketing	57,815	49,801	38,393
Research and development	122,769	100,870	78,552
General and administrative	102,429	80,668	66,486
(Gain) loss on foreign exchange	(6,150)	14,460	4,496
Total operating expenses	276,863	245,799	187,927
OPERATING INCOME	523,405	551,112	364,313
OTHER INCOME, Net:			
Interest income, net	9,057	737	1,304
Other income, net	1,933	22	948
Total other income	10,990	759	2,252
INCOME BEFORE PROVISION FOR INCOME TAXES	534,395	551,871	366,565
PROVISION FOR INCOME TAXES	(130,226)	(204,283)	(105,849)
NET INCOME	404,169	347,588	260,716
LESS: NET INCOME (LOSS) ATTRIBUTABLE TO NONCONTROLLING INTERESTS	142	(26)	(36)
NET INCOME ATTRIBUTABLE TO IPG PHOTONICS CORPORATION	\$ 404,027	\$ 347,614	\$ 260,752
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

See notes to consolidated financial statements.

IPG PHOTONICS CORPORATION
CONSOLIDATED STATEMENTS OF COMPREHENSIVE INCOME

	Year Ended December 31,		
	2018	2017	2016
	(In thousands)		
Net income	\$ 404,169	\$ 347,588	\$ 260,716
Other comprehensive income (loss), net of tax:			
Foreign currency translation adjustments	(85,590)	100,999	3,163
Unrealized gain (loss) on derivatives	15	(58)	49
Effect of adopted accounting standards	10	—	—
Unrealized loss on available-for-sale investments	—	(240)	(298)
Loss on available-for-sale investments, net of tax reclassified to net income	—	538	—
Total other comprehensive (loss) income	(85,565)	101,239	2,914
Comprehensive income	318,604	448,827	263,630
Comprehensive gain (loss) attributable to noncontrolling interest	129	31	(21)
Comprehensive income attributable to IPG Photonics Corporation	\$ 318,475	\$ 448,796	\$ 263,651

See notes to consolidated financial statements.

IPG PHOTONICS CORPORATION
CONSOLIDATED STATEMENTS OF EQUITY
(In thousands)

	Year Ended December 31,									
	Common Stock		Treasury Stock		Additional Paid In Capital	Retained Earnings	Accumulated Other Comprehensive (Loss) Income	Non- controlling Interest	Total Stockholders' Equity	
	Shares	Amount	Shares	Amount						
										1,260,665
Balance, January 1, 2016	52,883,902	\$ 5	—	\$ —	\$ 607,649	\$ 833,356	\$ (181,482)	\$ 1,137	\$	
Exercise of stock options and vesting of RSU's and PSU's	430,930	—	—	—	18,889	—	—	—		18,889
Common stock issued under employee stock purchase plan	39,747	—	—	—	2,702	—	—	—		2,702
Purchased common stock	(102,774)	—	(102,774)	(8,946)	—	—	—	—		(8,946)
Stock-based compensation	—	—	—	—	21,734	—	—	—		21,734
Purchase of noncontrolling interest	—	—	—	—	—	—	—	(950)		(950)
Net income	—	—	—	—	—	260,752	—	(36)		260,716
Foreign currency translation adjustments	—	—	—	—	—	—	3,148	15		3,163
Unrealized gain on derivatives, net of tax	—	—	—	—	—	—	49	—		49
Unrealized loss on available-for-sale investments, net of tax	—	—	—	—	—	—	(298)	—		(298)
Balance, December 31, 2016	53,251,805	5	(102,774)	(8,946)	650,974	1,094,108	(178,583)	166		1,557,724
Exercise of stock options and vesting of RSU's and PSU's	617,662	—	—	—	25,062	—	—	—		25,062
Common stock issued under employee stock purchase plan	35,467	—	—	—	3,592	—	—	—		3,592
Purchased common stock	(275,495)	—	(275,495)	(39,987)	—	—	—	—		(39,987)
Stock-based compensation	—	—	—	—	23,021	—	—	—		23,021
Recently adopted accounting standards	—	—	—	—	2,078	2,145	—	—		4,223
Purchase of noncontrolling interest	—	—	—	—	—	—	—	(197)		(197)
Net income	—	—	—	—	—	347,614	—	(26)		347,588
Foreign currency translation adjustments	—	—	—	—	—	—	100,999	57		101,056
Unrealized loss on derivatives, net of tax	—	—	—	—	—	—	(58)	—		(58)
Unrealized loss on available-for-sale investments, net of tax	—	—	—	—	—	—	(240)	—		(240)
Realized loss on available-for-sale investments, net of tax	—	—	—	—	—	—	538	—		538
Balance, December 31, 2017	53,629,439	5	(378,269)	(48,933)	704,727	1,443,867	(77,344)	—		2,022,322
Exercise of stock options and vesting of RSU's and PSU's	351,795	—	—	—	9,895	—	—	—		9,895
Common stock issued under employee stock purchase plan	12,198	—	—	—	2,288	—	—	—		2,288
Purchased common stock	(1,051,825)	—	(1,051,825)	(176,065)	—	—	—	—		(176,065)
Stock-based compensation	—	—	—	—	28,027	—	—	—		28,027
Recently adopted accounting standards	—	—	—	—	—	606	10	—		616
Noncontrolling interest of acquired company	—	—	—	—	—	—	—	558		558
Net income	—	—	—	—	—	404,027	—	142		404,169
Foreign currency translation adjustments	—	—	—	—	—	—	(85,577)	(13)		(85,590)
Unrealized gain on derivatives, net of tax	—	—	—	—	—	—	15	—		15
										2,206,235
Balance, December 31, 2018	52,941,607	\$ 5	(1,430,094)	\$ (224,998)	\$ 744,937	\$ 1,848,500	\$ (162,896)	\$ 687	\$	

See notes to consolidated financial statements.

IPG PHOTONICS CORPORATION
CONSOLIDATED STATEMENTS OF CASH FLOWS

	Year Ended December 31,		
	2018	2017	2016
	(In thousands)		
CASH FLOWS FROM OPERATING ACTIVITIES:			
Net income	\$ 404,169	\$ 347,588	\$ 260,716
Adjustments to reconcile net income to net cash provided by operating activities:			
Depreciation and amortization	80,271	64,568	51,475
Deferred income taxes	(4,576)	22,881	(12,908)
Stock-based compensation	28,027	23,021	21,734
Unrealized losses (gains) on foreign currency transactions	(2,670)	7,949	2,298
Other	(3,586)	986	2,724
Provisions for inventory, warranty and bad debt	38,862	44,978	46,469
Changes in assets and liabilities that (used) provided cash, net of acquisitions:			
Accounts receivable	(18,814)	(63,225)	(11,444)
Inventories	(135,440)	(71,080)	(53,626)
Prepaid expenses and other current assets	(7,062)	(911)	(4,069)
Accounts payable	(1,426)	2,309	(407)
Accrued expenses and other liabilities	(19,666)	9,612	5,480
Income and other taxes payable	35,212	16,719	(10,746)
Net cash provided by operating activities	393,301	405,395	297,696
CASH FLOWS FROM INVESTING ACTIVITIES:			
Purchases of property, plant and equipment	(160,343)	(126,535)	(127,042)
Proceeds from sales of property, plant and equipment	1,026	15,882	658
Proceeds from short-term investments	470,328	212,515	198,808
Purchases of short and long-term investments	(765,310)	(211,832)	(299,508)
Acquisitions of businesses, net of cash acquired	(109,115)	(60,483)	(47,792)
Other	415	(352)	468
Net cash used in investing activities	(562,999)	(170,805)	(274,408)
CASH FLOWS FROM FINANCING ACTIVITIES:			
Proceeds from line-of-credit facilities	255	6,761	7,992
Payments on line-of-credit facilities	(255)	(6,761)	(7,992)
Proceeds on long-term borrowings	—	28,000	23,750
Principal payments on long-term borrowings	(3,604)	(19,842)	(2,594)
Proceeds from issuance of common stock under employee stock option and purchase plans less payments for taxes related to net share settlement of equity awards	12,183	28,654	16,183
Cash contributed by noncontrolling interest	839	—	—
Purchase of noncontrolling interests	—	(197)	(950)
Purchase of treasury stock, at cost	(176,065)	(39,987)	(8,946)
Net cash (used in) provided by financing activities	(166,647)	(3,372)	27,443
EFFECT OF CHANGES IN EXCHANGE RATES ON CASH AND CASH EQUIVALENTS	(29,197)	54,827	(9,408)
NET (DECREASE) INCREASE IN CASH AND CASH EQUIVALENTS	(365,542)	286,045	41,323
CASH AND CASH EQUIVALENTS — Beginning of period	909,900	623,855	582,532
CASH AND CASH EQUIVALENTS — End of period	\$ 544,358	\$ 909,900	\$ 623,855
SUPPLEMENTAL DISCLOSURES OF CASH FLOW INFORMATION:			
Cash paid for interest	\$ 3,052	\$ 2,583	\$ 942
Cash paid for income taxes	\$ 112,762	\$ 155,559	\$ 126,964
Non-cash transactions:			
Demonstration units transferred from inventory to other assets	\$ 6,270	\$ 4,114	\$ 6,293
Property, plant and equipment transferred from inventory	\$ 2,535	\$ 8,425	\$ 4,529
Changes in accounts payable related to property, plant and equipment	\$ (2,852)	\$ 1,594	\$ 973

See notes to consolidated financial statements.

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1. NATURE OF BUSINESS AND SUMMARY OF SIGNIFICANT ACCOUNTING POLICIES

Nature of Business — IPG Photonics Corporation (the "Company" or "IPG") is the leading developer and manufacturer of a broad line of high-performance fiber lasers, fiber amplifiers, diode lasers, laser systems, communications systems and optical accessories that are used for diverse applications, primarily in materials processing. Its world headquarters are located in Oxford, Massachusetts. It also has facilities and sales offices elsewhere in the United States, Europe and Asia.

Principles of Consolidation — The Company was incorporated as a Delaware corporation in December 1998. The accompanying financial statements include the accounts of the Company and its majority-owned subsidiaries. All intercompany accounts and transactions have been eliminated.

Use of Estimates — The preparation of financial statements in conformity with accounting principles generally accepted in the United States of America requires management to make estimates and assumptions that affect the reported amounts of assets and liabilities, disclosure of contingent assets and liabilities at the date of the financial statements and the reported amounts of revenue and expenses during the reporting period. The Company bases its estimates on historical experience and on various other assumptions that are believed to be reasonable under the circumstances. Actual results could differ from those estimates.

Foreign Currency — The financial information for entities outside the United States is measured using local currencies as the functional currency. Assets and liabilities are translated into U.S. dollars at the exchange rate in effect on the respective balance sheet dates. Income and expenses are translated into U.S. dollars based on the average rate of exchange for the corresponding period. Exchange rate differences resulting from translation adjustments are accounted for directly as a component of accumulated other comprehensive loss.

Cash and Cash Equivalents and Short-Term and Long-Term Investments — Cash and cash equivalents consist primarily of highly liquid investments, such as bank deposits, mutual funds and marketable securities with maturities of three months or less at the date of purchase with insignificant interest rate risk. Short-term and long-term investments consist primarily of similar highly liquid investments and marketable securities with insignificant interest rate risks.

Accounts Receivable and Allowance for Doubtful Accounts — Accounts receivable include \$ 27,335 and \$ 46,123 of bank acceptance drafts at December 31, 2018 and 2017, respectively. Bank acceptance drafts are bank guarantees of payment on specified dates. The weighted average maturity of these bank acceptance drafts is less than 90 days. The Company maintains an allowance for doubtful accounts to provide for the estimated amount of accounts receivable that will not be collected. The allowance is based upon an assessment of customer creditworthiness, historical payment experience and the age of outstanding receivables.

Activity related to the allowance for doubtful accounts was as follows:

	2018	2017	2016
Balance at January 1	\$ 2,198	\$ 2,016	\$ 1,811
Provision for bad debts, net of recoveries	14	51	111
Uncollectable accounts written off	(198)	(38)	(76)
Foreign currency translation	(283)	169	170
Balance at December 31	<u>\$ 1,731</u>	<u>\$ 2,198</u>	<u>\$ 2,016</u>

Inventories — Inventories are stated at the lower of cost or market on a first-in, first-out basis. Inventories include parts and components that may be specialized in nature and subject to rapid obsolescence. The Company periodically reviews the quantities and carrying values of inventories to assess whether the inventories are recoverable. The costs associated with provisions for excess quantities, technological obsolescence, or component rejections are charged to cost of sales as incurred.

Goodwill — Goodwill is the amount by which the cost of the acquired net assets in a business acquisition exceeded the fair values of the net identifiable assets on the date of purchase. Goodwill is assessed for impairment at least annually, on a reporting unit basis, or more frequently when events and circumstances occur indicating that the recorded goodwill may be impaired. The process of evaluating the potential impairment of goodwill is subjective and requires significant judgment at many points during the analysis. If the book value of a reporting unit exceeds its fair value, the implied fair value of goodwill is compared with the carrying amount of goodwill. If the carrying amount of goodwill exceeds the implied fair value, an impairment loss is recorded in an amount equal to that excess. As a result of the procedures performed of assessing both qualitative and quantitative factors provide that the goodwill amounts stated as of December 31, 2018, are not impaired.

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Intangible Assets — Intangible assets result from the Company's various business acquisitions. Intangible assets are reported at cost, net of accumulated amortization, and are amortized on a straight-line basis either over their estimated useful lives of one year to thirteen years or over the period the economic benefits of the intangible asset are consumed.

Property, Plant and Equipment — Property, plant and equipment are stated at cost, less accumulated depreciation. Depreciation is determined using the straight-line method based on the estimated useful lives of the related assets. In the case of leasehold improvements, the estimated useful lives of the related assets do not exceed the remaining terms of the corresponding leases. The following table presents the assigned economic useful lives of property, plant and equipment:

Category	Economic Useful Life
Buildings	30 years
Machinery and equipment	5-12 years
Office furniture and fixtures	3-5 years

Expenditures for maintenance and repairs are charged to operating expense.

Long-Lived Assets — Long-lived assets, which consist primarily of property, plant and equipment, are reviewed by management for impairment whenever events or changes in circumstances indicate that the carrying amount may not be recoverable. When undiscounted expected future cash flows are less than the carrying value, an impairment loss is recorded equal to the amount by which the carrying value exceeds the fair value of assets. The Company recorded impairment losses of \$ 162 and \$ 2,857 for its corporate aircraft, which are included in general and administrative expense in its consolidated statements of income for the years ended December 31, 2017 and 2016, respectively. The corporate aircraft was sold during the second quarter of 2017. There were no impairments recorded in 2018.

Included in other long-term assets is certain demonstration equipment. The demonstration equipment is amortized over the respective estimated economic lives, generally 3 years. The carrying value of the demonstration equipment totaled \$ 7,037 and \$ 6,277 at December 31, 2018 and 2017, respectively. Amortization expense of demonstration equipment for the years ended December 31, 2018, 2017 and 2016, was \$ 3,870 , \$ 3,769 and \$ 2,959 , respectively.

Authorized Capital — The Company has authorized capital stock consisting of 175,000,000 shares of common stock, par value \$ 0.0001 per share, and 5,000,000 shares of preferred stock, par value \$ 0.0001 per share. There are no shares of preferred stock outstanding as of December 31, 2018.

Revenue Recognition — Revenue is recognized when transfer of control to the customer occurs in an amount reflecting the consideration that the Company expects to be entitled. In order to achieve this core principle, the Company applies 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.

The Company considers customer purchase orders, which in some cases are governed by master sales agreements, to be contracts with a customer. As part of its consideration of the contract, the Company evaluates certain factors including the customer's ability to pay (or credit risk). For each contract, the Company considers the promise to transfer products, each of which is distinct as the identified performance obligations. In determining the transaction price, the Company evaluates whether the price is subject to refund or adjustment to determine the net consideration to which the Company expects to be entitled. As the Company's standard payment terms are less than one year, the Company has elected the practical expedient under ASC 606-10-32-18 to not assess whether a contract has a significant financing component. The Company allocates the transaction price to each distinct product based on its relative standalone selling price. Revenue is recognized when control of the product is transferred to the customer (i.e., when the Company's performance obligation is satisfied), which typically occurs at shipment but which can occur over time for certain of the Company's systems contracts.

The Company often receives orders with multiple delivery dates that may extend across several reporting periods. The Company allocates the transaction price of the contract to each delivery based on the product standalone selling price. The Company invoices for each scheduled delivery upon shipment and recognizes revenues for such delivery at that point, assuming transfer of control has occurred. As scheduled delivery dates are generally within one year , under the optional exemption provided by ASC 606-10-50-14 revenues allocated to future shipments of partially completed contracts are not disclosed.

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Rights of return generally are not included in customer contracts. Accordingly, upon application of steps one through five above, product revenue is recognized upon shipment and transfer of control. Returns are infrequent and are recorded as a reduction of revenue.

In certain subsidiaries the Company provides sales commissions to sales representatives based on sales volume. The Company has determined that the incentive portion of its sales commissions qualify as contract costs. The Company has elected the practical expedient in ASC 340-40-25-4 to expense sales commissions when incurred as the amortization period of the asset that would otherwise have been recognized is one year or less.

Revenue Recognition at a Point in Time — Revenues recognized at a point in time consist primarily of product, installation and service sales. The Company sells products to original equipment manufacturers ("OEMs") that supply materials processing laser systems, communications systems, medical laser systems and other laser systems for advanced applications to end users. The Company also sells products to end users that use IPG products directly to build their own systems, which incorporate or use IPG products as an energy or light source. The Company recognizes revenue for laser and spare part sales following the transfer of control of such products to the customer, which typically occurs upon shipment or delivery depending on the terms of the underlying contracts. Installation revenue is recognized upon completion of the installation service, which typically occurs within 90 days of delivery. For laser systems that carry customer specific processing requirements, revenue is recognized at the latter of customer acceptance date or shipment date if the customer acceptance is made prior to shipment. When sales contracts contain multiple performance obligations, such as the shipment or delivery of products and installation, the Company allocates the transaction price to each performance obligation identified in the contract based on relative standalone selling prices and recognizes the related revenue as control of each individual product or service is transferred to the customer, in satisfaction of the corresponding performance obligations.

Revenue Recognition over Time — The Company offers extended warranty agreements, which extend the standard warranty periods. Warranties are limited and provide that the product meets specifications and is free from defects in materials and workmanship. Extended warranties are sold separately from products and represent a distinct performance obligation. Revenue related to the performance obligation for extended warranties is recognized over time as the customer simultaneously receives and consumes the benefits provided by the Company. The customer receives the assurance that the product will operate in accordance with agreed-upon specifications evenly during the extended warranty period regardless of whether they make a claim during that period, and therefore, revenue at time of sale is deferred and recognized over the time period of the extended warranty period.

With the acquisition of Genesis Systems Group, LLC in December 2018, the Company enters 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 the Company's judgment that the customized robotic system does not have an alternative use and the Company has an enforceable right to payment for performance completed to date.

The determination of the revenue to be recognized in a given period for performance obligations over time is based on the input method. The Company generally uses the total cost-to-cost input method of progress because it best depicts the transfer of control to the customer that occurs as costs are incurred. Under the cost-to-cost method, the extent of progress towards completion is measured based on the proportion of costs incurred to date to the total estimated costs at completion of the performance obligation.

Customer Deposits and Deferred Revenue — When the Company receives consideration from a customer or such consideration is unconditionally due prior to transferring goods or services under the terms of a sales contract, the Company records customer deposits or deferred revenue, which represent contract liabilities. The Company recognizes deferred revenue as net sales after control of the goods or services has been transferred to the customer and all revenue recognition criteria are met.

Warranties — The Company typically provides one to three-year parts and service warranties on lasers and amplifiers. Most of the Company's sales offices provide support to customers in their respective geographic areas. The Company estimates the warranty accrual considering past claims experience, the number of units still covered by warranty and the average life of the remaining warranty period. The warranty accrual has generally been sufficient to cover product warranty repair and replacement costs.

Stock-Based Compensation — The Company accounts for stock-based compensation using the fair value of the awards granted. The Company estimates the fair value of stock options granted using the Black-Scholes model, it values restricted

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stock units using the intrinsic value method, and it uses a Monte Carlo simulation model to estimate the fair value of market-based performance stock units. The Company amortizes the fair value of stock options and awards on a straight-line basis over the requisite service periods of the awards, which are generally the vesting periods. The Company accounts for forfeitures as they occur. The description of the Company's stock-based employee compensation plans and the assumptions it uses to calculate the fair value of stock-based employee compensation is more fully described in Note 12, "Stock-based Compensation".

Advertising Expense — The cost of advertising is expensed as incurred. The Company conducts substantially all of its sales and marketing efforts through trade shows, professional and technical conferences, direct sales and our website. The Company's advertising costs were not material for the periods presented.

Research and Development — Research and development costs are expensed as incurred.

Income Taxes — Deferred tax assets and liabilities are recognized for the future tax consequences of temporary differences between the financial statement carrying amounts and tax basis of assets and liabilities and net operating loss and credit carryforwards using enacted rates in effect when those differences are expected to reverse. Valuation allowances are provided against deferred tax assets that are not deemed to be recoverable. The Company recognizes tax positions that are more likely than not to be sustained upon examination by relevant tax authorities. The tax positions are measured at the greatest amount of tax benefit that is more than 50 percent likely to be realized upon ultimate settlement.

The Company provides reserves for potential payments of tax to various tax authorities related to uncertain tax positions and other issues. The reserves are based on a determination of whether and how much of a tax benefit taken in its tax filings or positions is more likely than not to be realized following resolution of uncertainties related to the tax benefit, assuming that the matter in question will be raised by the tax authorities.

Concentration of Credit Risk — Financial instruments that potentially subject the Company to credit risk consist primarily of cash and cash equivalents, short and long-term investments, auction rate securities and accounts receivable. The Company maintains substantially all of its cash, short-term and long-term investments and marketable securities in various financial institutions, which it believes to be high-credit quality financial institutions. The Company grants credit to customers in the ordinary course of business and provides a reserve for potential credit losses. Such losses historically have been within management's expectations.

One customer comprised 12 %, 13 % and 9 % of net sales during the years ended December 31, 2018, 2017 and 2016 respectively. The Company has historically depended on a few customers for a significant percentage of its annual net sales. The composition of this group can change from year to year. Net sales derived from the Company's five largest customers as a percentage of its annual net sales were 26 %, 28 % and 22 % in 2018, 2017 and 2016, respectively.

Comprehensive Income — Comprehensive income includes charges and credits to equity that are not the result of transactions with stockholders. Included within comprehensive income is the cumulative foreign currency translation adjustment, change in carrying value of auction rate securities, unrealized gains or losses on derivatives and unrealized gains or losses on available-for-sale investments. These adjustments are accumulated within the consolidated statements of comprehensive income.

Total components of accumulated other comprehensive loss were as follows:

	December 31,	
	2018	2017
Foreign currency translation adjustments	\$ (163,155)	\$ (77,578)
Unrealized gain on auction rate securities	232	232
Unrealized gain on derivatives, net of tax of \$4 and \$14, respectively	27	2
Accumulated other comprehensive loss	<u>\$ (162,896)</u>	<u>\$ (77,344)</u>

Derivative Instruments — The Company's primary market exposures are to interest rates and foreign exchange rates. The Company from time to time may use certain derivative financial instruments to help manage these exposures. The Company executes these instruments with financial institutions it judges to be credit-worthy. The Company does not hold or issue

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derivative financial instruments for trading or speculative purposes. The Company recognizes all derivative financial instruments as either assets or liabilities at fair value in the consolidated balance sheets.

Business Segment Information — The Company operates in one segment which involves the design, development, production and distribution of fiber lasers, laser systems, fiber amplifiers, and related optical components. The Company has a single, company-wide management team that administers all properties as a whole rather than as discrete operating segments. The chief operating decision maker, who is the Company's chief executive officer, measures financial performance as a single enterprise and not on legal entity or end market basis. Throughout the year, the chief operating decision maker allocates capital resources on a project-by-project basis across the Company's entire asset base to maximize profitability without regard to legal entity or end market basis. The Company operates in a number of countries throughout the world in a variety of product lines. Information regarding product lines and geographic financial information is provided in Note 2, "Revenue from Contracts with Customers" and Note 6, "Property, Plant and Equipment."

Earnings Per Share — The Company computes net income per share in accordance with ASC 260, *Earnings Per Share*.

Recent Accounting Pronouncements

Adopted Pronouncements — On January 1, 2018, the Company adopted ASC 606 "Revenue from Contracts with Customers," ("ASC 606" or the "new revenue standard") and all related amendments using the modified retrospective method for contracts that were not completed as of the date of initial application. The Company recognized the cumulative effect of initially applying the new revenue standard as an adjustment to the opening balance of retained earnings. The comparative information has not been restated and continues to be reported under the accounting standards in effect for those periods. The Company expects the impact of the adoption of the new standard to be immaterial to net income on an ongoing basis.

A majority of revenue continues to be recognized at a point in time when control transfers based on the terms of underlying contract. Under the new revenue standard, the Company changed from deferring revenue for installation services in an amount equal to the greater of the cash received related to installation or the fair value to deferring the standalone selling price for these services.

In February 2018, the FASB issued ASU No. 2018-02, "Income Statement - Reporting Comprehensive Income (Topic 220): Reclassification of Certain Tax Effects from Accumulated Other Comprehensive Income" ("ASU 2018-02"). ASU 2018-02 allowed a reclassification from accumulated other comprehensive income to retained earnings for stranded tax effects resulting from the Tax Cuts and Jobs Act ("the Act"). The Company adopted this standard during the first quarter of 2018, which resulted in the reclassification of \$ 10 related to the tax effect of unrealized gains on derivatives.

In October 2016, the FASB issued ASU No. 2016-16, "Income Taxes (Topic 740) - Intra-Entity Transfers of Assets other than Inventory" ("ASU 2016-16"). ASU 2016-16 eliminated the exception that prohibited the recognition of current and deferred income tax consequences for intra-entity asset transfers (other than inventory) until the asset has been sold to an outside party. The amendments have been applied on a modified retrospective basis through a cumulative effect adjustment to retained earnings. The Company adopted this standard during the first quarter of 2018, which resulted in the reclassification of prepaid income taxes, deferred income taxes and retained earnings.

In January 2017, the FASB issued ASU No. 2017-04, "Intangibles—Goodwill and Other (Topic 350)" ("ASU 2017-04"). ASU 2017-04 simplified the accounting for goodwill impairments by eliminating step 2 from the goodwill impairment test. The Company early adopted this standard, which was applied prospectively, during the first quarter of 2018. The Company performs its annual goodwill impairment assessment on October 1 of each year. There was no impact from adoption of this standard as goodwill was not impaired in 2018.

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The cumulative effect of the changes made to the Company's consolidated January 1, 2018 balance sheet for the adoption of ASC 606, ASU 2018-02 and ASU 2016-16 was as follows:

	Balance at 12/31/2017	Adoption of ASC 606	Adoption of ASU 2018-02	Adoption of ASU 2016-16	Balance at 1/1/2018
Balance Sheet					
Prepaid income taxes	\$ 44,944	\$ —	\$ —	\$ (1,203)	\$ 43,741
Deferred income tax assets	26,976	(55)	—	1,229	28,150
Customer deposits and deferred revenue (short-term)	47,324	(816)	—	—	46,508
Income taxes payable	15,773	37	—	—	15,810
Deferred income tax liabilities	21,362	134	—	—	21,496
Retained earnings	1,443,867	590	(10)	26	1,444,473
Accumulated other comprehensive loss	(77,344)	—	10	—	(77,334)

In March 2016, the FASB issued ASU No. 2016-09, "Compensation - Stock Compensation (Topic 718): Improvements to Employee Share-Based Payment Accounting" ("ASU 2016-09"). ASU 2016-09 was intended to simplify several areas of accounting for share-based compensation arrangements, including income tax impact and classification on the consolidated statement of cash flows. ASU 2016-09 was effective for fiscal years, and interim periods within those years, beginning after December 15, 2016, and the Company adopted this statement effective January 1, 2017. Under ASU 2016-09, excess tax benefits and deficiencies as a result of stock option exercises and restricted stock unit vesting are being recognized as discrete items within income tax expense or benefit in the consolidated statements of comprehensive income in the reporting period in which they occur.

The adoption of ASU 2016-09 also required the cumulative effect of initially applying the standard to be recorded as an adjustment to the opening balance of retained earnings of the annual reporting period that included the date of initial application. This resulted in a cumulative effect increase of \$ 3,464 to retained earnings and deferred tax assets. Also, as a result of the adoption of ASU 2016-09, the Company made an accounting policy election to record forfeitures as they occur rather than by estimating expected forfeitures. The calculated cumulative effect was a decrease in retained earnings of \$ 1,319 and an increase in deferred tax assets and additional paid-in capital of \$ 759 and \$ 2,078 , respectively, as of January 1, 2017.

Other Pronouncements Currently Under Evaluation — In February 2016, the FASB issued ASU No. 2016-02, "Leases (Topic 842)" ("ASU 2016-02" or "the new lease standard"). ASU 2016-02 requires a lessee to recognize assets and liabilities on the balance sheet for leases with lease terms greater than twelve months. ASU 2016-02 is effective for fiscal years, and interim periods within those years, beginning after December 15, 2018. In July 2018, the FASB issued ASU 2018-11, which provides an additional transition method for implementing the new lease standard. The Company will adopt the provisions of ASU 2018-11 by applying the standard at the adoption date and recognizing a cumulative-effect adjustment. The Company has completed its review of the lease population and implementation of a software solution to assist with lease accounting and is currently evaluating footnote disclosures and policy revisions. The Company expects that the lease liability recorded upon adoption will be less than \$ 25,000 .

2. REVENUE FROM CONTRACTS WITH CUSTOMERS

Sales are derived from products for different applications: fiber lasers, diode lasers, diodes and systems for materials processing, fiber lasers and amplifiers for advanced applications, fiber amplifiers for communications applications, and fiber

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lasers for medical applications. The following tables represent a disaggregation of revenue from contracts with customers for the year ended December 31, 2018.

<u>Sales by application</u>		
Materials processing	\$	1,374,448
Other applications		85,426
Total	\$	1,459,874

<u>Sales by product</u>		
High Power Continuous Wave ("CW") Lasers	\$	909,726
Medium and Low Power CW Lasers		95,764
Pulsed Lasers		162,048
Quasi-Continuous Wave ("QCW") Lasers		66,700
Laser Systems		59,330
Other Revenue including Amplifiers, Service, Parts, Accessories and Change in Deferred Revenue		166,306
Total	\$	1,459,874

<u>Sales by geography</u>		
North America	\$	202,743
Europe:		
Germany		111,259
Other including Eastern Europe/CIS		296,917
Asia and Australia:		
China		629,079
Japan		87,619
Other		127,251
Rest of World		5,006
Total	\$	1,459,874

<u>Timing of revenue recognition</u>		
Goods and services transferred at a point in time	\$	1,447,343
Services transferred over time		12,531
Total	\$	1,459,874

The Company enters into contracts to sell lasers and spare parts, for which revenue is generally recognized upon shipment or delivery, depending on the terms of the contract. The Company also provides installation services and extended warranties. The Company frequently receives consideration from a customer prior to transferring goods to the customer under the terms of a sales contract. The Company records customer deposits related to these prepayments, which represent a contract liability. The Company also records deferred revenue related to installation services when consideration is received before the services have been performed. The Company recognizes customer deposits and deferred revenue as net sales after control of the goods or services has been transferred to the customer and all revenue recognition criteria is met. The Company bills customers for extended warranties upon entering into the agreement with the customer, resulting in deferred revenue. The timing of customer payments on contracts for the sale of customized robotic systems generally differs from the timing of revenue recognized, resulting in contract assets and liabilities. Contract assets are included within prepaid expense and other current assets on the

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consolidated balance sheets. Contract liabilities are included within accrued expenses and other current liabilities on the consolidated balance sheets.

Before the transition date (under ASC 605, *Revenue Recognition*), the Company deferred revenue for installation services in an amount equal to the greater of the cash received or the fair value for installation. Under the new revenue standard, the standalone selling price for installation services is deferred until control has transferred. The standalone selling price for installation services is determined based on the estimated number of days of service technician time required for installation at standard service rates.

The following table reflects the changes in the Company's contract assets and liabilities for the year ended December 31, 2018:

	December 31, 2018	January 1, 2018	Change	
Contract assets				
Contract assets	10,102	—	10,102	100.0 %
Contract liabilities				
Contract liabilities - current	52,606	46,508	6,098	13.1 %
Contract liabilities - long-term	1,413	182	1,231	676.4 %

During the year ended December 31, 2018, the Company recognized revenue of \$ 40,944 that was included in the contract liabilities at the beginning of the period.

The Company has elected the practical expedient in ASC 606-10-50-14, whereby the performance obligations for contracts with an original expected duration of one year or less are not disclosed. The following table represents the Company's remaining performance obligations from contracts that are recognized over time as of December 31, 2018:

	Remaining Performance Obligations						
	2019	2020	2021	2022	2023	2024	Total
Revenue expected to be recognized for extended warranty agreements	3,302	760	375	203	71	4	4,715
Revenue to be earned over time from contracts to sell robotic systems	38,038	1,700	—	—	—	—	39,738
Total	<u>\$ 41,340</u>	<u>\$ 2,460</u>	<u>\$ 375</u>	<u>\$ 203</u>	<u>\$ 71</u>	<u>\$ 4</u>	<u>\$ 44,453</u>

3. FAIR VALUE MEASUREMENTS

The Company's financial instruments consist of cash equivalents, short-term investments, accounts receivable, auction rate securities, accounts payable, drawings on revolving lines of credit, long-term debt, interest rate swaps and contingent purchase consideration.

The valuation techniques used to measure fair value are based upon observable and unobservable inputs. Observable inputs reflect market data obtained from independent sources, while unobservable inputs reflect internal market assumptions. These two types of inputs create the following fair value hierarchy: Level 1, defined as observable inputs such as quoted prices for identical instruments in active markets; Level 2, defined as inputs other than quoted prices in active markets that are either directly or indirectly observable; and Level 3, defined as unobservable inputs for which little or no market data exists, therefore requiring an entity to develop its own assumptions.

The carrying amounts of money market fund deposits, term deposits, accounts receivable, accounts payable and drawings on revolving lines of credit are considered reasonable estimates of their fair market value due to the short maturity of most of these instruments or as a result of the competitive market interest rates, which have been negotiated. The Company's bond securities are reported at fair value based upon quoted prices for instruments with identical terms in active markets. The Company's commercial paper securities reported at fair value are based upon model-driven valuations in which all significant inputs are observable or can be derived from or corroborated by observable market data for substantially the full term of the

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asset or liability, and are therefore classified as Level 2. At December 31, 2018, the Company's long-term notes consisted of a variable rate note and a fixed rate note, and the book value is considered a reasonable estimate of fair market value.

The following table presents fair value information related to the Company's assets and liabilities measured at amortized cost on the Consolidated Balance Sheets with the exception of the interest rate swap, which is measured at fair value:

		Fair Value Measurements at December 31, 2018		
	Total	Level 1	Level 2	Level 3
Assets				
Cash equivalents:				
Money market fund deposits and term deposits	\$ 180,965	\$ 180,965	\$ —	\$ —
U.S. Treasury and agency obligations	6,495	6,495	—	—
Commercial paper	78,948	—	78,948	—
Short-term investments:				
U.S. Treasury and agency obligations	116,800	116,800	—	—
Corporate bonds	227,009	227,009	—	—
Commercial paper	156,321	—	156,321	—
Long-term investments and other assets:				
Corporate bonds	3,859	3,859	—	—
Auction rate securities	847	—	—	847
Interest rate swap	31	—	31	—
Total assets	\$ 771,275	\$ 535,128	\$ 235,300	\$ 847
Liabilities				
Long-term notes	\$ 45,378	\$ —	\$ 45,378	\$ —
Contingent purchase consideration	898	—	—	898
Total liabilities	\$ 46,276	\$ —	\$ 45,378	\$ 898

		Fair Value Measurements at December 31, 2017		
	Total	Level 1	Level 2	Level 3
Assets				
Cash equivalents:				
Money market fund deposits and term deposits	\$ 425,917	\$ 425,917	\$ —	\$ —
Short-term investments:				
U.S. Treasury and agency obligations	41,217	41,217	—	—
Corporate bonds	131,048	131,048	—	—
Commercial paper	33,896	33,896	—	—
Long-term investments and other assets:				
Auction rate securities	1,016	—	—	1,016
Interest rate swap	16	—	16	—
Total assets	\$ 633,110	\$ 632,078	\$ 16	\$ 1,016
Liabilities				
Long-term notes	\$ 48,982	\$ —	\$ 48,982	\$ —
Contingent purchase consideration	902	—	—	902
Total liabilities	\$ 49,884	\$ —	\$ 48,982	\$ 902

Short-term investments consist of liquid investments including U.S. government and government agency notes, corporate bonds, commercial paper and certificates of deposit with original maturities of greater than three months but less than one year

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and are recorded at amortized cost. The fair value of the short-term investments considered held-to-maturity as of December 31, 2018 and December 31, 2017 was \$ 500,130 and \$ 206,161 , respectively, which represents an unrealized loss of \$ 302 and \$ 96 , respectively, as compared to the book value recorded on the consolidated balance sheets for the same periods. The fair value of the long-term investments considered held-to-maturity as of December 31, 2018 was \$ 3,859 , which represents the book value recorded on the Consolidated Balance Sheet for the same period. There were no long-term investments considered held-to-maturity as of December 31, 2017. There were no impairments for the investments considered held-to-maturity at December 31, 2018 and December 31, 2017.

The Company entered into an interest rate swap that is designated as a cash flow hedge associated with a new long-term note issued during the second quarter of 2016 that will terminate with the long-term note in May 2023. The fair value at December 31, 2018 for the interest rate swap considered pricing models whose inputs are observable for the securities held by the Company.

Auction rate securities and contingent consideration are measured at fair value on a recurring basis using significant unobservable inputs (Level 3). The fair value of the auction rate securities was determined using prices observed in inactive markets with limited observable data for the securities held by the Company. The auction rate securities are considered available-for-sale securities. They had a cost basis of \$ 847 and \$ 1,012 at December 31, 2018 and December 31, 2017, respectively. There were no impairments for the available-for-sale securities at December 31, 2018 and December 31, 2017.

The fair value of contingent consideration was determined using an income approach at the respective business combination date and at the reporting date. That approach is based on significant inputs that are not observable in the market and include key assumptions such as assessing the probability of meeting certain milestones required to earn the contingent consideration.

The following table presents information about the Company's movement in Level 3 assets and liabilities measured at fair value:

	2018	2017	2016
Auction rate securities			
Balance, January 1	\$ 1,016	\$ 1,144	\$ 1,136
Period transactions	(207)	—	—
Change in fair value	38	(128)	8
Balance, December 31	<u>\$ 847</u>	<u>\$ 1,016</u>	<u>\$ 1,144</u>
Contingent purchase consideration			
Balance, January 1	\$ 902	\$ —	\$ 20
Period transactions	—	902	(21)
Change in fair value	48	—	1
Foreign exchange adjustment	(52)	—	—
Balance, December 31	<u>\$ 898</u>	<u>\$ 902</u>	<u>\$ —</u>

The following table presents the effective maturity dates of debt investments as of December 31, 2018 and December 31, 2017:

	December 31, 2018		December 31, 2017	
	Book Value	Fair Value	Book Value	Fair Value
Investment maturity				
Held-to-maturity				
Less than 1 year	\$ 585,875	\$ 585,573	\$ 206,257	\$ 206,161
1 through 5 years	3,859	3,859	—	—
Total	<u>\$ 589,734</u>	<u>\$ 589,432</u>	<u>\$ 206,257</u>	<u>\$ 206,161</u>
Available-for-sale				
Greater than 5 years	<u>\$ 847</u>	<u>\$ 847</u>	<u>\$ 1,012</u>	<u>\$ 1,016</u>

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4. INVENTORIES

Inventories consist of the following:

	December 31,	
	2018	2017
Components and raw materials	\$ 233,594	\$ 145,261
Work-in-process	66,498	43,646
Finished goods	103,487	118,805
Total	<u>\$ 403,579</u>	<u>\$ 307,712</u>

The Company recorded inventory provisions totaling \$ 12,981 , \$ 16,946 and \$ 22,796 for the years ended December 31, 2018, 2017 and 2016, respectively. These provisions relate to the recoverability of the value of inventories due to technological changes and excess quantities. These provisions are reported as a reduction to components and raw materials and finished goods.

5. GOODWILL AND INTANGIBLES

The following table sets forth the changes in the carrying amount of goodwill for the years ended December 31, 2018 and 2017:

	December 31, 2018	December 31, 2017
Balance at January 1	\$ 55,831	\$ 19,828
Foreign exchange adjustment	(452)	(2)
Total goodwill arising from business combinations	47,705	36,005
Adjustments to goodwill during the measurement period	(2,362)	—
Balance at December 31	<u>\$ 100,722</u>	<u>\$ 55,831</u>

Intangible assets, subject to amortization, consisted of the following:

December 31, 2018					December 31, 2017			
	Gross Carrying Amount	Accumulated Amortization	Net Carrying Amount	Weighted- Average Lives	Gross Carrying Amount	Accumulated Amortization	Net Carrying Amount	
Patents	\$ 8,036	\$ (6,028)	\$ 2,008	8 years	\$ 8,036	\$ (5,486)	\$ 2,550	
Customer relationships	57,849	(6,427)	51,422	11 years	26,768	(5,584)	21,184	
Production know-how	9,211	(6,212)	2,999	7 years	6,820	(5,035)	1,785	
Technology, trademark and trade name	41,184	(10,474)	30,710	7 years	32,564	(6,860)	25,704	
Total	<u>\$ 116,280</u>	<u>\$ (29,141)</u>	<u>\$ 87,139</u>		<u>\$ 74,188</u>	<u>\$ (22,965)</u>	<u>\$ 51,223</u>	

Amortization expense for the years ended December 31, 2018, 2017 and 2016 was \$ 8,170 , \$ 5,899 and \$ 3,759 , respectively.

The estimated future amortization expense for intangibles as of December 31, 2018 is as follows:

2019	2020	2021	2022	2023	Thereafter	Total
\$ 12,861	\$ 12,027	\$ 11,661	\$ 10,794	\$ 9,844	\$ 29,952	\$ 87,139

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6. PROPERTY, PLANT AND EQUIPMENT

Property, plant, and equipment consist of the following:

	December 31,	
	2018	2017
Land	\$ 41,937	\$ 26,623
Buildings	332,150	267,256
Machinery and equipment	384,259	344,905
Office furniture and fixtures	65,775	55,885
Construction-in-progress	54,454	49,256
Total property, plant and equipment	878,575	743,925
Accumulated depreciation	(335,507)	(283,719)
Total property, plant and equipment — net	<u>\$ 543,068</u>	<u>\$ 460,206</u>

The Company recorded depreciation expense of \$ 68,231 , \$ 54,900 and \$ 44,757 for the years ended December 31, 2018, 2017 and 2016, respectively.

Long lived assets include property, plant and equipment, related deposits on such assets and demonstration equipment. The geographic locations of the Company's long-lived assets, net, based on physical location of the assets, as of December 31, 2018, 2017, and 2016 are as follows:

	December 31,	
	2018	2017
United States	\$ 346,343	\$ 273,947
Russia	76,359	87,612
Germany	81,218	83,826
China	9,123	8,191
Other	40,689	20,278
Total	<u>\$ 553,732</u>	<u>\$ 473,854</u>

7. ACCRUED EXPENSES AND OTHER LIABILITIES

Accrued expenses and other liabilities consist of the following:

	December 31,	
	2018	2017
Accrued compensation	\$ 60,107	\$ 63,203
Customer deposits and deferred revenue	46,703	47,324
Current portion of accrued warranty	23,106	25,059
Contract liabilities	9,819	—
Other	14,905	8,831
Total	<u>\$ 154,640</u>	<u>\$ 144,417</u>

8. PRODUCT WARRANTIES

Activity related to the warranty accrual was as follows:

	2018	2017	2016
Balance at January 1	\$ 47,517	\$ 33,978	\$ 28,210
Provision for warranty accrual	24,948	26,995	22,483
Warranty claims	(18,922)	(16,250)	(16,220)
Foreign currency translation and other	(2,121)	2,794	(495)
Balance at December 31	<u>\$ 51,422</u>	<u>\$ 47,517</u>	<u>\$ 33,978</u>

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Accrued warranty reported in the accompanying consolidated financial statements as of December 31, 2018 and December 31, 2017 consists of \$ 23,106 and \$ 25,059 in accrued expenses and other liabilities and \$ 28,316 and \$ 22,458 in other long-term liabilities, respectively.

9. FINANCING ARRANGEMENTS

The Company's borrowings under existing financing arrangements consist of the following:

	December 31,	
	2018	2017
Term debt:		
Long-term notes	\$ 45,378	\$ 48,982
Less: current portion	(3,671)	(3,604)
Total long-term debt	\$ 41,707	\$ 45,378

Term Debt:

Long-Term Notes — At December 31, 2018, the outstanding principal balance on the long-term notes was \$ 45,378 of which \$ 3,671 is the current portion. The Company has an unsecured long-term note of \$ 20,781 of which \$ 1,188 is the current portion. The interest on this unsecured long-term note is variable at 1.20 % above LIBOR and is fixed using an interest rate swap at 2.85 % per annum. The unsecured long-term note matures in May 2023, at which time the outstanding principal balance will be \$ 15,438 . The Company has another note that is secured by this corporate aircraft with an outstanding principal balance of \$ 24,597 of which \$ 2,483 is the current portion. The interest on this collateralized long-term note is fixed at 2.74 % per annum. The collateralized long-term note matures in July 2022, at which time the outstanding principal balance will be \$ 15,375 .

Revolving Line of Credit Facilities:

U.S. Line of Credit — The Company maintains an unsecured revolving line of credit with available principal of up to \$ 50,000 , expiring in April 2020. The line of credit bears interest at a variable rate of LIBOR plus 0.80 % to 1.20 % depending on the Company's financial performance. Part of this credit facility is available to the Company's foreign subsidiaries including those in India, China, Japan and South Korea based on management discretion. At December 31, 2018, there were no outstanding drawings, however there were \$ 930 of guarantees issued against the line which reduced the total availability. At December 31, 2018, the remaining availability under this line was \$ 49,070 .

The Company is required to meet certain financial covenants associated with its U.S. line of credit and collateralized long-term note. These covenants, tested quarterly, include a debt service coverage ratio and a funded debt to earnings before interest, taxes, depreciation and amortization ("EBITDA") ratio. The debt service coverage covenant requires the Company to maintain a trailing twelve month ratio of cash flow to debt service that is greater than 1.5 :1. Debt service in the calculation is decreased by our cash held in the U.S. in excess of \$ 50,000 up to a maximum of \$ 250,000 . Cash flow is defined as EBITDA less unfunded capital expenditures. The funded debt to EBITDA covenant requires that the sum of all indebtedness for borrowed money on a consolidated basis be less than three times the Company's trailing twelve months EBITDA.

Euro Line of Credit — The Company maintains an unsecured revolving line of credit with a principal amount of Euro 50,000 (\$ 57,219 at December 31, 2018), expiring in July 2020. The line of credit bears interest at various rates based upon the type of loan. This credit facility is available to the Company's foreign subsidiaries including those in Germany, Russia, China and Italy based on management discretion. At December 31, 2018, there were no drawings, however there were \$ 1,166 of guarantees issued against the line which reduced the total availability. At December 31, 2018, the remaining availability under this line was \$ 56,053 .

Other European Facilities — The Company maintains two Euro credit lines in Italy with aggregate available principal of Euro 2,000 (\$ 2,289 as of December 31, 2018), with no expiration date, which bear interest at market rates that reset at the beginning of each quarter. At December 31, 2018, there were no outstanding drawings and the aggregate remaining availability under these lines was \$ 2,289 . These facilities are collateralized by a common pool of the assets of the Company's Italian subsidiary.

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10. DERIVATIVE INSTRUMENTS

The Company's only outstanding derivative financial instrument is an interest rate swap that is classified as a cash flow hedge of its variable rate debt. The fair value amounts in the consolidated balance sheets were:

Notional Amounts ¹		Other Assets	
December 31,		December 31,	
2018	2017	2018	2017
\$ 20,781	\$ 21,969	\$ 31	\$ 16

- Notional amounts represent the gross contract/notional amount of the derivative outstanding.

The derivative gains and losses in the consolidated financial statements for the years ended December 31, 2018, 2017 and 2016, related to the Company's current and previous interest rate swap contracts were as follows:

	Year Ended December 31,		
	2018	2017	2016
Effective portion recognized in other comprehensive income (loss), pretax:			
Interest rate swap	\$ 15	\$ (61)	\$ 85
Effective portion reclassified from other comprehensive income (loss) to interest expense, pretax:			
Interest rate swap	—	—	(8)
Ineffective portion recognized in income:			
Interest rate swap	—	—	—

During the year ended December 31, 2018, the Company also entered into foreign currency forward contracts to hedge the value of intercompany dividends declared and paid in Euros by the Company's German subsidiary. These contracts were not designated as hedging instruments for accounting purposes and were fully settled during the year.

Losses associated with derivative instruments not designated as hedging instruments were as follows:

	Classification	Year Ended December 31,		
		2018	2017	2018
Losses recognized in income	Gain (loss) on foreign exchange	\$ (19)	\$ —	\$ —

11. COMMITMENTS AND CONTINGENCIES

Operating Leases — The Company leases certain facilities under cancelable and noncancelable operating lease agreements which expire through April 2041. In addition, it leases capital equipment and automobiles under operating leases. Rent expense for the years ended December 31, 2018, 2017 and 2016, totaled \$ 6,175 , \$ 8,095 and \$ 7,091 , respectively.

Commitments under the noncancelable lease agreements as of December 31, 2018 are as follows:

Years Ending December 31	Facilities and Land	Equipment and Automobiles	Total
2019	\$ 5,323	\$ 991	\$ 6,314
2020	3,945	658	4,603
2021	2,989	369	3,358
2022	2,493	103	2,596
2023	2,077	1	2,078
Thereafter	11,340	—	11,340
Total	\$ 28,167	\$ 2,122	\$ 30,289

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Employment Agreements — The Company has entered into employment agreements with certain members of senior management. The terms of these agreements are up to three years and include noncompetition, nonsolicitation and nondisclosure provisions, as well as provisions for defined severance for terminations of employment under certain conditions and a change of control of the Company. The Company also maintains a severance plan for certain of its senior management providing for defined severance for terminations of employment under certain conditions and a change of control of the Company.

Contractual Obligations — The Company has entered into various purchase obligations that include agreements for construction of buildings, raw materials and equipment. Obligations under these agreements were \$ 114,396 and \$ 119,960 as of December 31, 2018 and 2017, respectively.

Legal proceedings — From time to time, the Company may be involved in disputes and legal proceedings in the ordinary course of its business. These proceedings may include allegations of infringement of intellectual property, commercial disputes and employment matters. As of December 31, 2018 and through the date of the Company's subsequent review period of February 27, 2019, the Company has no legal proceedings ongoing that management estimates could have a material effect on the Company's Consolidated Financial Statements.

12. STOCK-BASED COMPENSATION

Stock-based compensation is included in the following financial statement captions:

	Year Ended December 31,		
	2018	2017	2016
Cost of sales	\$ 6,535	\$ 5,863	\$ 6,018
Sales and marketing	2,550	2,041	1,820
Research and development	6,410	5,001	4,905
General and administrative	12,532	10,116	8,991
Total stock-based compensation	28,027	23,021	21,734
Tax benefit recognized	(6,632)	(7,367)	(6,971)
Net stock-based compensation	\$ 21,395	\$ 15,654	\$ 14,763

Incentive Plans — In February 2006, the Company's board of directors adopted the 2006 Incentive Compensation Plan (the "2006 Plan"), which provides for the issuance of stock options, restricted stock units, performance stock units, other equity-based awards and cash awards to the Company's directors, employees, consultants and advisors. In June 2006, the Company's board of directors adopted the Non-Employee Directors Stock Plan (the "Directors Plan") for non-employee directors, which was subsequently merged into the 2006 Plan. A total of 10,363,465 shares are reserved under the 2006 Plan. At December 31, 2018, 3,680,071 shares of the Company's stock were available for future grant under the 2006 Plan. The Company may grant stock options only at an exercise price equal to or greater than the fair market value of its common stock on the date of grant. Equity awards generally become exercisable over periods of one to four years and generally expire ten years after the date of the grant. The vesting of awards under the 2006 Plan accelerate following the occurrence of certain change of control events, if the participant's employment is terminated within two years without cause or if the successor entity does not agree to assume existing awards or replace with equivalent value awards. Awards granted to non-employee directors automatically become exercisable upon a change of control. All shares issued under the 2006 Plan and Directors Plan are registered shares, newly issued by the Company.

Compensation cost for all stock-based payment awards is based on the estimated grant-date fair value. The Company allocates and records stock-based compensation expense on a straight-line basis over the requisite service period. Determining the appropriate fair value model and calculating the fair value of stock-based payment awards requires the use of highly subjective assumptions, including the expected life of the stock-based payment awards, stock price volatility and, prior to the adoption of ASU 2016-09 effective January 1, 2017, forfeiture rates. The assumptions used in calculating the fair value of stock-based payment awards represent management's best estimates, but the estimates involve inherent uncertainties and the application of management judgment. As a result, if factors change and the Company uses different assumptions, its stock-based compensation expense could be materially different in the future.

The Company calculates the fair value of stock option grants using the Black-Scholes option pricing model. The assumptions used in the Black-Scholes model or the calculation of compensation were as follows for the years ended December 31.

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	<u>2018</u>	<u>2017</u>	<u>2016</u>
Expected term	4.1 - 4.9 years	3.8 - 5.0 years	4.4 - 6.1 years
Volatility	31% - 36%	31% - 35%	37% - 45%
Risk-free rate of return	2.54% - 3.01%	1.57% - 1.97%	1.06% - 1.41%
Dividend yield	0.25 %	0.25 %	0.25 %
Forfeiture rate	— %	— %	2.65% - 5.26%

A summary of option activity is presented below (see Note 13, "Employee Benefit Plans" for further information):

	<u>Number of Options</u>	<u>Weighted- Average Exercise Price</u>	<u>Weighted- Average Remaining Contractual Life (In years)</u>	<u>Aggregate Intrinsic Value (In thousands)</u>
Outstanding — January 1, 2016	2,224,169	\$ 53.82		
Granted	260,930	82.84		
Exercised	(392,887)	35.81		
Forfeited	(27,959)	72.87		
Outstanding — December 31, 2016	2,064,253	60.65	6.04	\$ 78,556
Granted	293,284	124.57		
Exercised	(546,931)	50.50		
Forfeited	(13,113)	90.81		
Outstanding — December 31, 2017	1,797,493	73.95	6.02	\$ 251,970
Granted	257,111	232.26		
Exercised	(282,720)	58.94		
Forfeited	(24,810)	131.36		
Outstanding — December 31, 2018	1,747,074	\$ 98.93	5.80	\$ 58,084
Unvested — December 31, 2018	830,076	\$ 140.80	7.82	\$ 9,179
Exercisable — December 31, 2018	916,998	\$ 61.03	3.96	\$ 48,905

The intrinsic value of the options exercised during the years ended December 31, 2018, 2017 and 2016, was \$ 51,266 , \$ 50,131 and \$ 23,315 , respectively. The weighted-average grant fair value per share for options granted during the years ended December 31, 2018, 2017 and 2016, was \$ 71.06 , \$ 38.01 and \$ 33.08 , respectively. The total compensation cost related to non-vested awards not yet recorded at December 31, 2018 was \$ 22,367 which is expected to be recognized over a weighted-average of 2.7 years. The aggregate fair value of awards vested during the year ended December 31, 2018 was \$ 12,660 .

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The following table summarizes the restricted stock units ("RSU's") activity for the year ended December 31:

	Number of Shares	Weighted-Average Grant-Date Fair Value	Weighted- Average Remaining Contractual Life (In years)	Aggregate Intrinsic Value (In thousands)
Outstanding — January 1, 2016	277,719	\$ 77.22		
Granted	140,452	81.86		
Converted	(44,656)	70.64		
Canceled	(6,745)	81.89		
Outstanding — December 31, 2016	366,770	79.72	2.55	\$ 36,204
Granted	106,764	127.29		
Converted	(90,385)	66.18		
Canceled	(4,888)	90.54		
Outstanding — December 31, 2017	378,261	96.23	2.55	\$ 80,997
Granted	80,254	227.45		
Converted	(97,997)	91.62		
Canceled	(9,497)	121.37		
Outstanding — December 31, 2018	351,021	\$ 126.93	2.62	\$ 39,767
Unvested — December 31, 2018	351,021	\$ 126.93	2.62	\$ 39,767

The intrinsic value of the RSU's converted during the years ended December 31, 2018, 2017 and 2016, was \$ 22,978 , \$ 11,684 and \$ 3,931 , respectively. The weighted-average grant fair value per share for RSU's granted during the years ended December 31, 2018, 2017 and 2016, was \$ 227.45 , \$ 127.29 and \$ 81.86 , respectively. The total compensation cost related to non-vested awards not yet recorded at December 31, 2018 was \$ 24,214 which is expected to be recognized over a weighted-average of 2.7 years. The aggregate fair value of awards vested during the year ended December 31, 2018 was \$ 8,979 .

The Company grants performance stock units to executive officers. The performance stock unit agreements provide for the award of performance stock units with each unit representing the right to receive one share of the Company's common stock to be issued after the applicable award vesting period. The final number of units awarded, if any, for these performance grants will be determined as of the vesting dates, based upon the Company's total shareholder return over the performance period compared to the Russell 3000 Index and could range from no units to a maximum of twice the amount of awarded units. The weighted-average fair value of these performance units was determined using the Monte Carlo simulation model incorporating the following weighted-average assumptions:

	2018	2017	2016
Performance term	3.0 years	3.0 years	3.0 years
Volatility	13% - 32%	13% - 31%	13% - 32%
Risk-free rate of return	2.41 %	1.49 %	.88 %
Dividend yield	— %	— %	— %
Weighted-average fair value per share	284.78	147.25	88.51

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The following table summarizes the performance stock units ("PSU's") activity for the year ended December 31:

	Number of Shares	Weighted-Average Grant-Date Fair Value	Weighted- Average Remaining Contractual Life (In years)	Aggregate Intrinsic Value (In thousands)
Outstanding — January 1, 2016	27,233	\$ 128.54		
Granted	27,272	88.51		
Converted	—			
Canceled	—			
Outstanding — December 31, 2016	54,505	108.51	2.64	\$ 5,380
Granted	21,444	147.25		
Converted	—			
Canceled	—			
Outstanding — December 31, 2017	75,949	119.45	1.93	\$ 16,263
Granted	33,706	238.12		
Converted	—			
Canceled	—			
Outstanding — December 31, 2018	109,655	\$ 146.96	1.77	\$ 12,423
Unvested — December 31, 2018	109,655	\$ 146.96	1.77	\$ 12,423

PSU's are included at 100 % of target goal; under the terms of the awards, the recipient may earn between 0 % and 200 % of the awarded units. The total compensation cost related to nonvested awards not yet recorded at December 31, 2018 was \$ 5,586 which is expected to be recognized over a weighted average of 1.8 years.

13. EMPLOYEE BENEFIT PLANS

The Company maintains a defined contribution retirement plan offered to all of its U.S. employees, as well as plans at certain foreign subsidiaries. The Company makes matching contributions to each plan, which amounted to approximately \$ 4,261 , \$ 3,363 and \$ 2,509 , respectively for years ended December 31, 2018, 2017 and 2016.

The Company has an employee stock purchase plan offered to its U.S. and German employees. The plan allows employees who participate to purchase shares of common stock through payroll deductions at a 15 % discount to the lower of the stock price on the first day or the last day of the six-month purchase period. Payroll deductions may not exceed 10 % of the employee's compensation and are subject to other limitations. Compensation expense related to the employee stock purchase plan was \$ 925 , \$ 967 and \$ 846 for the years ended December 31, 2018, 2017 and 2016, respectively. As of December 31, 2018, there were 387,498 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 are subject to approval of the employee stock purchase plan at the 2019 annual meeting of stockholders.

14. INCOME TAXES

Income before the impact of income taxes for the years ended December 31 consisted of the following:

	2018	2017	2016
U.S.	\$ 146,855	\$ 190,480	\$ 103,798
Foreign	387,540	361,391	262,767
Total	\$ 534,395	\$ 551,871	\$ 366,565

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The Company's provision for income taxes for the years ended December 31 consisted of the following:

	2018	2017	2016
Current:			
Federal	\$ (7,274)	\$ (85,761)	\$ (41,407)
State	(2,097)	(2,387)	(4,750)
Foreign	(125,431)	(93,254)	(72,600)
Total current	(134,802)	(181,402)	(118,757)
Deferred:			
Federal	(2,497)	(12,459)	8,709
State	(8,449)	(649)	383
Foreign	15,522	(9,773)	3,816
Total deferred	4,576	(22,881)	12,908
Provision for income taxes	\$ (130,226)	\$ (204,283)	\$ (105,849)

A reconciliation of income tax expense at the U.S. federal statutory income tax rate to the recorded tax provision for the years ended December 31, were as follows:

	2018	2017	2016
Tax at statutory rate	\$ (112,223)	\$ (193,155)	\$ (128,298)
Non-U.S. rate differential — net	(26,985)	25,795	16,718
State income taxes — net	(3,367)	(3,413)	(2,640)
Stock-based compensation - tax benefit	13,298	14,015	—
Foreign derived intangible income benefit	7,930	—	—
Global intangible low-taxed income taxed in the U.S.	(5,955)	—	—
Effect of 2017 U.S. Tax Cuts and Jobs Act	4,747	(48,126)	—
Effect of changes in enacted tax rates on deferred tax assets and liabilities	(1,422)	(1,281)	(111)
Effect of changes in enacted tax rates on prepaid taxes	(6,585)	—	—
Federal and state tax credits	11,024	9,210	9,840
Change in reserves, including interest and penalties	(2,290)	(4,350)	1,105
Change in valuation allowance	(7,421)	51	26
Other — net	(977)	(3,029)	(2,489)
Provision for income taxes	\$ (130,226)	\$ (204,283)	\$ (105,849)

The tax effects of temporary differences that give rise to significant portions of the deferred tax assets and deferred tax liabilities at December 31, were as follows:

	2018	2017
Property, plant and equipment	\$ (22,443)	\$ (20,191)
Inventory provisions	12,963	13,437
Allowances and accrued liabilities	(2,599)	3,588
Other tax credits	10,771	10,294
Deferred compensation	17,481	(5,223)
Net operating loss carryforwards	3,364	3,993
Valuation allowance	(7,910)	(284)
Net deferred tax assets	\$ 11,627	\$ 5,614

On December 22, 2017, the U.S. government enacted comprehensive tax legislation commonly referred to as the Tax Cuts and Jobs Act (the "Tax Act"). The Tax Act makes broad and complex changes to the U.S. tax code including, but not limited to, (1) reducing the U.S. federal corporate tax rate from 35% to 21%, (2) requiring a one-time transition tax on certain undistributed earnings of foreign subsidiaries that is payable over eight years, (3) generally eliminating U.S. federal income taxes on dividends from foreign subsidiaries, (4) providing an incentive benefit for U.S. income from intangibles (Foreign Derived Intangible Income); (5) increasing U.S. taxable income to include all income earned by foreign subsidiaries in excess

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of ten percent of the fixed assets in those entities (Global Intangible Low-taxed Income) and (6) providing for bonus depreciation that will allow for full expensing of qualified property.

The Securities and Exchange Commission ("SEC") staff issued Staff Accounting Bulletin ("SAB") 118, which provides guidance on accounting for the tax effects of the Tax Act. SAB 118 provides a measurement period that should not extend beyond one year from the Tax Act enactment date for companies to complete the accounting under ASC 740. In accordance with SAB 118, a company must reflect the income tax effects of those aspects of the Tax Act for which the accounting under ASC 740 is complete. To the extent that a company's accounting for certain income tax effects of the Tax Act is incomplete but it is able to determine a reasonable estimate, it must record a provisional estimate in the financial statements. If a company cannot determine a provisional estimate to be included in the financial statements, it should continue to apply ASC 740 on the basis of the provisions of the tax laws that were in effect immediately before the enactment of the Tax Act.

The Company's accounting for the Deemed Repatriation Transition Tax ("Transition Tax") element of the Tax Act is now complete. The final calculation for the 2017 tax return was \$ 43,379 . As of December 31, 2017, the Company had recorded a provisional expense for the Transition Tax of \$ 48,126 . The decrease of \$ 4,747 was recorded as a reduction in tax expense in the third quarter of 2018. As the Transition Tax is payable over 8 years, \$ 30,263 and \$ 44,366 of this amount is included within other long-term liabilities on the consolidated balance sheets at December 31, 2018 and 2017, respectively. In addition, the Company has calculated a \$ 1,422 reduction in the valuation of net deferred tax assets related to the decrease in the U.S. federal tax rate. As of December 31, 2017, the Company had recorded a provisional decrease of \$ 1,281 . The increase of \$ 141 was recorded as an increase to tax expense in the third quarter of 2018. The impact of other provisions in the Tax Act that were effective January 1, 2018, including the tax impact of the Foreign Derived Intangible Income ("FDII") and Global Intangible Low-Taxed Income ("GILTI") sections, are included in the effective tax rate calculation for 2018. The Company has included a benefit from FDII of \$ 7,930 and a detriment from GILTI of \$ 5,955 in the tax expense for 2018.

In 2018 the Company repatriated \$ 521,820 from its German subsidiary, which increased U.S. state taxes by \$ 1,084 . No federal taxes were provided as a result of the Tax Act as it provided for a deduction equal to the amount of the dividend. The Company has recorded a \$ 2,225 deferred tax liability for certain withholding and dividend taxes related to possible future distributions from non-U.S. subsidiaries to their non-U.S. parents. With regard to future repatriation of undistributed earnings of non-U.S. subsidiaries back to the U.S., the Company continues to consider these earnings to be indefinitely reinvested and, accordingly, has not recorded any deferred income taxes for state tax or withholding taxes that would be assessed on such a repatriation. At December 31, 2018 and 2017, the cumulative undistributed earnings in non-U.S. subsidiaries were approximately \$ 930,993 and \$ 1,266,000 , respectively.

As of December 31, 2018 and 2017, the Company had state tax credit carry-forwards of \$ 11,801 and \$ 10,294 , respectively. The state tax credit carry-forwards begin expiring in 2020. The Company has determined that it is not more likely than not that some of the state credits will be used before the expiration date and had provided a valuation allowance of \$ 7,439 in 2018. In addition, at December 31, 2018, the Company has net operating loss carry-forwards available for future periods of \$ 2,888 related to its U.K. subsidiary. The U.K. net operating loss can be carried-forward indefinitely; however, the Company does not believe it is more likely than not it can be used and has provided a valuation allowance for part of this amount.

The Company's acquisition of Menara Networks, Inc. ("Menara") in 2016 included net operating loss carry-forwards of \$ 22,242 . As of December 31, 2018 and 2017 , the Company had \$ 12,577 and \$ 16,202 of these net operating loss carry-forwards remaining, respectively. No valuation allowance has been provided for these carry-forwards as the Company expects to be able to fully utilize them to offset future income.

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. The following is a tabular reconciliation of the total amounts of unrecognized tax benefits:

	2018	2017
Balance at January 1	\$ 10,370	\$ 6,403
Change in prior period positions	(1,067)	(2,240)
Additions for tax positions in current period	2,726	6,207
Foreign exchange adjustments	\$ (823)	
Balance at December 31	<u>11,206</u>	<u>10,370</u>

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Substantially all of the liability for uncertain tax benefits related to various federal, state and foreign income tax matters, would benefit the Company's effective tax rate, if recognized.

Estimated penalties and interest related to the underpayment of income taxes were \$ 631 , \$ 121 and (\$ 163) for the years ended December 31, 2018, 2017 and 2016, respectively, and are included within the provision for income taxes. Total accrued penalties and interest related to the underpayment of income taxes were \$ 1,419 and \$ 789 at December 31, 2018 and 2017, respectively.

The Company's uncertain tax positions are related to tax years that remain subject to examination by the relevant taxing authorities. If these uncertain tax positions were realized, they would benefit the Company's effective tax rate. The Company is currently under a tax audit in Germany for the years 2013 to 2016. Open tax years by major jurisdictions are:

United States	2016 - 2018
Germany	2013 - 2018
Russia	2015 - 2018

At December 31, 2018, we had \$ 243.4 million of cash and cash equivalents and \$ 500.4 million in short-term investments in the United States and \$ 301.0 million of cash and cash equivalents at foreign locations. Cash and cash equivalents outside of the United States are intended to fund working capital, capital expenditures and business expansion outside the United States.

15. NET INCOME ATTRIBUTABLE TO IPG PHOTONICS CORPORATION PER SHARE

The following table sets forth the computation of diluted net income attributable to IPG Photonics Corporation per share:

	Year Ended December 31,		
	2018	2017	2016
Net income attributable to IPG Photonics Corporation	\$ 404,027	\$ 347,614	\$ 260,752
Net income attributable to common stockholders	404,027	347,614	260,752
Weighted average shares	53,522	53,495	53,068
Dilutive effect of common stock equivalents	1,204	1,204	729
Diluted weighted average common shares	54,726	54,699	53,797
Basic net income attributable to IPG Photonics Corporation per share	\$ 7.55	\$ 6.50	\$ 4.91
Basic net income attributable to common stockholders	\$ 7.55	\$ 6.50	\$ 4.91
Diluted net income attributable to IPG Photonics Corporation per share	\$ 7.38	\$ 6.36	\$ 4.85
Diluted net income attributable to common stockholders	\$ 7.38	\$ 6.36	\$ 4.85

For the years ended December 31, 2018, 2017 and 2016, respectively, the computation of diluted weighted average common shares excludes common stock equivalents of 30,880 shares, 16,104 shares and 60,797 shares which includes RSU's of 19,370 , 10,724 and 12,711 and PSU's of 6,310 , nil and 809 , because the effect would be anti-dilutive.

In July 2016, the Company announced that its Board of Directors authorized a share repurchase program (the "2016 Program") to mitigate the dilutive impact of shares issued upon exercise or release under the Company's various employee and director equity compensation and employee stock purchase plans. Under the 2016 Program, the Company's management was authorized to repurchase shares of common stock in an amount not to exceed 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, 2016 through December 31, 2017. The 2016 Program limited aggregate share repurchases to no more than \$100,000 over a period ending June 30, 2018.

On July 31, 2018, the Company announced that its Board of Directors authorized a new anti-dilutive stock repurchase program (the "2018 Program") following the completion of the Program. Under the 2018 Program, IPG management was authorized to repurchase shares of common stock in an amount not to exceed the greater of (a) the number of shares issued to employees and directors under the Company's various employee and director equity compensation and employee stock purchase plans from January 1, 2018 through March 31, 2019 and (b) \$125,000, exclusive of any fees, commissions or other expenses. Repurchases under the 2018 Program were completed in November 2018.

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For the years ended December 31, 2018, 2017 and 2016, respectively, the Company repurchased 1,051,825 shares, 275,495 shares, and 102,774 shares of its common stock with an average price of \$ 167.39 , \$ 145.15 and \$ 87.01 per share in the open market. The impact on the reduction of weighted average shares for years ended December 31, 2018, 2017 and 2016 was 363,936 shares, 160,440 shares and 20,935 shares, respectively.

16. BUSINESS COMBINATIONS

During the fourth quarter of 2018, the Company acquired 100 % of the membership units of Genesis System Group, LLC (“Genesis”). Genesis is based in Davenport, Iowa, and has production facilities in the United States, Mexico, and Japan. Genesis develops innovative robotic system solutions for applications that include welding, non-destructive inspection, machine vision, materials handling, removal and dispensing. The Company paid \$ 107,539 to acquire Genesis, which represents the fair value on that date. Of the purchase price, \$ 3,350 was held back in escrow for potential post-closing adjustments related to working capital and indemnities provided by the seller. As a result of the acquisition, the Company recorded intangible assets of \$ 32,350 related to customer relationships with a weighted-average estimated useful life of 11 years and \$ 11,350 related to technology, trademark and tradename with a weighted-average estimated useful life of 6 years. Any excess of the acquisition consideration over the fair value of assets acquired and liabilities assumed is allocated to goodwill, which amounted to \$ 45,236 , most of which will be deductible for tax purposes.

The purchase price allocations included in the Company's financial statements are not complete. They represent the preliminary fair value estimates as of December 31, 2018 and are subject to subsequent adjustment as the Company obtains additional information during the measurement period and finalizes its fair value estimates. Any subsequent adjustments to these fair value estimates occurring during the measurement period will result in an adjustment to intangibles or income, as applicable.

During the second quarter of 2018, the Company acquired 100 % of the shares of robot concept GmbH (“RC”). RC located near Munich, Germany, designs and manufactures customized laser systems. The purchase price was \$ 4,453 , which represents the fair value on that date. As a result of the acquisition, the Company recorded intangible assets of \$ 111 related to customer relationships with a weighted-average estimated useful life of 1 year and \$ 594 related to technology, trademark and tradename with a weighted-average estimated useful life of 10 years. Any excess of the acquisition consideration over the fair value of assets acquired and liabilities assumed is allocated to goodwill, which amounted to \$ 4,072 . The goodwill arising from this acquisition will not be deductible for tax purposes.

The fair values of net tangible assets and intangible assets acquired were based upon the Company's estimates and assumptions at the acquisition dates. The following table summarizes the allocation of the assets acquired and liabilities assumed at the acquisition dates for the year ended December 31, 2018:

	Genesis	RC	Total
Cash and cash equivalents	\$ 2,847	\$ 30	\$ 2,877
Assets acquired excluding cash and cash equivalents and deferred tax assets	39,262	2,151	41,413
Liabilities assumed excluding deferred tax liabilities	(23,506)	(1,932)	(25,438)
Deferred tax liabilities, net	—	(573)	(573)
Intangible assets	43,700	705	44,405
Total identifiable net assets	62,303	381	62,684
Goodwill	45,236	4,072	49,308
Total purchase price	<u>\$ 107,539</u>	<u>\$ 4,453</u>	<u>\$ 111,992</u>

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The operating results of Genesis are included in the consolidated results of operations from the date of acquisition. The impact of earnings from Genesis from January 1, 2017 to the date of acquisition were not material to the Company. The following table presents consolidated pro forma information as if the acquisition had occurred on January 1, 2017:

	Pro forma (Unaudited)	
	Years ended December 31,	
	2018	2017
Net sales	\$ 1,551,373	\$ 1,511,051

During the fourth quarter of 2017, the Company acquired 100 % of the shares of Laser Depth Dynamics Inc. (“LDD”). LDD, located in Kingston, Ontario, Canada, provides in-process quality monitoring and control solutions for laser-based welding applications. The purchase price was \$ 9,992 , which represents the fair value on that date. As a result of the acquisition, the Company recorded intangible assets of \$ 1,006 related to customer relationships with a weighted-average estimated useful life of 6 years and \$ 2,608 related to technology, trademark and tradename with a weighted-average estimated useful life of 6 years. Any excess of the acquisition consideration over the fair value of assets acquired and liabilities assumed is allocated to goodwill, which amounted to \$ 5,276 . The goodwill arising from this acquisition will be deductible for tax purposes.

During the third quarter of 2017, the Company acquired 100 % of the membership units of Innovative Laser Technologies, LLC ("ILT") located in Minneapolis, Minnesota. ILT produces high precision laser-based systems for the medical device industry and other end user markets. The Company paid \$ 40,256 to acquire ILT, which represents the fair value on that date. As a result of the acquisition, the Company recorded intangible assets of \$ 11,660 related to customer relationships with an estimated useful life of 13 years and \$ 7,480 related to technology, trademark and tradename with a weighted-average estimated useful life of 8 years. Any excess of the acquisition consideration over the fair value of assets acquired and liabilities assumed is allocated to goodwill, which amounted to \$ 19,467 . The majority of goodwill arising from this acquisition will not be deductible for tax purposes.

During the second quarter of 2017, the Company acquired 100 % of the shares of OptiGrate Corporation ("OptiGrate") located in Oviedo, Florida. OptiGrate is a developer and manufacturer of volume Bragg gratings used in the production of lasers and laser diodes. The Company paid \$ 16,870 to acquire OptiGrate, which represents the fair value on that date. As a result of the acquisition, the Company recorded intangible assets of \$ 1,010 related to customer relationships with an estimated useful life of 4 years and \$ 4,650 related to technology, trademark and tradename with a weighted-average estimated useful life of 9 years. Any excess of the acquisition consideration over the fair value of assets acquired and liabilities assumed is allocated to goodwill, which amounted to \$ 8,900 . The goodwill arising from this acquisition will not be deductible for tax purposes.

The following table summarizes the allocation of the assets acquired and liabilities assumed at the acquisition dates for the year ended December 31, 2017:

	LDD	ILT	OptiGrate	Total
Cash and cash equivalents	\$ 1,002	\$ 969	\$ 3,714	\$ 5,685
Assets acquired excluding cash and cash equivalents and deferred tax assets	1,346	14,353	1,351	17,050
Liabilities assumed excluding deferred tax liabilities	(708)	(11,669)	(687)	(13,064)
Deferred tax liabilities, net	(538)	(2,004)	(2,068)	(4,610)
Intangible assets	3,614	19,140	5,660	28,414
Total identifiable net assets	4,716	20,789	7,970	33,475
Goodwill	5,276	19,467	8,900	33,643
Total purchase price	<u>\$ 9,992</u>	<u>\$ 40,256</u>	<u>\$ 16,870</u>	<u>\$ 67,118</u>

During the fourth quarter of 2016, the Company acquired BioPhotonic Solutions, Inc. ("BSI") located in East Lansing, Michigan. BSI develops and sells pulse shaping software technology for use in ultrafast lasers. The total purchase price was \$ 1,481 , which represents the fair value of BSI on that date. As a result of the acquisition, the Company recorded intangible assets of \$ 1,395 related to patents with an estimated useful life of 7 years.

During the second quarter of 2016, the Company acquired Menara located in Dallas, Texas. Menara develops and sells pluggable transceivers used in telecom and data-com networks. The Company paid \$46,831 which represents the fair value of Menara on that date. As a result of the acquisition, the Company recorded intangible assets of \$ 9,900 related to technology and

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tradename with a weighted-average estimated useful life of 7 years and \$ 9,500 related to customer relationships with an estimated useful life of 10 years. Additionally, the Company recorded \$ 19,325 of goodwill related to anticipated expansion of the Company's product offerings within the telecom market. The goodwill arising from this acquisition will not be deductible for tax purposes.

The following table summarizes the allocation of the assets acquired and liabilities assumed at the acquisition dates for the year ended December 31, 2016:

	Year Ended December 31, 2016		
	BSI	Menara	Total
Cash and cash equivalents	\$ —	\$ 520	\$ 520
Assets acquired excluding cash and cash equivalents and deferred tax assets	219	9,585	9,804
Liabilities assumed excluding deferred tax liabilities	(133)	(1,876)	(2,009)
Deferred tax liabilities, net	—	(123)	(123)
Intangible assets	1,395	19,400	20,795
Total identifiable net assets	1,481	27,506	28,987
Goodwill	—	19,325	19,325
Total purchase price	\$ 1,481	\$ 46,831	\$ 48,312

Results of operations for the businesses acquired above have been included in the Company's consolidated financial statements after the date of such acquisitions. Also, pro forma results of operations in accordance with authoritative guidance for prior periods have not been presented because the effect of the acquisitions were not material to the Company's prior period consolidated financial results.

17. RELATED-PARTY TRANSACTIONS

The CEO leases the annual right to use 30 % of the Company's aircraft under an October 2014 lease, which was superseded by a new lease signed in July 2017 in connection with the purchase of a different aircraft. The 2017 lease expires July 2022. The annual lease rate under the 2017 lease was \$ 925 and future rent payments are adjusted annually. The annual lease rate under the 2014 lease was \$ 651 . The CEO paid the Company \$ 925 , \$ 753 , and \$ 651 in 2018, 2017, and 2016, respectively, under the aircraft leases. In addition, the CEO directly pays an unrelated flight management firm for the operating costs of his private use including pilot fees, fuel and other costs.

In 2018, 2017 and 2016, the Company purchased various equipment, parts and services from a company for which one of the Company's independent directors is an executive officer. The payments made for such equipment, parts and services for 2018, 2017 and 2016, totaled \$ 947 , \$ 2,296 , and \$ 5,392 , respectively. There were no amounts due to this company at December 31, 2018 or at December 31, 2017. In 2017 and 2016, the Company sold products totaling \$ 503 and \$ 146 , respectively to a company where another member of the Company's independent directors is an executive officer. No sales were made to this company in 2018.

In 2016, the Company purchased an office building located in Marlborough, Massachusetts from a subsidiary of IP Fibre Devices (UK) Ltd. ("IPFD") for \$ 23,750 . The purchase price was based on the fair market value of the building determined using an independent appraisal. The appraisal was commissioned by the Nominating and Corporate Governance Committee of the Board of Directors. The Company's Chief Executive Officer ("CEO") is the managing director of IPFD. The CEO and certain founding members of the Company, which include the Senior Vice President, Chief Technology Officer and the Senior Vice President, Chief Operating Officer and Managing Director of IPG Laser GmbH, own shares in IPFD which is a stockholder of the Company. The Company leased space in the building prior to purchasing it and reimbursed the landlord for its portion of certain operational costs. The Company paid IPFD \$ 10 and \$ 443 for 2017 and 2016, respectively, under the office lease.

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18. SELECTED QUARTERLY FINANCIAL DATA (UNAUDITED)

	First Quarter	Second Quarter	Third Quarter	Fourth Quarter
<u>2018</u>				
Net sales	\$ 359,864	\$ 413,613	\$ 356,346	\$ 330,051
Gross profit	203,362	234,975	195,184	166,747
Net income attributable to IPG Photonics Corporation	106,334	121,617	100,517	75,559
Basic earnings per share	1.98	2.27	1.88	1.42
Diluted earnings per share	1.93	2.21	1.84	1.40

	First Quarter	Second Quarter	Third Quarter	Fourth Quarter
<u>2017</u>				
Net sales	\$ 285,846	\$ 369,373	\$ 392,615	\$ 361,055
Gross profit	157,267	206,296	224,555	208,793
Net income attributable to IPG Photonics Corporation	74,945	104,116	115,597	52,956
Basic earnings per share	1.40	1.95	2.16	0.99
Diluted earnings per share	1.38	1.91	2.11	0.96

Net income attributable to IPG Photonics Corporation as well as basic and diluted earnings per share in the fourth quarter of the year ended December 31, 2017 were impacted by the legislation that enacted the Tax Act. Refer to Note 14 for further explanation.

19. SUBSEQUENT EVENTS

On February 12, 2019, the Company announced that its board of directors authorized a new \$ 125 million anti-dilutive stock repurchase program (the "2019 Program") following the completion of its \$ 125 million repurchase program authorized in July 2018. Under the 2019 Program, IPG management is authorized to repurchase shares of common stock in an amount not to exceed the lesser of (a) the number of shares issued to employees and directors under the Company's various employee and director equity compensation and employee stock purchase plans from January 1, 2019 through December 31, 2020 and (b) \$ 125 million, exclusive of any fees, commissions or other expenses. Share repurchases will be made periodically in open-market transactions using the Company's working capital, and are subject to market conditions, legal requirements and other factors. The 2019 Program authorization does not obligate the Company to repurchase any dollar amount or number of its shares, and repurchases may be commenced or suspended from time to time without prior notice.

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EXHIBIT

<u>Exhibit Number</u>	<u>Description</u>
3.1	<u>Form of Second Amended and Restated Certificate of Incorporation of the Registrant (incorporated by reference to Exhibit 3.2 to Registration Statement No. 333-136521 filed with the Securities and Exchange Commission (the "Commission") on August 11, 2006)</u>
3.2	<u>Form of Amended and Restated By-laws of the Registrant (incorporated by reference to Exhibit 3.2 to the Registrant's current Report on Form 8-K filed with the Commission on October 30, 2018)</u>
4.1	<u>Specimen Stock Certificate (incorporated by reference to Exhibit 4.1 to Registration Statement No. 333-136521 filed with the Commission on November 14, 2006)</u>
10.1	<u>2006 Incentive Compensation Plan, as amended (incorporated by reference to Exhibit 10.1 to the Registrant's Current Report on Form 8-K/A filed with the Commission on February 22, 2017)</u>
10.2	<u>IPG Photonics Corporation Non-Employee Director Compensation Plan, as amended (incorporated by reference to Exhibit 10.5 to the Registrant's Current Report on Form 8-K/A filed with the Commission on February 22, 2017)</u>
10.3	<u>Senior Executive Annual Incentive Plan, as amended (incorporated by reference to Exhibit 10.2 to the Registrant's Current Report on Form 8-K/A filed with the Commission on February 22, 2017)</u>
10.4	<u>2008 Employee Stock Purchase Plan (incorporated by reference to Exhibit 10.8 to the Registrant's Current Report on Form 8-K filed with the Commission on May 13, 2008)</u>
10.5	<u>Amendment to 2008 Employee Stock Purchase Plan (incorporated by reference to Exhibit 10.1 to the Registrant's Current Report on Form 8-K filed with the Commission on June 15, 2009)</u>
10.6	<u>Employment Agreement dated October 7, 2013 between the Registrant and Dr. Valentin P. Gapontsev, (incorporated by reference to Exhibit 10.1 to the Registrant's Current Report on Form 8-K filed with the Commission on October 15, 2013)</u>
10.7	<u>Service Agreement dated October 7, 2013 between IPG Laser GmbH and Dr. Eugene Scherbakov, (incorporated by reference to Exhibit 10.2 to the Registrant's Current Report on Form 8-K filed with the Commission on October 15, 2013)</u>
10.8	<u>Form of Employment Agreement dated October 7, 2013 between the Registrant and each of Timothy P.V. Mammen, Angelo P. Lopresti and Alexander Ovtchinnikov, (incorporated by reference to Exhibit 10.3 to the Registrant's Current Report on Form 8-K filed with the Commission on October 15, 2013)</u>
10.9	<u>Form of Letter amending Employment Agreements and Confidentiality, Non-Competition and Confirmatory Assignment Agreements between the Registrant and each of the named executive officers and certain other executive officers (incorporated by reference to Exhibit 10.4 to the Registrant's Current Report on Form 8-K/A filed with the Commission on February 22, 2017)</u>
10.10	<u>Form of Indemnification Agreement between the Registrant and each of its Directors and Executive Officers (incorporated by reference to Exhibit 10.3 to Registrant's Current Report on Form 8-K/A filed with the Commission on February 22, 2017)</u>
10.11	<u>Amended and Restated Loan Agreement between the Registrant and Bank of America, N.A., dated as of April 30, 2015 (incorporated by reference to Exhibit 10.1 to the Registrant's Quarterly Report on Form 10-Q filed with the Commission on May 6, 2015)</u>
10.12	<u>Revolving Credit Note by the Registrant dated as of April 30, 2015 (incorporated by reference to Exhibit 10.2 to the Registrant's Quarterly Report on Form 10-Q filed with the Commission on May 6, 2015)</u>
10.13	<u>First Amendment to the Amended and Restated Loan Agreement, between the Registrant and Bank of America, N.A. dated as of May 19, 2016 (incorporated by reference to Exhibit 10.3 to the Registrant's Current Report on Form 8-K filed with the Commission on May 20, 2016)</u>
10.14	<u>Term Note, between the Registrant and Bank of America, N.A., dated May 19, 2016 (incorporated by reference to Exhibit 10.4 to the Registrant's Current Report on Form 8-K filed with the Commission on May 20, 2016)</u>

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<u>Exhibit Number</u>	<u>Description</u>
10.15	Third Amendment to Credit Facility Agreement between IPG Laser GmbH and Deutsche Bank AG, dated November 1, 2016 (incorporated by reference to Exhibit 10.1 to the Registrant’s Quarterly Report on Form 10-Q filed with the Commission on November 2, 2016)
10.16	Annex I (Third Amendment) to Guarantee of IPG Laser GmbH to Deutsche Bank AG dated November 1, 2016 (incorporated by reference to Exhibit 10.2 to the Registrant’s Quarterly Report on Form 10-Q filed with the Commission on November 2, 2016)
10.17	Fourth Amendment to Credit Facility Agreement between IPG Laser GmbH and Deutsche Bank AG, dated December 16, 2016 (incorporated by reference to Exhibit 10.43 on the Registrant's Annual Report on Form 10-K filed with the Commission on February 27, 2017)
10.18	Annex I (Fourth Amendment) to Guarantee of IPG Laser GmbH to Deutsche Bank AG dated December 16, 2016 (incorporated by reference to Exhibit 10.44 on the Registrant's Annual Report on Form 10-K filed with the Commission on February 27, 2017)
10.19	Credit Facility Agreement between IPG Laser GmbH and Deutsche Bank AG, dated July 27, 2017 (incorporated by reference to Exhibit 10.1 on Current Report on Form 8-K filed with the Commission on August 1, 2017)
10.20	Annex I to Credit Facility Agreement between IPG Laser GmbH and Deutsche Bank AG, dated July 27, 2017 (incorporated by reference to Exhibit 10.2 on Current Report on Form 8-K filed with the Commission on August 1, 2017)
10.21	Guarantee of the Registrant to Deutsche Bank dated July 27, 2017 (incorporated by reference to Exhibit 10.3 on Current Report on Form 8-K filed with the Commission on August 1, 2017)
10.22	Loan and Aircraft Security Agreement between TVPX Aircraft Solutions, as Trustee under the Trust Pledge Agreement between Registrant and Trustee dated July 27, 2017, and Banc of America Leasing & Capital, LLC dated July 27, 2017 (incorporated by reference to Exhibit 10.22 to the Registrant's Annual Report on Form 10-K filed with the Commission on February 28, 2018)
10.23	Promissory Note between TVPX Aircraft Solutions dated July 27, 2017, as Trustee under the Trust Pledge Agreement between Registrant and Trustee dated July 27, 2017, and Banc of America Leasing & Capital, LLC dated July 27, 2017 (incorporated by reference to Exhibit 10.23 to the Registrant's Annual Report on Form 10-K filed with the Commission on February 28, 2018)
10.24	Guaranty of the Registrant to Banc of America Lease & Capital, LLC, dated July 27, 2017
21.1	List of Subsidiaries
23.1	Consent of Deloitte & Touche LLP
31.1	Certification of Chief Executive Officer pursuant to Rule 13a-14(a) of the Securities Exchange Act of 1934, as amended
31.2	Certification of Chief Financial Officer pursuant to Rule 13a-14(a) of the Securities Exchange Act of 1934, as amended
32.1	Certification of Chief Executive Officer and Chief Financial Officer pursuant to Section 1350
101.INS	XBRL Instance Document - the instance document does not appear in the Interactive Data File because its XBRL tags are embedded within the Inline XBRL document
101.SCH	XBRL Taxonomy Extension Schema
101.CAL	XBRL Taxonomy Extension Calculation Linkbase
101.DEF	XBRL Taxonomy Definition Linkbase
101.LAB	XBRL Taxonomy Extension Label Linkbase
101.PRE	XBRL Taxonomy Extension Presentation Linkbase

Exhibit 21.1

Subsidiaries of Registrant

<u>Name</u>	<u>State or Jurisdiction of Incorporation</u>	<u>Ownership by Registrant as of December 31, 201 8</u>
IPG Laser GmbH	Germany	100%
NTO IRE-Polus	Russia	100%

Exhibit 23.1

CONSENT OF INDEPENDENT REGISTERED PUBLIC ACCOUNTING FIRM

We consent to the incorporation by reference in Registration Statement Nos. 333-139509, 333-151571, 333-167381, 333-177818, 333-206931, and 333-223045 each on Form

S-8 of our reports dated February 27, 2019 , relating to the consolidated financial statements of IPG Photonics Corporation and subsidiaries (the " Company "), and the effectiveness of the Company ' s internal control over financial reporting , appearing in this Annual Report on Form 10-K of IPG Photonics Corporation for the year ended December 31, 2018 .

/s/ DELOITTE & TOUCHE LLP

Boston, Massachusetts
February 27, 2019

Exhibit 31.1

**CERTIFICATION OF CHIEF EXECUTIVE OFFICER
PURSUANT TO RULE 13a-14(a) OR RULE 15d-14(a)
OF THE SECURITIES EXCHANGE ACT OF 1934**

I, Valentin P. Gapontsev, certify that:

1. I have reviewed this Annual Report on Form 10-K of IPG Photonics Corporation for the year ended December 31, 2018;
2. Based on my knowledge, this report does not contain any untrue statement of a material fact or omit to state a material fact necessary to make the statements made, in light of the circumstances under which such statements were made, not misleading with respect to the period covered by this report;
3. Based on my knowledge, the financial statements, and other financial information included in this report, fairly present in all material respects the financial condition, results of operations and cash flows of the registrant as of, and for, the periods presented in this report;
4. The registrant's other certifying officer(s) and I are responsible for establishing and maintaining disclosure controls and procedures (as defined in Exchange Act Rules 13a-15(e) and 15d-15(e)) and internal control over financial reporting (as defined in Exchange Act Rules 13a-15(f) and 15d-15(f)) for the registrant and have:
 - a. Designed such disclosure controls and procedures, or caused such disclosure controls and procedures to be designed under our supervision, to ensure that material information relating to the registrant, including its consolidated subsidiaries, is made known to us by others within those entities, particularly during the period in which this report is being prepared;
 - b. Designed such internal control over financial reporting, or caused such internal control over financial reporting to be designed under our supervision, to provide reasonable assurance regarding the reliability of financial reporting and the preparation of financial statements for external purposes in accordance with generally accepted accounting principles;
 - c. Evaluated the effectiveness of the registrant's disclosure controls and procedures and presented in this report our conclusions about the effectiveness of the disclosure controls and procedures, as of the end of the period covered by this report based on such evaluation; and
 - d. Disclosed in this report any change in the registrant's internal control over financial reporting that occurred during the registrant's most recent fiscal quarter that has materially affected, or is reasonably likely to materially affect, the registrant's internal control over financial reporting; and
5. The registrant's other certifying officer(s) and I have disclosed, based on our most recent evaluation of internal control over financial reporting, to the registrant's auditors and the audit committee of the registrant's board of directors (or persons performing the equivalent functions):
 - a. All significant deficiencies and material weaknesses in the design or operation of internal control over financial reporting which are reasonably likely to adversely affect the registrant's ability to record, process, summarize and report financial information; and
 - b. Any fraud, whether or not material, that involves management or other employees who have a significant role in the registrant's internal control over financial reporting.

Date: February 27, 2019

/s/ Valentin P. Gapontsev

Valentin P. Gapontsev
Chairman and Chief Executive Officer
(Principal Executive Officer)

Exhibit 31.2

**CERTIFICATION OF CHIEF FINANCIAL OFFICER
PURSUANT TO RULE 13a-14(a) OR RULE 15d-14(a)
OF THE SECURITIES EXCHANGE ACT OF 1934**

I, Timothy P.V. Mammen, certify that:

1. I have reviewed this Annual Report on Form 10-K of IPG Photonics Corporation for the year ended December 31, 2018;

2. Based on my knowledge, this report does not contain any untrue statement of a material fact or omit to state a material fact necessary to make the statements made, in light of the circumstances under which such statements were made, not misleading with respect to the period covered by this report;
3. Based on my knowledge, the financial statements, and other financial information included in this report, fairly present in all material respects the financial condition, results of operations and cash flows of the registrant as of, and for, the periods presented in this report;
4. The registrant's other certifying officer(s) and I are responsible for establishing and maintaining disclosure controls and procedures (as defined in Exchange Act Rules 13a-15(e) and 15d-15(e)) and internal control over financial reporting (as defined in Exchange Act Rules 13a-15(f) and 15d-15(f)) for the registrant and have:
 - a. Designed such disclosure controls and procedures, or caused such disclosure controls and procedures to be designed under our supervision, to ensure that material information relating to the registrant, including its consolidated subsidiaries, is made known to us by others within those entities, particularly during the period in which this report is being prepared;
 - b. Designed such internal control over financial reporting, or caused such internal control over financial reporting to be designed under our supervision, to provide reasonable assurance regarding the reliability of financial reporting and the preparation of financial statements for external purposes in accordance with generally accepted accounting principles;
 - c. Evaluated the effectiveness of the registrant's disclosure controls and procedures and presented in this report our conclusions about the effectiveness of the disclosure controls and procedures, as of the end of the period covered by this report based on such evaluation; and
 - d. Disclosed in this report any change in the registrant's internal control over financial reporting that occurred during the registrant's most recent fiscal quarter that has materially affected, or is reasonably likely to materially affect, the registrant's internal control over financial reporting; and
5. The registrant's other certifying officer(s) and I have disclosed, based on our most recent evaluation of internal control over financial reporting, to the registrant's auditors and the audit committee of the registrant's board of directors (or persons performing the equivalent functions):
 - a. All significant deficiencies and material weaknesses in the design or operation of internal control over financial reporting which are reasonably likely to adversely affect the registrant's ability to record, process, summarize and report financial information; and
 - b. Any fraud, whether or not material, that involves management or other employees who have a significant role in the registrant's internal control over financial reporting.

Date: February 27, 2019

/s/ Timothy P.V. Mammen

Timothy P.V. Mammen
Senior Vice President and Chief Financial Officer
(Principal Financial Officer)

Exhibit 32.1

**CERTIFICATION PURSUANT TO
18 U.S.C. SECTION 1350, AS ADOPTED PURSUANT TO
SECTION 906 OF THE SARBANES-OXLEY ACT OF 2002**

In connection with the filing of the Annual Report on Form 10-K for the fiscal year ended December 31, 2018 (the "Report") by IPG Photonics Corporation (the "Company"), Valentin P. Gapontsev, the Chief Executive Officer of the Company, and Timothy P.V. Mammen, the Chief Financial Officer of the Company, each hereby certifies pursuant to 18 U.S.C. Section 1350, as adopted pursuant to Section 906 of the Sarbanes-Oxley Act of 2002, that:

- 1 the Report fully complies with the requirements of Section 13(a) or Section 15(d) of the Securities Exchange Act of 1934; and
- 2 the information contained in the Report fairly presents, in all material respects, the financial condition and results of operations of the Company.

Date: February 27, 2019

/s/ VALENTIN P. GAPONTSEV

**Valentin P. Gapontsev
Chairman and Chief Executive Officer**

/s/ TIMOTHY P.V. MAMMEN

**Timothy P.V. Mammen
Senior Vice President and Chief Financial Officer**

A signed original of this written statement required by 18 U.S.C. Section 1350 has been provided to IPG Photonics Corporation and will be retained by IPG Photonics Corporation and furnished to the Securities and Exchange Commission or its staff upon request.

