IPG PHOTONICS®

THE ACTIVE FIBER™

FALL 2009

Arthur L. Schawlow Award Presented to Valentin Gapontsev

Gapontsev Accepts Prestigious Laser Science and Engineering Award
Recognized as "Father of Fiber Laser Industry"

IPG Photonics Corporation is proud to announce that Founder, Chairman and Chief Executive Officer Valentin Gapontsev was the recipient of the Laser Institute of America's (LIA) 2009 Arthur L. Schawlow award. The Schawlow award, which was first presented by the LIA in 1982, honors individuals who have made distinguished contributions to applications of lasers in science, industry, education or medicine. The award is named for Professor Arthur L. Schawlow, who received The Nobel Prize in Physics in 1981 for his contribution to the development of laser spectroscopy, and is LIA's highest achievement award.

The Award was presented at LIA's International Congress on Applications of Lasers & Electro-Optics (ICALEO) conference, November 4, 2009. At the ceremony, Gapontsev was recognized as "the father of the fiber-laser industry as it is known today, who has pioneered the field in five decades of academic work and as the founder and CEO of a global technology company that continues to transform the laser industry." Dr. Gapontsev joins the world-renowned list of recipients including Arthur Schawlow, Arthur Guenther and Theodor Hänsch. The complete citation is available to read on IPG's web site, www.ipgphotonics.com.

About Dr. Valentin Gapontsev

Valentin P. Gapontsev, Ph.D., founded IPG in 1990 and has been Chief Executive Officer and Chairman of IPG's Board of Directors since the Company's inception. Prior to that time, he served as senior scientist in laser material physics and head of the laboratory at the Soviet Academy of Science's Institute of Radio Engineering and Electronics in Moscow. He has over 30 years of academic research experience in the fields of solid state laser materials, laser spectroscopy and non-radiative energy transfer between rare earth ions and is the author of many scientific publications and several international patents. Dr. Gapontsev holds a Ph.D. in Physics from the Moscow Institute of Physics and Technology. In 2006, he was awarded the Ernst & Young® Entrepreneur of the Year Award for Industrial Products and Services in New England.

IPG Photonics Midwest Operations Update

Although the media attention to the automotive industry has been mostly negative over the last year, IPG Photonics continues to grow in this market segment. The advantages of IPG fiber lasers make it a "must have" tool for tier-one suppliers who are forced to get leaner and show increased efficiencies. Most car manufactures have sent notices to suppliers that each must now have full laser capabilities. Gaining laser capacity can be the difference for some suppliers staying on a vendor list or being taken off.

The IPG Midwest office has seen a steady increase of activity over the last year working with manufacturers from all segments of industry to get them up to speed on fiber laser advantages. "People are telling us our lasers are almost twice the efficiency of our nearest competitor's latest offerings" states Mike Klos, General Manager of Midwest Operations. "Also, it becomes a simple matter of cost efficiency when you are talking about millions of parts produced per year. We've even seen some customers get government funds for selecting our high efficient lasers."

Growth in the market for high powered lasers (1 kW and above) is not limited to automotive. Other sectors including aerospace, battery technology, solar and heavy equipment have also shown increased laser activity. The added benefit of not needing an in-house laser support staff has opened the door to many smaller manufactures to explore adding laser welding or cutting to their overall capability. Smaller companies are investing in laser technology as the choice is clear to them.

Along with increased applications and demonstration work at the Midwest office, an annual Laser Safety Officer (LSO) class conducted by the Laser Institute of America has been added. This adds another savings benefits for companies wanting to provide training for their employees.

ALSO IN THIS ISSUE:

Growing Oxides on Stainless Steel Surfaces

The Secrets to Understanding Laser Marking Processes

IPG Photonics has been manufacturing fiber lasers for laser marking for a number of years and a large proportion of the laser marking market has changed to fiber lasers. The IPG YLP series of fiber lasers has led this charge from lamp pumped lasers to fiber lasers over the last few years. Recent advances in these lasers, such as the newer High Contrast (HC) version, and the increase in the pulse repetition rate capability up to 200 kHz have further improved the model.

The YLP series of lasers has a 1mJ at 80 kHz capability and has a market-leading brightness of M^2 ~ 1.5. This means that with standard focusing optics, this laser has the ability to make a mark that is clearly visible to the unaided eye at a scanning speed of 2 m/s. If the pulse repetition rate of the laser is increased further at a fixed average power, pulse energy decreases and the laser becomes useful for more subtle effects on the surface of the target.

As repetition rates increase above 100 kHz, pulse energy (again at 20 W fixed average power) decreases to 0.2 mJ. At this pulse energy, the effect on the surface of a metal is less obvious and at 200 kHz, < 0.1 mJ, even more so. In fact, even at focus at high scan speeds approaching 5000 mm/s, there is often no visible mark made. If speed is reduced to < 50 mm/s, the overlap of the laser spots can increase to >95%. In this regime, slight surface discoloration starts to be seen on stainless steels.

Alternatively, if multiple laser passes are made over a well-defined area of the target surface, then this coloration darkens with each subsequent pass. In this low power density regime, it is clear that oxides are being formed on the surface. A more detailed description of the mechanisms involved will be published shortly as the phenomena are now well understood from a qualitative viewpoint.

Although these mechanisms can be addressed using the 80 kHz capability of the laser, this leads to relatively slow processes that are difficult to control. Using a higher repetition rate, up to 200 kHz, enables a very well controlled process of oxide growth. Lower energy pulses striking the target in quick succession are able to control the temperature of the surface more accurately than lower repetition rate higher energy pulses. A mathematical model has not yet been established to confirm this, but empirical evidence is clear. In this way oxides can be grown evenly over a specified area of the surface. If heat input per unit area is increased by very small increments, it can be seen that this oxide layer changes color as the thickness of the layer increases. The colors appear as follows: gold, red, blue, blue/green, grey, black.

One of the applications for the higher repetition rate capability will be significant commercially. A technique has been developed where this smooth oxide coating can be grown to the point at which it appears dark but shiny to the naked eye. This type of mark is known as dark marking, or incorrectly as ‘anneal marking’ and is widely used by surgical implement manufacturers to identify surgical tools. This mark needs to be corrosion resistant to withstand subsequent passivation or autoclaving. It should be noted that it is easy to produce rough dark marks that involve severe disruption of the surface but again this type of mark inevitably leads to the generation of free oxides and rapid corrosion. The real benefit of the work here is that it has been clearly shown that a non-corroding smooth dark mark can be produced at high speeds using these higher repetition rate parameters. In fact, 200 kHz is more than adequate for this application, repetition rates higher than 200 kHz reduce the pulse energy to the point at which the process again becomes very difficult to control. The optimum technique developed at IPG’s West Coast laboratory involves careful control of laser parameters to produce a crack free corrosion resistant oxide coating that gives excellent visible contrast.

Now that we feel we have greatly improved our understanding of these marking processes, we look forward to helping our customers with their marking applications. IPG Photonics’ Laser Micro Processing facility is located at 3930 Freedom Circle, Suite 103, Santa Clara, CA 95054, office (408) 492-8830 and fax (408) 748-1376. Dr. Tony Hoult can be also reached directly at (408) 821-1925 or thoult@ipgphotonics.com.

Typical medical device dark marking application

Complete coverage of the laser marked area is required for effective corrosion resistance

PRODUCT SPOTLIGHT
Featuring Everything New & Enhanced

Diode Laser Products

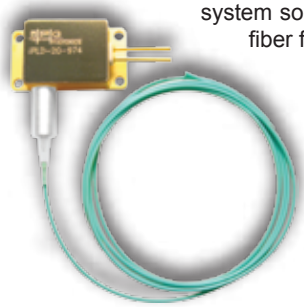
IPG Photonics offers a full line of high brightness diode laser products in the 800-990 nm wavelength range. The line is starting with 90 µm chips on Submount (Cos), the G-Cos and S-Cos series, up to 13 watts at 9xxnm or up to 7 watts at 8xxnm.

After fiber coupling those chips in single emitter or multi emitter configurations, IPG is offering the iPLD series with powers up to 50 watts at 8xxnm or up to 100 watts at 980 - 1060 nm range in a 105 um core fiber. All of those fiber coupled products are specified with a NA < 0.12, the highest brightness available in the market.

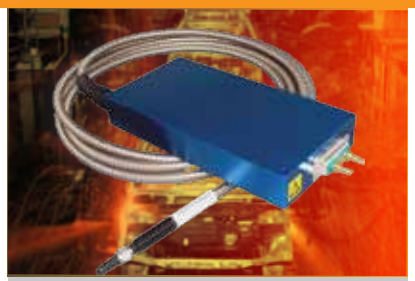
By combining these diode lasers, IPG also proposes high power diode laser modules or complete system solutions with power from 100 watts to up to several kWs out of a small core diameter fiber for direct diode laser applications like material processing.

IPG's semiconductor products division is the largest vertically integrated high power single emitter based diode laser manufacturer. If you have an application where a diode laser could be used, we will help you find the right diode laser solution.

For more information, please contact Franck Leibreich at fleibreich@ipgphotonics.com.



30 watt iPLD Series



DLM Series, low power

DLM Series

NEW Quasi-CW Fiber Laser

- 750 to 1500 W Peak Power
- 100 W to 150 W Average Power
- Plug & Play Design
- Air or Water-Cooled
- Pulse Energy 15 J to 30 J
- M^2 < 1.1, Single Mode
- 19" Rack 3U
- 200-240VAC

Introducing the **YLR-150/1500-QCW-AC**, IPG's NEW Quasi-CW Ytterbium Fiber Laser. With a high peak power up to 1500 watts with 120 watts average power, the QCW is substantially more cost effective than traditional YAG lasers. With a BPP at 0.35 mm x mrad and M^2 of ~1.1, the QCW is perfect for spot welding and drilling applications. Also operates in CW mode with power up to 250 W.

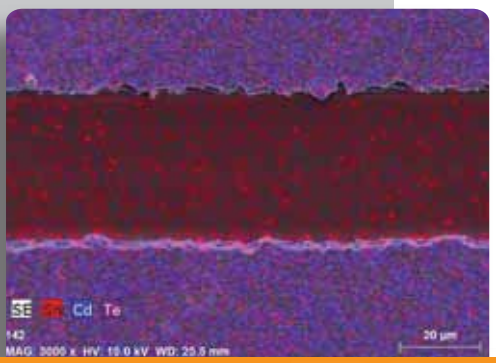
NEW 500 Watt Pulsed Fiber Laser

- Ultra Compact
- High Ablation Rates
- Plug & Play Design
- Water-Cooled
- Flat Top Profile
- Square or Round Fiber Option
- 19" Rack 6U
- Internal Coupler

Introducing the **YLP-HP-50/100/10/500**, IPG's NEW High Power Pulsed Fiber Laser. With an average power of 500 watts, peak power to 83 kW, variable pulse duration from 25 ns to 200 ns and 50 mJ energy, the HP laser allows for high ablation rates greater than 40 cm^2/s. The compact 19" rack design allows for easy integration into edge deletion production lines for thin film solar modules. Available with either square or round delivery fibers, they both provide flat top beam profiles that guarantee high ablation rates.

- Pulsed Mode
- High Peak Power
- 532 nm Wavelength
- Air-Cooled
- Short Pulse Duration
- Compact Design
- Single Mode Beam Quality
- Wall Plug efficiency >20%

NEW Pulsed Green Fiber Laser
Perfect for Scribing P2 & P3



At an output wavelength of 532 nm, the new pulsed green fiber laser from IPG provides single-mode beam quality, ease of use and high reliability. Featuring M^2 of less than 1.2, the YLP-G has a narrow line width and provide high peak power up to 15 kW with scalable average output power up to 10W. This novel fiber laser is maintenance free, more efficient **(wall plug efficiency >20%)**, compact and cheaper than conventional lasers and is built to run 24/7 in demanding industrial environments. IPG Photonics' YLP-G is the perfect solution for a multitude of applications from solar cell manufacturing, resistor trimming, marking plastics, micromachining thin metals, polymer ablation to ablation of thin films.

P2 layer scribing (a-Si). Peformed with just 0.1 W average power, clean scribing of the a-Si layer is achieved without any damage to the underlying TCO layer. The scribing speeds achieved were 2000 mm/sec and the frequency used was 150 kHz.

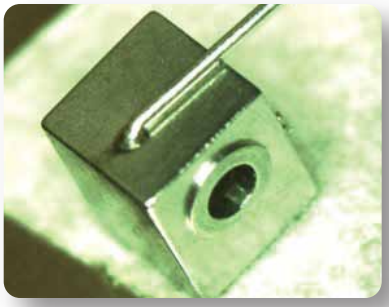
IPG's Single Mode Lasers for a Variety of Applications

Single mode (SM) lasers have the best beam quality (M^2 < 1.07) and are traditionally best suited for micromachining applications. However, the availability of these lasers at hundreds of watts of power opens up many other applications in the macro regime as well. Examples mentioned below shed more light on the vast capabilities of these 1070 nm, SM lasers at different power levels under 500 W. IPG's SM lasers can be run in continuous mode (CW) and pulsed mode (PWM) at up to 50 kHz pulse frequency, produce optical pulses as short as 1 µs and be focused down to spot sizes 10 µm or smaller. The high mode quality and small spot size with optimized pulse settings yield the best results in the micro domain. The high power density and high CW power also translates into faster and superior cutting quality and high aspect ratio welds in the macro domain of applications.

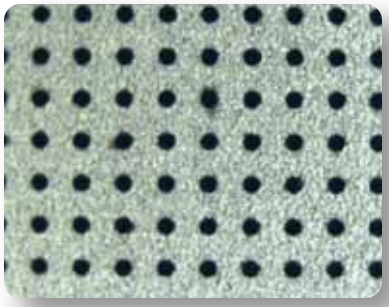
The very compact SM Lasers 50 W and under are used for applications such as soldering of small electrical and IC components, bending of HD landing drives, and simple metal and IC marking. The dynamic power range of 10-100% allows users to adjust laser power finely to suit these delicate applications. SM lasers between 50 W and 200 W are routinely used for fine cutting of metal stents and stencils. Typical materials are SS and Nitinol, 50-100 microns thick; intricate cutting and tight tolerances are achieved with careful selection of pulse parameters. Some of the other applications in this power range are drilling micron sized pits on printing rolls, crack free cutting of silicon wafers and high speed anneal marking.

SM lasers ranging from 200-300 W are required for applications such as metal sintering for rapid 3D prototypes, spot welding of razors and thin flexures, trimming of automotive plastics, sealing ends of thin metal braided wires, high speed cutting of sheet metal (up to 1.5 mm) and some ceramic scribing. Many of the SM applications processed in the applications lab fall under 300 watts as a good balance between laser power, application suitability and cost is achieved at this level. SM 300-500 W lasers are best suited for applications requiring high throughput in cutting, drilling and welding. High aspect ratio keyhole welds with minimal warping are achieved and the best example of this is welding fuel cell stacks. Applications at these power levels include narrow width scribing, cutting thick ceramics, high density single pulse hole drilling for industrial filters and sound abatement panels and high-speed cutting of thin sheets (up to 1 m/sec) with minimal dross. These fiber lasers can be quickly integrated into a variety of different work stations including robots, cartesian co-ordinate systems and high speed scanners.

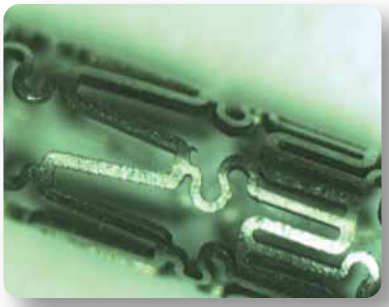
IPG's YLR-SM Series represents a break-through generation of diode pumped single mode CW Ytterbium fiber lasers of near infrared spectral range (~1070nm) with a unique combination of high power, ideal beam quality, fiber delivery, high wall-plug efficiency, compactness and relia-bility. These lasers possess a reliability that is unmatched by conventional solid state or gas laser and are maintenance free. Selectivity of operating wavelengths, ultra-low amplitude noise, high stability and ultra-long pump diode lifetime completes an impressive list of advantages of this modern fiber laser system.



Spot Welding for Electrical Content



High Speed Hole Drilling



Micro-machining Stents

Unique Dual Wavelength Laser System to be Installed at IPG West Coast Facility

IPG Photonics recently opened an 8,000 sq. ft. Laser Micro Processing facility to serve West Coast customers. Our first lab is now outfitted with operational lasers and laser systems and is available for free sample evaluation and process development.

Trials with a new 1 MHz laser with short nanosecond pulses have been completed with interesting processing performance highlighted. The lab is also performing process development work with IPG's newly upgraded YLP Q-switched laser at 200 kHz. Results have shown that at this repetition rate, the more subtle, less disruptive marking processes used on stainless steel can be reproduced at high speed with excellent surface quality. This laser has been known for some time to perform better than competitive products at the more widely encountered lower repetition rate parameters, but now has been shown to match the competition for all relevant laser applications. Furthermore, an in-depth study of these marking processes (discussed on page 2 of this newsletter) has improved our empirical understanding significantly. A specialized in-house accelerated corrosion test was developed to give rapid feedback on results that will be of real interest to the medical device industry.

Two additional advanced motion systems will soon be added to the lab to complement the two existing side-by-side marking systems. The first is a high accuracy 3 axis Cartesian X, Y & Z motion system based on the Aerotech A3200 controller. This system will be equipped with a focusing head from Laser Mechanisms, Inc. and initially fitted with IPG's new 300 W air-cooled YLR laser. A higher average and peak power laser will be installed in the future. VyTek Laser Systems will be delivering the second unit, a unique 2 and 3 axis scanner based system with both short and long pulse infrared lasers fitted with the new IPG 532 nm pulsed green laser. This highly anticipated system will allow side-by-side applications trials for the first time as all laser beams will be delivered through the same delivery optics.

Customer applications are progressing through the laboratory as the lab demonstrates the very wide range of applications that IPG's fiber lasers address. IPG's West Coast facility acts as a Center of Expertise for micro-machining within IPG and coordinates with IPG Photonics Applications facilities around the world including Oxford, MA, Novi, MI, Yokohama-shi, Japan, Moscow, Russia, Daejon, Korea, Beijing, China and Burbach, Germany.

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IPG Fiber Lasers Inspire New Product

Wide acceptance of the IPG high power fiber laser into industry has produced benefits in other areas. We have seen speed increases in robots used for cutting based on faster cutting with fiber lasers. Helium consumption for laser welding is no longer needed and lens consumption is almost eliminated when replacing CO_2 lasers with fiber lasers.

Probably the most visible changes have been in the end effectors used with IPG fiber lasers. A number of remote welding heads have become mainstream as well as enhanced lines of welding and cladding heads.

Appearing now are heads designed for use specifically with high powered IPG fiber lasers. Laser Mechanisms introduced its new high speed robot mounted laser cutting head in Munich this past June. Named the FiberCut™, it displays a variety if features that are best exploited when used with fiber lasers in industry.

Laser Mechanisms started with a clean slate to build a head that compliments the unique attributes of fiber lasers. Since the fiber laser has been shown to produce cut speeds faster than other lasers, a feature was added to auto-calibrate "on the fly". There is continuous calibration which keeps the tip a safe distance from the material even at high speeds. In the event of a part defect and the head does crash, the internal clutching mechanism reduces the risk of damage.

Another feature of the new FiberCut™ is that it displays insensitivity to heat changes on the tip or the effects of splatter from the cutting surface.

Laser Mechanism has added a whole line of beam delivery to its website aimed at fiber laser users. Other manufactures plan to introduce fiber laser heads also and we will highlight them here as we become aware of them.

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Make Sure to Visit IPG Photonics at these 2009 & 2010 Trade Shows & Speaking Engagements

TRADE SHOWS

November 15-18	FABTECH International	Chicago, IL	Booth #35021
January 26-28	Photonics West	San Francisco, CA	Booth #1107
February 1-3	OSA laser, Sources & Related Photonic Devices	San Diego, CA	Booth #318
February 9-11	MD&M West	Anaheim, CA	Booth #3069

SPEAKING ENGAGEMENTS

January 26-28	Photonics West Leveraging Fiber Laser Technology into Micro-machining Applications	San Francisco, CA	Tony Hoult
March 18-19	Invest in Photonics 2010 Plenary Address	Bordeaux, France	Bill Shiner

KICK OUT YOUR CLUNKER

& Transform Your Entire System

Retrofit your existing CO_2 or YAG Laser
and enjoy all the benefits of IPG's Fiber Lasers

INTRODUCING IPG'S NEW RETROFIT TEAM

Our premiere team of trained professionals will come to your facility to evaluate your needs and provide you with the most cost-effective and tailored solution to replace your older production laser with an energy-efficient fiber laser from IPG.

Operating worldwide, our team will provide you with an initial assessment of your current system and will re-qualify the application to assure you that IPG's products are the best solution toward improving your manufacturing operations.

By replacing older, inefficient lasers for applications such as **cutting, welding** or **cladding** with fiber lasers, manufacturers can utilize their existing motion system while gaining significant operating cost savings. Fiber lasers consume substantially less electric compared to conventional lasers. It is estimated that fiber lasers are 15-30 times more electrically efficient than lamp pumped YAG lasers and 3 times more electrically efficient than CO2 lasers.

Customers that switch to fiber lasers also benefit from lower maintenance, no diodes to replace and lower down time.

DID YOU KNOW?

You may be eligible to receive rebate money from your utility or state government by switching from old laser technology to efficient fiber lasers. Retrofit customers may also take advantage of accelerated tax depreciation in 2009 under Section 179 of the I.R.C. provided by the American Recovery and Reinvestment Act.

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