High Power Fiber Laser Technology

Bill Shiner VP Industrial
September 10, 2013
Global Production Facilities

Production Facilities and World Headquarters – Oxford, Massachusetts

Production Facilities – Fryazino, Russia

Production Facilities – Burbach, Germany
About IPG Photonics

- Innovator and Worlds Largest Manufacturer of Fiber Lasers
- Went public in 2006  NASDDAQ symbol  IPGP
- Largest Market Cap of Public Laser Companies >3 billion dollars
- >3000  World wide employees
- 10 Application centers around the world
- R&D staff > 300
- Large Fiber Laser Product Portfolio
- Vertical Integration Strategy
- Delivered first 100 kW for Material Processing 2014

Forbes award 2012 for the number 9th fastest growing company in U.S. on total return. (Revenue growth and profit ) Apple was 8th
<table>
<thead>
<tr>
<th>Rank</th>
<th>Company</th>
<th>Business</th>
<th>Latest 12 Mo. Sales (mil)</th>
<th>Latest 12 Mo. Sales Growth</th>
<th>3-Yr Avg Sales Growth</th>
<th>Est. EPS Growth</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>LinkedIn</td>
<td>Social Networking</td>
<td>$1,109</td>
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<td>102%</td>
<td>51%</td>
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<td>2</td>
<td>Facebook</td>
<td>Social Networking</td>
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<td>87%</td>
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<tr>
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<td>Computer Hardware/Software</td>
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<td>3D printers</td>
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<td>5</td>
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<td>Lasers/Amplifiers</td>
<td>$581</td>
<td>17%</td>
<td>46%</td>
<td>26%</td>
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<td>6</td>
<td>EPAM Systems</td>
<td>IT Software/Services</td>
<td>$464</td>
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<td>7</td>
<td>Shutterstock</td>
<td>Online Commercial Digital Imagery</td>
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<td>41%</td>
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<td>8</td>
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<td>OpenTable</td>
<td>Online Reservation Services</td>
<td>$168</td>
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<td>11</td>
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<tr>
<td>12</td>
<td>Cognizant Technology Solutions</td>
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<td>31%</td>
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<tr>
<td>13</td>
<td>athenahealth</td>
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<tr>
<td>14</td>
<td>Ixia</td>
<td>Communications Equipment</td>
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<tr>
<td>15</td>
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<td>Data Center Services</td>
<td>$1,981</td>
<td>17%</td>
<td>29%</td>
<td>29%</td>
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</tbody>
</table>

No. 5: IPG Photonics
CEO: Valentin Gapontsev
Manufacturers love its fiber-optic lasers, which weld, cut and drill more precisely and with less energy than traditional lasers do. IPG is looking to bounce back after a narrow earnings and revenue miss last quarter.
IPG’s Advantage

Vertical Integrated Business Model

Strong IP Portfolio

Manufacturing Scale
Vertical Integration Drives Significant Benefits

- Reduce costs
- Controls quality
- Focuses & accelerates R&D
- Drives industry leading profitability
- Short Lead Times
- Limits spread of trade secrets
- Prevents competitors from using IPG economies of scale in component pricing
Why Customers Choose Fiber Lasers

- Reduced Running and maintenance costs
- Drastic reduction in energy consumption
- Greater productivity
- Works on wide range of materials
- Compact
- Versatility
- Easy to use and integrate
- Performance and Product Choice
- Unique Reliability
- Reduced Running and maintenance costs
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- Unique Reliability
- Easy to use and integrate
- Versatility
- Compact
- Works on wide range of materials
- Greater productivity
- Drastic reduction in energy consumption
- Reduced Running and maintenance costs
IPG is the Fiber Laser Company

Total 2012 IPG Sales

- Fiber Lasers: $514 million (91%)
- Diodes and Diode Lasers: $28 million
- Telecom Devices & Amplifiers: $18 million
- Parts and Service: $3 million

(1) For the year ended 12/31/12
Broad End Applications and End-Users for IPG’s Products 2012

% Broad End Uses (1)
- Materials Processing: 88%
- Other (Telecom, Advanced and Medical): 12%

(1) For the year ended 12/31/12
Acceptance Drives High-Power Growth IPG Growth

2007 – 2012 Total Units Sold CAGR: 26%
2007 – 2012 KW Power Sold CAGR: 50%

Units Sold

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Units Sold</th>
<th>KW Power Sold</th>
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<tbody>
<tr>
<td>2007</td>
<td>7,888</td>
<td>597</td>
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<tr>
<td>2008</td>
<td>9,652</td>
<td>901</td>
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<tr>
<td>2009</td>
<td>7,347</td>
<td>860</td>
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<tr>
<td>2010</td>
<td>13,996</td>
<td>1,636</td>
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<tr>
<td>2011</td>
<td>22,052</td>
<td>3,472</td>
</tr>
<tr>
<td>2012</td>
<td>25,161</td>
<td>4,541</td>
</tr>
</tbody>
</table>

Note: KiloWatt of power sold only represents medium and high-power sales.
Units excludes telecom components and component PLDs
Significant Growth for Fiber Laser Sources

Fiber Laser Market Analysis

Materials Processing Growth:
- 2011: 70%
- 2012 to 2015: 25% estimated

Source: Optech Consulting and IPGP estimates
Key Drivers for Fiber Laser Growth

- Penetration of CO2 market for welding and cutting
- Replacement of lamp pumped Nd:YAG Lasers
- Ease of integrating to Robotic motion systems
- Multi-use and multiple work stations from single laser
- Power levels never before available for material processing
- Multiple wave length choices
- High wall plug efficiency
- Power levels covering the complete material processing requirements
- Low cost per watt
Fiber Laser Manufacturers

- Coherent
- Rofin
- SPI (Trumpf)
- GSI Lumonics
- Hypertherm
- Amada/JDS
- Numerous low power and pulsed fiber lasers
**Active Fiber:**
- Multi-Clad, Circular Cladding,
- Low Diameter, ~2-10m Total Length
- High Yb$^{3+}$ Concentration

**Pump Diodes:**
- Multimode
- 90$\mu$m stripe
- 30W to 100W Output Power
Higher power, high reliability, broad stripe diodes

No limitation on insertion of pump photons - can distribute gain

No residual pump light in output
500 watt Ytterbium Fiber Laser

500 W CW Single Mode Output Power
TEM$_{00}$ operation ($M^2 < 1.05$)
Single Mode Fiber Delivery Line
Size: 19 x 7 x 18 inches  Weight: 20kg  Air Cooled / 110-220V AC
• Single Mode
  – TEM 00, $M^2 = 1$, Pure Gaussian
  – Used for cutting,
    High speed welding
    Micro machining
High Power SM Fiber Laser Modules

• $P = 250 \& 400 \& 750 \& 1000 \text{ W}$

• $\lambda = 1070 \text{ nm}$

• $\text{BPP} = 0.34 \text{ mm x mrad ( } M^2 < 1.05 \text{ )}$

• $W \times H \times D = 42 \times 33 \times 4.7 \text{ cm}$

• DC wall-plug efficiency $> 32\%$
• 1 to 10kW Output Optical Power
• >50,000 hrs Estimated Diode Life Time
• High Brightness
• Wall Plug Efficiency ~30%

• Single or Multiple Output Fibers
• Air or Water Cooled
• 19” Rack Mountable or OEM Module Versions
## High Power Fiber Lasers

<table>
<thead>
<tr>
<th>Power Level , kW</th>
<th>Beam Product, mm x mrad</th>
<th>Output Fiber, μm</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>2.2</td>
<td>50</td>
</tr>
<tr>
<td>4</td>
<td>2.2</td>
<td>50</td>
</tr>
<tr>
<td>6</td>
<td>2.2</td>
<td>50</td>
</tr>
<tr>
<td>10</td>
<td>5.0</td>
<td>100</td>
</tr>
<tr>
<td>20</td>
<td>5.0</td>
<td>100</td>
</tr>
</tbody>
</table>
Beam Profile of 4kW Fiber Laser
Schematic of Q-Switched Fiber Lasers

AOM - acusto-optical modulator
LD - laser diode
coll. - collimator
1mJ Q-switched Fiber Lasers

20W CW Average Output Power
Size: 8.5 x 11 x 4 inches
Air Cooled / 24V DC
INDUSTRIAL PRODUCT LINES

YLS  Ytterbium Laser System
YLR  Ytterbium Laser Rackmount
YLP  Pulsed Ytterbium Laser
QCW  Quasi-CW Laser
GLR  Green CW Laser
GLP  Pulsed Green Laser
YLS High Power Fiber Lasers

- Power Levels from 1 kilowatt to 100 kilowatts
- Single mode to 3 kilowatts available low order mode to 50kW
- Water cooled
- Industrial interface: Laser net, Profibus, Device Net, Ethernet, Digital, Analog
- NEMA 12 construction
- Switching up to 6 way
- Wide spread use on welding, cutting, cladding, and brazing applications in a wide range of industries

World wide acceptance in the Automotive, Aerospace, Oil and Gas, Nuclear and metal manufacturing
QCW Fiber Lasers

- Lasers feature high Peak powers and CW operation
- 8 models available with peak powers to 20kW and CW power to 2000 watts.
- Very cost effective developed to compete with lamp pumped YAG
- Available in single mode to Peak of 3kW and CW power to 300 Watts.
- Applications include welding, cutting, drilling
- Highly accepted as YAG replacement in Aerospace, Medical Device and Electronics industries applications.
YLR Fiber Lasers

- Rack mount Fiber Lasers available in power levels from 10 watts to 1000 watts.
- Both single mode and multimode configurations at all power levels
- Air cooled to 500 watts water cooled to 1 kilowatts
- Beam switching available
- Modulation to 50 kilo-hertz
- Touch screen with pulse generator and pulse shaping
- Ideal for welding, cutting, drilling, sintering

Wide use in medical device and electronic applications
Pulsed Fiber Lasers

- YLP Pulsed Lasers at 1070 nano-meters 25 different models with pulse durations from 1 nano-second to 400 nano-seconds, peak powers to 1 mega Watt and energy per pulse to 50 millijoules.
- A wide range of applications, Marking, engraving, drilling, ablating. High use in the Solar, Computer, Mobile Phone industries and the number one choice worldwide for metal marking.

Over 13,000 shipped in 2012
Partial list of New Products for 2013

- Single mode RM CW Green @ 532 to 200 watts
- Multimode RM Green @ 532 to 1000 watts
- Pulsed ps @ 1.54 microns 20 watts peak 5MW
- Pulsed femtosecond @ 1.54 microns 10MW peak
- Pulsed one nanosecond @ 355 nm peak 50 KW
- Pulsed one nanosecond @ 532 nm peak 200kW
- 10kW single mode at 1070nm
- 100KW multimode 300 micron feed fiber
- QCW 20kW peak at 1070 nm 2000 watt average power
Conclusions

- Fiber Lasers have made major Impact world wide material processing market
- The reliability has been proven on multiple material processing applications at all power levels in production environments
- The performance of fiber lasers exceeds previous laser technologies while offering substantial cost benefit to users
- Fiber Lasers have expanded the market for laser material processing
- IPGs double digit growth is a strong indicator that Fiber Lasers are taking market share from both CO\textsuperscript{2} and YAG Lasers
Thank You For Your Attention