High-power diode-laser modules and their applications

Jörg Neukum

Laser 2007 Munich Workshop / World of Photonics
DILAS Diodenlaser GmbH

DILAS GmbH
founded 1994
located in Mainz
Germany

DILAS Inc.
founded 2005
located in Tucson
Arizona
DILAS in numbers

Founded: 1994

Employees:
- 181
- 11

Majority Shareholder:
Rofin Sinar Technologies Inc. since 1997 (Nasdaq RSTI)

ISO 9001-2000 certified Quality Management System

Markets:
- DPSSL pumping
- Material processing
- Graphic Arts
- Medical
- Defence
- Instrumentation

Research:
- 38 academics
  & engineers

R&D Budget:
- ~11% of revenue

Facilities:
- Mainz / Germany
  - 2 buildings
  - ~3300m² total
  - 500m² clean room
  - with class 100 workbenches
  - other production area of ~700m²
- Tucson / Arizona
  - 300m² facility

Products:
- Laser diode bars
  - vertical / horizontal
- Laser diode stacks
- Fibre coupled LD
- Laser Diode Systems
- Custom solutions
- Available wavelengths
  - 650...690nm
  - 785nm, 792...797nm
  - 808nm
  - 830nm
  - 880nm
  - 915nm
  - 940nm
  - 980nm
  - 1064nm
  - 1470nm and higher

Sales offices:
- Representatives in all major market areas or direct sales from headquarters
**Wavelength / Application < 800nm**

<table>
<thead>
<tr>
<th>WAVELENGTH</th>
<th>APPLICATION</th>
<th>MARKET</th>
</tr>
</thead>
<tbody>
<tr>
<td>630 – 635nm</td>
<td>Medical Photodynamic Therapy</td>
<td>Medical</td>
</tr>
<tr>
<td>652nm</td>
<td>Medical Photodynamic Therapy</td>
<td>Medical</td>
</tr>
<tr>
<td>668nm</td>
<td>Medical Photodynamic Therapy</td>
<td>Medical</td>
</tr>
<tr>
<td>670nm</td>
<td>Cr $^{3+}$ LiSAF – fs-Laser</td>
<td>DPSSL</td>
</tr>
<tr>
<td>689nm</td>
<td>age-related macular degeneration</td>
<td>Medical</td>
</tr>
<tr>
<td>730nm</td>
<td>Medical Photodynamic Therapy</td>
<td>Medical</td>
</tr>
<tr>
<td>780nm, $\Delta \lambda &lt;&lt;1$nm</td>
<td>Diode Pumped Gas Laser (Rubidium Vapour)</td>
<td>Military (High Energy Laser)</td>
</tr>
<tr>
<td>785nm</td>
<td>TM$^{3+}$ YAG =&gt; 2μm</td>
<td>DPSSL</td>
</tr>
<tr>
<td>792 / 797nm</td>
<td>Nd $^{3+}$ : YLF</td>
<td>DPSSL</td>
</tr>
<tr>
<td>795nm, $\Delta \lambda &lt; 1$nm</td>
<td>Rb $^{3+}$ / Xe $^{139}$ / - pumping</td>
<td>Instrumentation</td>
</tr>
</tbody>
</table>
# Wavelength / Application  800 – 1000nm

<table>
<thead>
<tr>
<th>WAVELENGTH</th>
<th>APPLICATION</th>
<th>MARKET</th>
</tr>
</thead>
<tbody>
<tr>
<td>801nm</td>
<td>TM³⁺: YAG =&gt; 2µm</td>
<td>DPSSL</td>
</tr>
<tr>
<td>805 /808nm</td>
<td>Nd³⁺: YAG</td>
<td>DPSSL</td>
</tr>
<tr>
<td>810± 10nm</td>
<td>hair removal, etc.</td>
<td>Medical, MAT</td>
</tr>
<tr>
<td>830nm</td>
<td>Pre-Press, Computer to plate (CTP), direct on press (DOP)</td>
<td>Printing</td>
</tr>
<tr>
<td>852nm, Δ λ&lt;&lt;1nm</td>
<td>Diode Pumped Gas Laser (Cesium Vapour)</td>
<td>Military (High Energy Laser)</td>
</tr>
<tr>
<td>868 – 885nm</td>
<td>Nd³⁺: XXX (various host crystals)</td>
<td>DPSSL</td>
</tr>
<tr>
<td>901nm</td>
<td>Yb³⁺: SFAB</td>
<td>DPSSL</td>
</tr>
<tr>
<td>905nm</td>
<td>Rangefinder direct</td>
<td>Instrumentation</td>
</tr>
<tr>
<td>915nm</td>
<td>Yb: Glas, Fiber Laser, Medical</td>
<td>DPSSL, Medical</td>
</tr>
<tr>
<td>940nm</td>
<td>Yb³⁺: YAG, Disk</td>
<td>DPSSL</td>
</tr>
<tr>
<td>968nm Δ λ &lt; 1nm</td>
<td>Yb³⁺: YAG, Disk</td>
<td>DPSSL</td>
</tr>
<tr>
<td>973 – 976nm</td>
<td>Yb³⁺: Glas, Fiber Laser</td>
<td>DPSSL</td>
</tr>
<tr>
<td>980± 10nm</td>
<td>Medical</td>
<td>Medical, MAT</td>
</tr>
</tbody>
</table>
# Wavelength / Application > 1000nm

<table>
<thead>
<tr>
<th>Wavelength</th>
<th>Application</th>
<th>Market</th>
</tr>
</thead>
<tbody>
<tr>
<td>1064nm</td>
<td>Medical</td>
<td>Medical</td>
</tr>
<tr>
<td>1330 – 1380nm</td>
<td>Medical</td>
<td>Medical</td>
</tr>
<tr>
<td>1450 – 1470nm</td>
<td>Akne, Turbulence Detection Er(^{3+}) pumping</td>
<td>Medical, various others</td>
</tr>
<tr>
<td>1530-1570nm</td>
<td>Rangefinder</td>
<td>Military</td>
</tr>
<tr>
<td>1700nm</td>
<td>Missile Defence</td>
<td>Military</td>
</tr>
<tr>
<td>1850nm</td>
<td>Turbulence Detection, Plastic welding &amp; Material Processing on transparent Material</td>
<td>Military, MAT,</td>
</tr>
<tr>
<td>1900-2000nm</td>
<td>Coagulation of Protein</td>
<td>Medical</td>
</tr>
</tbody>
</table>
conduction cooling
Conduction cooled bar – packages

<table>
<thead>
<tr>
<th>Package Type</th>
<th>Footprint</th>
<th>Beam height</th>
</tr>
</thead>
<tbody>
<tr>
<td>M7</td>
<td>25x25mm²</td>
<td>6.0mm</td>
</tr>
<tr>
<td>M3</td>
<td>25x25mm²</td>
<td>7.7mm</td>
</tr>
<tr>
<td>M10</td>
<td>25x25mm²</td>
<td>7.95mm</td>
</tr>
<tr>
<td>M1</td>
<td>25x25mm²</td>
<td>8.7mm</td>
</tr>
<tr>
<td>M8</td>
<td>10.3x25mm²</td>
<td>8mm</td>
</tr>
</tbody>
</table>

40W+ cw at standard wavelength
FC Conduction cooled single bar

40W
400µm
NA 0.22
incl. power monitor, pointer and fiber interlock

30W
200µm
NA 0.22
fiber coupled multi-bar
FC Conduction cooled Multi-bar Concept

- Conduction cooled laser diode array
- Laser chip
- Deflection mirrors or prisms
- Staircase manifold
- Cross-section of optically stacked combined beam
FC Conduction cooled Multi-bar

100W
400µm
NA 0.22

or

50W
200µm
NA 0.22
FC Conduction cooled Multi-bar

200W
400µm
NA 0.22

or

100W
200µm
NA 0.22
FC Conduction cooled Multi-bar

400W
400µm
NA 0.22
QBH
## FC Conduction cooled Multi-bar

<table>
<thead>
<tr>
<th>Module Type</th>
<th>Number of bars inside</th>
<th>Fiber core diameter, numerical aperture</th>
<th>800-980nm</th>
<th>1470nm</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS3.2 (H200)</td>
<td>2x1</td>
<td>SMA 400µm, NA 0.22</td>
<td>60W</td>
<td></td>
</tr>
<tr>
<td>IS3.1 (H139)</td>
<td>3x1</td>
<td>SMA 400µm, NA 0.22</td>
<td>100W</td>
<td>40W</td>
</tr>
<tr>
<td>IS5.6 (H242)</td>
<td>6x1 (3x2)</td>
<td>SMA 400µm, NA 0.22</td>
<td>200W</td>
<td>80W</td>
</tr>
<tr>
<td>IS5.3 (H293)</td>
<td>4x1 (2x2)</td>
<td>Liquid cooled SMA, 200µm, NA 0.22</td>
<td>120W @ 976nm</td>
<td></td>
</tr>
<tr>
<td>IS11.6 (H271)</td>
<td>12x1 (6x2)</td>
<td>QBH, 400µm, NA 0.22</td>
<td>400W @ 808 or 976nm</td>
<td></td>
</tr>
</tbody>
</table>

All ISQ’s contain hour counters and temperature sensors (NTC)
Options: P=pointer, F=fibre interlock, M=power monitoring
for fiber laser pumping & material processing...
Soldering in electronic manufacturing

Potentiometer

Externe CMOS-Kamera

Diode laser system DFx06

Interne CCD-Kamera

Production with 100 parts/minute
2-Dimensional Stacks IV

2001 - 6x10 bar CW lensed
11 x 8 stacks
each stack
25 bars stack
264 kW total
1msec pulse
941nm

scalable
stacks
10kW homogenized spot (60x18mm²)
Modules for avionics
Modules for space
Thank you for your attention

Please visit us at B3.401

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