Cladding & Coating

with Diode Lasers

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Cladding & Alloying with Diode Laser

Advantages of Diode Lasers

- Homogeneous alloying results
- Optimized focus adaptation
- Highest process efficiency of all lasers
- Easily automated, high process stability

Applications

- Repair welding of valuable parts, corrosion and wear protection in automotive industry, e.g. valve seats, drilling and forming tools, e.g. down-hole drilling in oil industry

Photo: Technogenia - LCT, UK
Cladding: Typical Data

Laser
- Direct and fiber-coupled diode lasers

Power
- 1000 W to 6000 W

Beam quality
- 100 to 400 mm mrad

Spot dimensions
- Ø 2 to 4 mm, 2 x 2, 3 x 3 or 1 x 5 mm²

Material
- Tools subject to wear are clad with powder from hard particles or hard metals

Clad samples
**Diode Laser Types for Cladding**

- **Fiber-coupled diode laser**
- **Direct diode laser, LDL 160 with coaxial powder cladding nozzle**
- **Multi diode laser**

Laserline GmbH, Germany
Cladding/Alloying: Principle

- Powder and assist gas is fed into the laser beam coaxially or off-axis
- Laser Beam melts powder and eventually base material
- Alloying or depositing of powder onto base material in one or more layers
- Repair or coating in a single process
- Spot geometry adapted to parts and process
Cladding: Options

- Cladding optics, different manufacturers (IWS, Precitec, Balliu and others)
- Integrated coaxial powder feeding, transport gas, shield gas
- Integrated sensors for process monitoring
- Mechanical shutter, stack management
- Cover Slide cassette for cladding optics
- Optics with different beam dimensions and working distances
- Supply unit with enhanced programming and PC-based control
- Additional sealing of laser head. Connection for dry, clean air. Pressure sensor
Alloying of Al Cylinder Liners with Si

- Power: 3000 - 6000 W
- Beam quality: 200 – 400 mm mrad
- Special optics for inside access to liners

Photo: Uni Bayreuth
Alloying of Al Cylinder Liners with Si

LDL 160-6000 / LDL 160-6000 S

- Wear protection of cylinder liners
- Aim: efficient process for alloying / cladding with Si powder

Photo: Uni Bayreuth
Alloying of Al Cylinder Liners with Si

Results of basic research

- Efficient process (40% of optical energy transferred)
- Alloying depth 1 mm, residual stress may be set
- Increase in hardness: 110 HV → 160 HV / 400 HV

Homogeneous alloying result
Evenly distributed primary Si grains
### Comparison of Technologies

<table>
<thead>
<tr>
<th></th>
<th>CO₂-Laser</th>
<th>Diode laser</th>
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<tbody>
<tr>
<td>Power [kW]</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Speed [mm/s]</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Width of clad [mm]</td>
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<td>5</td>
</tr>
<tr>
<td>Speed of clad [mm²/s]</td>
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<td>75</td>
</tr>
<tr>
<td>Amount of clad [kg/h]</td>
<td>2,16</td>
<td>2,2</td>
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Data: IREPA, Strasbourg, France

- Diode Lasers achieve comparable results as CO₂-Lasers with only 60% of the energy required.

![Powder Cladding Nozzle for Diode Laser](image)
Cladding with Diode Laser

- Examples of components
- Wire based cladding (left)
- Powder based process (right)
Cladding with Direct Diode Laser

- Core: edge modification
- Preparing of moulds
- Material build-up 2 x 2 mm at the edge
- Requirements:
  - sharp edge
  - 100 % density
  - hardness HRC 50
  - good connection to side wall
- Welding time: 18 min
- Process finish time high speed cutting: 47 min

Photo: Röders
Integration: Diode Laser System

Direct diode laser for laser assisted machining (Hembrug turning machine)

Photo: Uni Dublin

Fiber-coupled diode laser for cladding
Photo: Technogenia - LCT UK
Cladding with Fiber-Coupled Laser

LDF 1500-4000:
- Repair of valuable parts
- Wear protection
- Efficient and cost-effective process
- Successful replacement of CO₂-Laser

Photos: Technogenia LCT, UK
Cladding/Coating with Diode laser

- High precision thick deposits (0.5 – 4 mm)
- Fully automated, industrial process
- Spherical Tungsten carbide hard facing
- Hardness > 3,000 HV

Applications

- Oil drilling – down hole tools
- Construction ceramics – Wear protection only where necessary
- Foundries – pan scrapers
- Steel industry – conveyor rollers in steel mills
Cladding with Diode Laser

Machining Tool

Cylinder for Cutting

3D-part for Treatment of Glass

Photos: Stiefelmayer
Cladding with Diode Laser

- 3-D parts for glass manufacturing
- Wear protection
- Powder-based cladding process
Cladding with Fiber-Coupled Laser

LDF 1500-4000:

- Wear protection of mixer blade
- Efficient and cost-effective process