Laser Cladding at Oerlikon Metco

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Dr.-Ing. Thomas Peters
Metco is now an important part of the Oerlikon group

Red is the new Blue – Metco stays Metco
Metco is now an important part of the Oerlikon group

Key figures Surface Solutions Segment
- Around 6'000 employees
- CHF 1.2 billion in sales
- More than 130 facilities with over 110 coating centers in 35 countries
Laser Cladding (LC) means **laser build-up welding**, also known as Laser Metal Forming (LMF), Laser Metal Deposition (LMD), Direct Metal Deposition (DMD™), Laser Engineered Net Shaping (LENS™) or Direct Energy Deposition (DED).
Laser Cladding – how does it work?

- The laser beam is (de)focused on the work piece with a selected spot size
- Metal powder as filler material is transferred with an inert carrier gas into the melt pool
- Laser beam and powder nozzle are moved over the work piece surface producing single tracks, layers, build-ups

Small beam focus and high power density mean highly localized part treatment
## Laser Cladding – the growing niche between Thermal Spray and PTA

Source: Fraunhofer IWS, 2011

<table>
<thead>
<tr>
<th></th>
<th>PTA Welding</th>
<th>Laser Cladding</th>
<th>Thermal Spray</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density [%]</td>
<td>100%</td>
<td>100%</td>
<td>95+%</td>
</tr>
<tr>
<td>Build-up rate [kg/h]</td>
<td>≤12</td>
<td>≤6</td>
<td>≤20</td>
</tr>
<tr>
<td>Typical thickness [mm]</td>
<td>0.5 - 4</td>
<td>0.2 - 2+</td>
<td>0.05 - 0.5</td>
</tr>
<tr>
<td>Heat input</td>
<td>High</td>
<td>Medium</td>
<td>Low</td>
</tr>
<tr>
<td>Dilution [%]</td>
<td>8-18</td>
<td>&lt;5</td>
<td>0</td>
</tr>
</tbody>
</table>

- Perfect metallurgical bonding, fully dense coatings vs TS
- Small heat affected zone, low dilution between substrate and filler material vs PTA
- Extended weldability of sensitive materials like C-rich steels or Ni super alloys vs PTA
- Near net-shape weld build-up, less finishing effort vs PTA
- Surface coating as well as weld build-up on edges possible vs TS
- Fine, homogeneous microstructure due to the high solidification rate vs TS

- LC is a complementing technology to thermal spray
- LC becomes more and more competitive against PTA welding vs PTA
- In advanced weld repair application LC outperforms conventional TIG welding vs TS
Laser Cladding and Oerlikon

- 1988 Sulzer: CO$_2$-laser system in operation for R&D purpose
- 2001 Laser Cladding as a coating service in Switzerland
- 2006 Fiber-laser system in operation
- 2012 Metco provides Laser Cladding services, materials and equipment
- 2014 Metco becomes part of Oerlikon

Metco has more than 25 years experience in Laser Cladding applications
Oerlikon Metco Laser Cladding services

- 3 large LC-systems in Winterthur (former Sulzer Innotec) and Wohlen
- LC service provider in several different business areas – from general industry to gas turbine components
- Experience with a broad range of materials – from Titanium to Steel to Co- and Ni-based super alloys, carbides, …

Our service business is the nucleus for our application know-how

Winterthur facility
- 2 kW CO₂-Laser
- 150 W Nd:YAG-Laser

Wohlen facility
- 6 kW Diode-Laser
- 1.7 kW Fiber-Laser
Laser Cladding in the MRO business

Industrial Gas Turbines

- component repair and modification

Welding process

Blade tip repair, 6mm weld build-up, MetcoClad™ 625 on In738

- Challenging materials
- Small heat-affected zone
- Near net-shape weld build-up, minimum finishing effort

Knife edge repair, up to 12mm high

(all Oerlikon Metco)
Laser Cladding in the MRO business

Compressors and Pumps

- bearings, blades

Turbocharger blade tip repair

- No post-weld heat treatment possible
- Qualified processes

Compressor shaft repair

(all Oerlikon Metco)
Laser Cladding hardfacing examples

Kneader teeth, fully covered with PlasmaDur™ 51302

- WC-coating with hardness 1500+ HV
- Homogeneous distribution of the WC particles
- Significantly improved wear resistance, several times increased service lifetime
The Oerlikon MetcoClad™ System in Wohlen

First system in Switzerland
- Application support and development
- Customer demonstration
- Laser Cladding services

Design features
- Oerlikon Metco LC Controller
- Oerlikon Metco Powder Feeder
- Oerlikon Metco Powder Nozzles
- 6 kW Diode Laser
- 10 axes handling system: track-mounted robot, tilting turn-table, lathe

Customer solutions will be tailored according to customer needs and may require less laser power, less robot-controlled axes, a smaller or larger or probably no lathe, ...

The MetcoClad™ system is the consistent enhancement of Metco’s available thermal spray coating equipment.
The Oerlikon MetcoClad™ System

Cabin 7.5 m long, 3.5 m wide, 3 m high
The Oerlikon MetcoClad™ System

Operator desk with LC-Controller, offline programming system, camera surveillance and device monitoring tools
The Oerlikon MetcoClad™ System

Handling system with robot on track, tilting turn-table, lathe and powder feeder
Laser Cladding of large parts

Water-cooled roll

1 layer with MetcoClad™ C-276, ~1.2mm
Laser Cladding Services around the world

APPLICATIONS

Advanced weld repairs (well known for a long time)

Tailored surfaces with improved wear/corrosion resistance (increasingly popular)

Additive manufacturing (an emerging application)

Application selection

- Dies
- Molds
- Wear / corrosion-resistant weld overlays

Other general industry

- Turbine blade, vane and drum repair
- New-part hardfacing

Heavy machinery

- Grader blades
- Scraper blades
- Cutting edges hardfacing
- Wear / corrosion-resistant weld overlays

Compressors & Pumps

- Impellers
- Bearings
- Shafts

Steel, Pulp & Paper

- Rollers
- Shafts
- Knifes
- Saws

Piston engines

- Valve seats
- Camshafts
- Piston ring grooves
- Cylinder liners
- Crankshafts
- Gears

Aero

- Turbine blade, vane and shaft repair
- New-part hardfacing

IGT

- Drill collars
- Drilling tools
- Downhole tools
- Stabilizer
- Bearings
- Impellers
- Rollers
- Pump parts
- Excavators

Oil &Gas

- Valves
- Shaftseeds
- Downhole tools
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Mining

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Laser Additive Manufacturing LAM by Direct Energy Deposition DED (= LC)

Advantages
- Material can be added to existing geometries
- Large work pieces possible
- Different materials applicable
- Higher laser power (=productivity) applicable

Limitations
- Limited geometrical freedom vs SLM
- LAM CAM-tools for DED with limited functionality only vs SLM
- «First time right» does not work
- Materials must be weldable

Challenges – Food for thoughts
- Tailored materials that benefit from rapid solidification
- Improved simulation and related CAM-tools
- Improved process monitoring for quality control i.e. absence of welding defects
Laser Additive Manufacturing by Direct Energy Deposition DED (= LC)

- Laser Additive Manufacturing in China
Summary

- Metco has 25 years experience with laser cladding
- Metco Laser Cladding services is active in several industries, from gas turbine component repair to hardfacing in new part manufacturing
- Metco offers a complete portfolio of laser cladding powders for wear resistance, corrosion resistance and general surface build-up and restoration
- Metco offers dedicated laser cladding systems, based on the long-standing experience with thermal spray equipment and laser cladding applications

Oerlikon Metco can combine material, equipment and application know-how like nobody else in the market