Laser Processing Technologies

Laser Hardening

Direct Laser Deposition
Pump Supplier To The World
Flowserve is the driving force in the global industrial pump marketplace. No other pump company in the world has the depth or breadth of expertise in the successful application of pre-engineered, engineered and special purpose pumps and systems.

Pumping Solutions
Flowserve is providing pumping solutions which permit customers to continuously improve productivity, profitability and pumping system reliability.

Market Focused Customer Support
Product and industry specialists develop effective proposals and solutions directed toward market and customer preferences. They offer technical advice and assistance throughout each stage of the product life cycle, beginning with the inquiry.

Dynamic Technologies
Flowserve is without peer in the development and application of pump technology, including:

- Hydraulic engineering
- Mechanical design
- Materials science
- Intelligent pumping
- Manufacturing technology

Broad Product Lines
Flowserve offers a wide range of complementary pump types, from pre-engineered process pumps, to highly engineered and special purpose pumps and systems. Pumps are built to recognized global standards and customer specifications.

Pump designs include:
- Single stage process
- Between bearing single stage
- Between bearing multistage
- Vertical
- Submersible motor
- Rotary
- Reciprocating
- Nuclear
- Specialty
Laser Processing Technologies

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Technology Development
Flowserve’s on-going commitment to providing extra value to customers is exemplified by its investment in laser technology. This technology is applied through two different processes:
- Laser Hardening
- Direct Laser Deposition

These processes have the ability to create superior surface properties on critical clearance parts, thereby improving pump reliability and durability.

Application Experience
Flowserve has placed thousands of Laser Hardened and Direct Laser Deposition parts in new and old machines. These wear rings, sleeves, bushings and other critical close-clearance running parts continue to benefit the pump user by improving pump life, operability and performance.

Wide Application Possibilities
- Stationary wear rings
- Rotating wear rings
- Close-clearance bushings
- Shaft sleeves
- Balancing drums and sleeves and other critical components

Pump Benefits
- Improved reliability and durability
- Increased mean time between repairs (MTBR) and pump life
- Maintained performance and efficiency

Meeting Special Needs for Pumps in Critical Services in All Industries
- Power generation
- Refining
- Pipeline
- Water injection
- Mining
- Steel
- Waste water

Laser Hardening

Direct Laser Deposition
The Hardening Tradeoff: Ductility vs. Hardness
To achieve greater gall resistance, martensitic stainless steel parts (400 series) are often heat treated for greater hardness. This is commonly referred to as “through-hardening”.
However, this amount of hardening must be limited to prevent brittle, crack-sensitive parts. For this reason, the hardness of rotating, close-clearance parts, such as impeller wear rings, is often held to a level less than the maximum which can be obtained from the material to ensure part reliability.

Eliminating the Hardness Tradeoff
The Laser Hardening process eliminates the Hardness Tradeoff in close-clearance rotating wear parts. Since the laser heat treatment only hardens the outer surface of the part, the base material remains unchanged. The result is a reliable, ductile part, with maximized surface hardness – the ideal blend of part characteristics.

The following table outlines the application and superior results of this process:

<table>
<thead>
<tr>
<th>Application</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>A martensitic stainless steel with specially controlled chemistry is used to provide uniform and repeatable hardness.</td>
<td>Part surface becomes Rc50 to 55. Note: This hardened depth is greater than expected running clearance wear.</td>
</tr>
<tr>
<td>The laser heats the material’s surface to the austenitizing temperature.</td>
<td>Part base material remains ductile (Rc20 max.)</td>
</tr>
<tr>
<td>The part is allowed to cool via a self-quenching action.</td>
<td>Consistent ring hardness is achieved through:</td>
</tr>
<tr>
<td></td>
<td>- Controlled chemical composition</td>
</tr>
<tr>
<td></td>
<td>- Precise laser application</td>
</tr>
<tr>
<td></td>
<td>- Repeatable manufacturing procedures</td>
</tr>
</tbody>
</table>

Pump Benefits
- Extends wear part life
- Helps preserve “as design” wear ring clearances, which benefits pump performance, efficiency and vibration
- Reduces sensitivity to galling, corrosion and erosion
- Eliminates possibility of cracking associated with brittle parts

Hardness Survey
Laser Impeller Ring

* Base material retains original hardness (typically less than Rc20)
Achieve Superior Surface Characteristics

The Direct Laser Deposition (DLD) welding process metallurgically bonds a metal powder to the base material. Due to a controlled and localized heat input, this process can be applied to various base metals without distortion or the need for post weld heat treatment.

Choice of Metal Powders

- Chemistry similar to or different from base material
- Application specific characteristics
  - Level of hardness
  - Corrosion resistance
- Brands
  - Ultimet®
  - Stellite®
  - Flowserve proprietary blends

Pump Benefits

- Improves pump reliability
  - Reduces chance of galling
  - Reduces chance for cracking
- Increases mean time between repairs
  - Improves life of wear parts
  - Maintains performance and efficiency
- Restores worn pump components
  - Repairs to “as design” geometry
  - Upgrading to superior surface characteristics
  - Salvages used parts that would otherwise be scrapped

Typical Applications

<table>
<thead>
<tr>
<th>Liquid</th>
<th>Base Material</th>
<th>Base Material Hardness (Rc)</th>
<th>DLD Hardness (Rc)</th>
<th>Pump Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water/ Hydrocarbons</td>
<td>Martensitic Stainless Steels (400 Series)</td>
<td>22</td>
<td>52</td>
<td>Boiler Feed Circulating Water Service Water Hydrocracker Charge</td>
</tr>
<tr>
<td>Seawater/ Corrosive Liquid</td>
<td>Austenitic Stainless Steels (300 Series)</td>
<td>15</td>
<td>42-58</td>
<td>Tower Bottoms Circulating Water Service Water Cooling Water Ash Sluice</td>
</tr>
</tbody>
</table>

Note: Above values are typical and may vary by application

Proof-testing of Ultimet Powder on 316 SS

Micrograph Showing DLD Cross Section

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© Stellite is a registered trademark of the Deloro Stellite Company, Inc.
Flowserve Model DMX
A standard upgrade for the DMX pump is to supply Laser Hardened impeller wear rings and sleeves, highlighted in red.

22 400 kW (30 000 hp), 5500 rpm Boiler Feedwater Pump Rotor Restoration
Upgraded to feature DLD treated impeller front and back integral wear rings and Laser Hardened balancing drum, highlighted in red.

Circulating Water Pump in Silty River Water Service
Retrofitted with DLD upgraded shaft sleeves for abrasion and corrosion resistance, highlighted in red.
Advanced Technologies
Few if any pump companies can match Flowserve’s capabilities in hydraulic and mechanical design or in materials engineering. These capabilities include:
• Computational fluid dynamics
• Flow visualization
• Cavitation studies
• Efficiency optimization
• Finite element analysis
• Rapid prototyping
• Captive high nickel alloy and light reactive alloy foundries
• Non-metallic materials processing and manufacturing

Service and Repair Group
Flowserve’s Service and Repair Group is dedicated to maximizing equipment performance and reliability-centered maintenance programs. Pump related services include:
• Startup and commissioning
• Diagnostics and prognostics
• Routine and repair maintenance
• ANSI and ISO power end exchange program
• Re-rates, upgrades and retrofits
• Spare parts inventory and management programs
• Training

Pump Improvement Engineering Services
Flowserve is committed to helping customers obtain the best possible return on their pump equipment investment. Engineering assistance and technological solutions for pumping problems are readily available.

These services include:
• Field performance testing
• Vibration analysis
• Design analysis and root-cause problem solving
• Material improvements
• Pump and system audit
• Advanced technology solutions
• PumpTrac™ remote pump monitoring and diagnostic services
• Instruction manual updates
• Training courses