We can’t stop the march of time.
But we can remove its traces.
Direct Metal Deposition from TRUMPF
Multiply the longevity of your tools and molds

**Refinement**
- Improved physical and mechanical properties
- Greater resistance to wear
- Reduced cycle times
- Protection against corrosion
- Improved thermal response

**Repairs**
- Quick design changes at low cost
- High rate of availability through preventative refurbishment
- Easily correct manufacturing defects
- Flexible adaptation of production tools in tests
- Immediate help if tools and components fail abruptly
- Reduce production downtimes
With Direct Metal Deposition (DMD), TRUMPF has set yet another milestone in metal processing with the laser. Whether your application involves automotive engineering, aviation and aerospace technologies, or heavy industry—whenever valuable parts wear out or need to be modified, DMD is the best choice. With DMD, metal parts can be selectively repaired, modified or refined, enabling you to effectively extend the service life of your tools and molds. Modify parts instead of manufacturing new ones, repair used parts instead of keeping spares—you can save time and money in the future. Expensive worn tools can be re-used multiple times—and this with substantially greater time savings than manufacturing from scratch.

In Direct Metal Deposition (DMD) process, metallic layers are deposited on existing components practically seamlessly—without any loss in quality over the original part, completely dense, and free of pores and cracks. This is true even if a combination of metals and alloys is used—exactly adapted to the needs of your tools and molds—and also automatically and reproducibly, thanks to feedback control.
From the very small to the very large—
No part is impossible

With the TRUMPF TrumaForm DMD 505, metal parts of different kinds and sizes can be processed—straight from your 3D-CAD data. At the heart of the machine is a high-powered TRUMPF laser with an output of up to 6,000 watts. The work table measuring 2 m by 1 m, with a carrying capacity of up to 7 tons, can be loaded and unloaded outside of the machine. This makes heavy workpieces easier to handle as well. Thanks to the open machine design which offers access from three sides, large components can also be accommodated using suitable handling systems according to customers’ requirements.

Compelling laser power
CO₂ lasers are the "work horses" of laser machining. They are deployed wherever a consistently high power output is required, for instance for greater track widths and thicker layers. The laser of the TRUMPF TrumaForm DMD 505 has a power output between 2,000 and 6,000 watts.

A control that responds quickly
Easy operation is ensured by the graphic process display which was designed with the operator's activities in mind. A “Teach panel” for manual control is used for set-up work.

Beam guidance by means of 3D-CAD
The 5-axes kinematics allows the deposition of 3D surfaces by tracing paths based on the NC data from the CAD/CAM programming system.
Everything under control—thanks to feedback system

The feedback system provides for precision material deposition of high quality across all layers. The geometric data of the weld pool are continuously recorded by 3 CCD cameras.

Based on this information and the setpoints, a high-powered computer compares the actual values with the set values. This serves to control the laser.

Parallel powder feed

A total of four powder feeders can be used in succession or simultaneously (mixed), so that suitable material combinations can be produced. The compact, automatic feeders can be removed and refilled in a few quick steps.
DMD proves itself wherever expensive parts are subject to wear

Be it in the forging sector, in press shops or in heavy industry, in automotive production, in aviation and aerospace or in off-shore applications—wherever expensive parts are subjected to wear or need to be modified, DMD proves its worth. With DMD, yesterday’s tools are also tomorrow’s tools—but better and faster than ever before.

Suppliers to the automotive industry who use warm and cold forming e.g. to manufacture transmission and chassis components know this, and they are not the only ones: Tools and molds must endure a lot. High material temperatures and enormous pressure during forming is quite the norm. The same applies to die casting of motor blocks, frying pans or alloy rims.

The possibilities that DMD technology offers are as diverse as its applications: Selective surface treatment of drill rods against abrasion, corrosion and heat impact; refurbishing worn turbine blades in the energy industry; adapting injection or die-cast molds for new models; repairing glass molding forms or the landing gear of aircraft—with TRUMPF DMD, this is no problem at all for you.
When tools and molds become worn or need to be modified, cost arise: Old valuable parts are thrown out, new parts have to be manufactured at great expense and adapted. DMD makes this a thing of the past. Because, with DMD, forming, die-casting and injection molding tools or also function parts can be repaired without a trace. More yet: By selectively depositing or combining materials—for instance the cheaper grey cast iron as the base material and high-grade steels for the machining faces—tool properties can be improved and cost can be reduced.

Leveraging existing properties
Different metals can be deposited with DMD on base materials such as tool steel, copper or cast iron, just to name a few. By skilfully selecting the appropriate materials, material properties like strength, resistance to corrosion or thermal properties can be optimally combined and used to enhance productivity.

Modifications for new models
“Scraping” expensive tools and molds is a thing of the past. With DMD, they can be modified and re-used—e.g. when introducing new models.
1. Material wear and tear
Forging, injection molding and press tools undergo enormous wear and tear during operation. With DMD, damaged metal structures can be rebuilt without trouble.

2. Preparation—Surface removal
After defining the target area, the surface is prepared accordingly (for instance by milling, erosion or turning). After that, new material can be deposited.

3. Deposition of new metal
As a result of the controlled cladding process, the resulting bond with the base material is extremely strong and the material structure is free of pores and cracks. The original tool loses nothing of its material properties and strength.

4. Reworking—Shaping contours
As soon as the spark erosion or reworking is completed, the surface can be polished or etched. Even textured tool surfaces can be repaired without leaving traces.

Repairs without a trace
Damage due to wear and tear can be corrected quickly without a trace. The properties of the newly deposited material are so similar to those of the original material that it is virtually impossible to distinguish between them after the final finish by polishing or etching. Even repaired surface structures, textures or changes in shape cannot be detected once the end product is finished.

Combining materials
Thanks to DMD refinement, the wear and tear on the machining faces, for example, of forging tools, can be drastically reduced. High-strength materials are selectively deposited in areas subject to heavy attrition. This yields properties that exactly meet stringent requirements and provide a long service life.

Multiply your options
In heavy industry, such as turbine construction, wear and damage often lead to expensive repairs. The same applies to forming or die-casting tools, which must withstand extremely high loads. Thanks to DMD, even large components can be repaired quickly and economically and adapted to changing needs.
Turn old into new—as often as you want

With Direct Metal Deposition from TRUMPF, you can now repair, modify and refine your metal parts as often as you want—with feedback system and repeat accuracy. Pure metal or alloy powder is injected through a nozzle into a laser-generated melt pool on the workpiece surface and completely melted. In this manner, the new structure is generated, layer by layer. Like all laser welding or cladding processes, DMD boasts an extremely small heat affected zone and minimal heat input into the workpiece.

The process steps
The process chain starts off with preparatory work at the CAD/CAM programming system. The next steps involve the repair or modification of a workpiece. Step 3 represents the actual DMD process itself, while steps 1 and 2 as well as 4 and 5 deal with preparation and finishing, respectively. This type of work is normally performed with conventional machines and processes.

1. Define worn-out material or structure to be modified
Tools and molds that are subjected to heavy wear and crack formation or which need to be modified can be easily re-built or refined with DMD. First, the user must define the damaged surface or the area he wants modified.

2. Surface removal down to the base material
Once the target area has been defined, the surface is removed all the way down to the “healthy” base material. After that, new material can be added through deposition.
**Totally different metals can be processed with DMD**

The feasibility and the attainable quality of a DMD layer depend primarily on the desired material combination and on the geometry of the part or DMD layer. If the substrate and DMD material do not match up, a so-called “buffer layer” may have to be applied. In some cases, such buffer layers are explicitly used as a design feature, for instance, to prevent corrosion.

Which material combinations are right for you? All the materials listed below can be processed in good quality with DMD. TRUMPF provides technology data records, for example, for warm works steel 1.2344 (H13) in combination with various DMD materials for the standard layer thickness $d_s=0.5$ mm at a corresponding track width of $s=2.0$ mm.
## Travel ranges of linear axes

<table>
<thead>
<tr>
<th>Axis</th>
<th>Travel Range (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>X axis</td>
<td>2,000</td>
</tr>
<tr>
<td>Y axis</td>
<td>1,000</td>
</tr>
<tr>
<td>Z axis</td>
<td>750</td>
</tr>
</tbody>
</table>

## Swivel ranges of rotary axes B, C

<table>
<thead>
<tr>
<th>Axis</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>B axis</td>
<td>± 45°</td>
</tr>
<tr>
<td>C axis</td>
<td>± 190°</td>
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</tbody>
</table>

## Axis travel speeds

<table>
<thead>
<tr>
<th>Direction</th>
<th>Speed (m/min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>30</td>
</tr>
<tr>
<td>Y</td>
<td>30</td>
</tr>
<tr>
<td>Z</td>
<td>30</td>
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</table>

### Linear axes acceleration

<table>
<thead>
<tr>
<th>Axis</th>
<th>Acceleration (m/s²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>120°/s</td>
</tr>
<tr>
<td>C</td>
<td>180°/s</td>
</tr>
</tbody>
</table>

## Machine accuracy

(in acc. with VDI/DGQ 3441, measured over a length of 1 m)

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Accuracy (mm/m / °)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smallest programmable increment</td>
<td>0.001 / 0.001°</td>
</tr>
<tr>
<td>Positioning accuracy (Pa)</td>
<td>0.08 / 0.015°</td>
</tr>
</tbody>
</table>

## Powder components

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of powder feeders</td>
<td>Max. 4</td>
</tr>
<tr>
<td>Powder grain size</td>
<td>45 – 105 µm (up to 160 µm)</td>
</tr>
<tr>
<td>Material deposition rates</td>
<td>Typically 20 – 60 cm³/h (up to 140 cm³/h)</td>
</tr>
<tr>
<td>Thickness per layer</td>
<td>Typically 0.1 – 1 mm*</td>
</tr>
</tbody>
</table>

## TRUMPF CO₂ laser

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Specification</th>
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</thead>
<tbody>
<tr>
<td>Laser power</td>
<td>2,000 – 6,000 watts</td>
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</table>

## Miscellaneous

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Machine control</td>
<td>SIEMENS 840 D</td>
</tr>
<tr>
<td>Space requirements (D x W x H)</td>
<td>approx. 5 m x 7 m x 3.3 m</td>
</tr>
</tbody>
</table>

*Variable layer thickness through programable spot diameter.

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The installation site and foundation must meet the requirements set forth in the Installation Conditions and Foundation Plan.
It is the result that makes DMD so special
Structures that are almost 100% dense (according to the characteristics of the original material), customized properties, thanks to special powder mixtures, 3D shapes and structures plus numerous other benefits—make the DMD so special for you.

- Material structures that are free of pores and cracks
- Little finishing due to warping
- High-strength bond with the substrate material
- Minimal dilution of DMD material into substrate material
- Different types of metals can be combined and deposited on
- Laser beam guidance follows a 3D path controlled by CNC
- Reproducible results thanks to automatic process with feedback control

3. Deposition of new metal
New material is deposited by injecting metal powder through a water-cooled nozzle coaxial to the laser beam into the molten pool created on the workpiece surface, where the powder melts. As a result of the melting process, the bond with the base material is extremely strong and the material structure is free of pores and cracks.

4. Reworking: Milling, turning, drilling, eroding
As soon as the newly deposited material has cooled down, the workpiece can be finish processed or, where necessary, it can be heat-treated with conventional methods. When spark erosion or reworking by means of milling, turning or drilling has been completed, the surface can be finished.

5. Surface finishing: Etching, texturing, polishing
The workpiece surface can then be polished or etched. Even textured structures can be repaired without leaving any traces. The tool is ready for use immediately after surface finishing.
TRUMPF is certified in accordance with DIN EN ISO 9001 and VDA 6.4