

# Laser Beam Build-up Welding



**Fraunhofer** Institut  
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# Surface protection and repair of heavily stressed components and tools

## Technology

Laser beam build-up welding is technologically comparable to plasma build-up welding and plasma spraying. It is applied to such cases where a high precision of the layer structure is required, or where the component which has to be coated has got a very complex form. Furthermore it finds its application in cases where the component is heavily stressed.

Compared to the conventional build-up welding, the laser technology distinguishes itself by:

- the exact controllability of the welding process and of the layer composition,
- the precise localization of the material build-up
- the near net shape deposition.

Due to this near net deposition you achieve an economical consumption of additional material and a low work-over need. Multilayer coatings are possible without intermediate machining thus even 3D-structures can be easily built up by a number of tracks. As the laser beam build-up welding is a very precise technique, it is not really recommended for large area coatings.

## Technological features and parameters

laser	- CO <sub>2</sub> - Nd:YAG - diode	up to 20 kW up to 4 kW up to 4 kW
layer geometry 6 kW-CO <sub>2</sub> laser	- track width - track height - single layer thickness - deposition rate	0.5 bis 8 mm 0.2 bis 2 mm 0.3 bis 3 mm up to 1 kg h <sup>-1</sup>
layer quality	- compact, dense structure - melt-bonded to the substrate - iron mixing 3 ... 5 % in case of metal coatings onto steel - surface corrugated roughness in the case of overlapping tracks 0.1 ... 0.3 mm	
ambience	- ambient air - inert gas recommended in some cases	

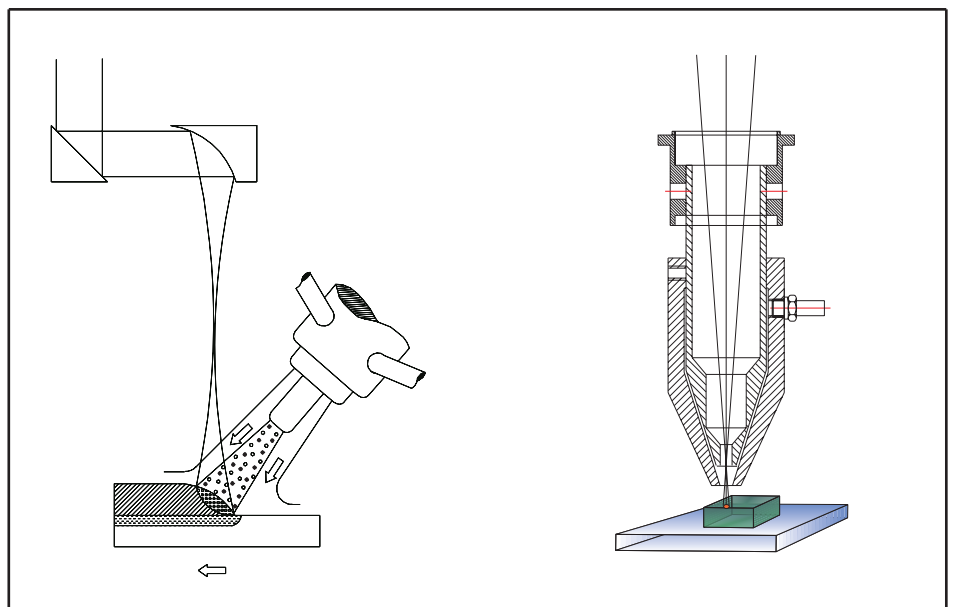


Fig. 1: Versions of laser beam powder build-up welding  
left: off axis powder feed with powder mixing head for one- and two-component powders  
right: welding head with co-axial powder feed for coating complex-shaped surfaces

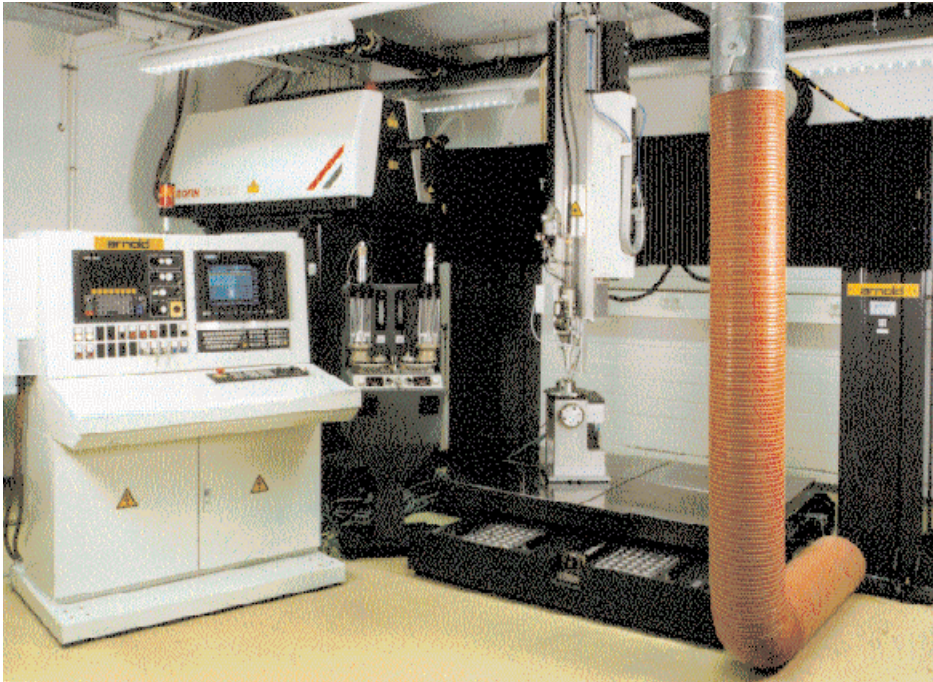


Fig. 2: Laser build-up welding plant

## Applications

Apart from the mere wear protection of components and tools the laser build-up welding is also applied to problems of surface refinement in order to increase the corrosion resistance, the thermal shock resistance and to increase the impact and fatigue strength. Besides the surface protection of new components this method offers the opportunity to repair cost-effectively wear damaged components and tools.

This technique is mainly used in the automotive and aircraft industry as well as in tool and mold making. The figures 3 to 7 show some application examples.

## Material combinations in laser build-up welding

	metall alloys	hard material / metall-composites	ceramics
base materials	<ul style="list-style-type: none"> <li>- steel</li> <li>- cast iron</li> <li>- Ni-, Ti-, Cu- and Al-alloys</li> </ul>		
coating materials	<ul style="list-style-type: none"> <li>- Co-alloys (Stellite)</li> <li>- Ni-alloys (as NiCrBSi, Nimonic)</li> <li>- Fe-alloys (as HSS)</li> <li>- Ti-alloys (as TiAl6V4)</li> <li>- Cu-alloys (as CuSn, CuNi)</li> </ul>	<ul style="list-style-type: none"> <li>up to 50 Vol.%</li> <li>- WC</li> <li>- <math>\text{Cr}_3\text{C}_2</math></li> <li>- TiC</li> <li>- VC</li> <li>within Ni-, Ti- or Fe-alloy matrix</li> </ul>	<ul style="list-style-type: none"> <li>- <math>\text{Al}_2\text{O}_3</math></li> <li>- <math>\text{Al}_2\text{O}_3/\text{TiO}_2</math></li> <li>- <math>\text{ZrO}_2/\text{Y}_2\text{O}_3</math></li> </ul>

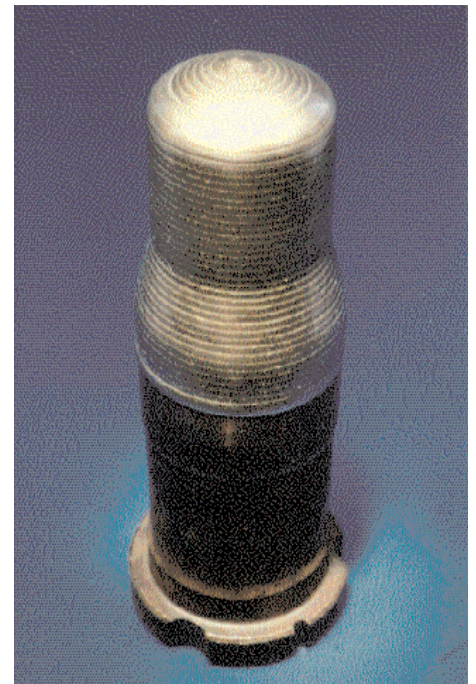


Fig. 3: Hot forming tool for forging car axle parts, tear area is coated with Stellite 21

## Offer

Based on our long-time, profound experience with build-up welding by power lasers we offer the following services:

- development of
  - technologies
  - technical components
  - materials and layer systems
- build-up welding on parts and tools
  - single-piece or small-lot production for industrial needs
- technical consulting and support
  - in using laser technologies
  - in developing laser processing machines

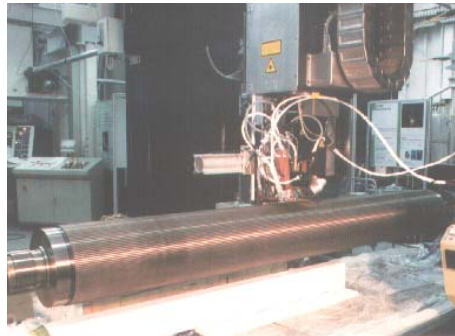


Fig. 4: Corrugating roll for paper production, tops precision coated with WC/Co-NiCrBSi



Fig. 5: Laser clad valve

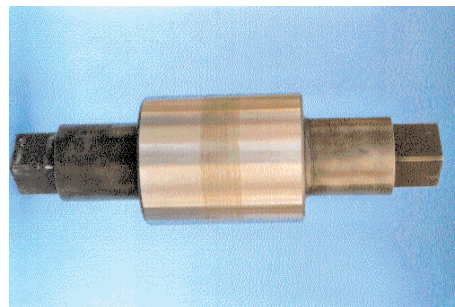


Fig. 6: Cold rolling tool for wire production, wear and tear area severally coated (5 mm thickness) with WC/Co-NiCrBSi by multi layer stacking

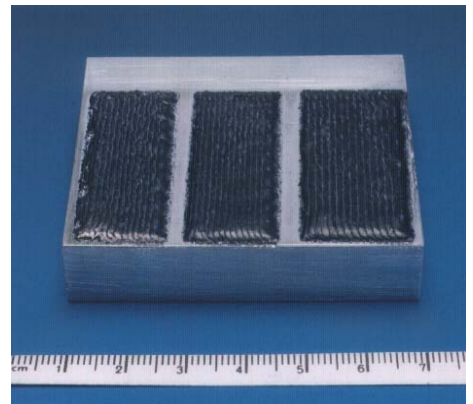


Fig. 7: Surface protection of light alloy: 0.8 mm  $Al_2O_3 / TiO_2$  on AlSi10Mg, to be applied within pump cases

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## Front page

- left: Laser clad car cam shaft  
center: Wear protective cladding of a corrugating roll  
right: Remanufactured part of a pressure casting die