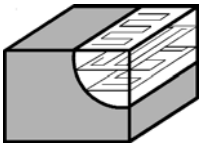
Fraunhofer Institut Werkstoff- und Strahltechnik

Rapid prototyping and tool repair through laser precision cladding

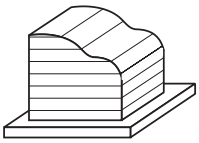
Problem

Laser precision cladding is a practical technique employed to generate dense and failure-free three-dimensional structures of various metal alloys with high hardness and high wear restance. Based on 3D CAD data sets, the material is NC controlled applied in the form of building up a large number of fine individual tracks until finally approaching very closely the desired contour. As a result, there emerges either functional metallic samples of tools and components or contour conforming coatings for surface protection or repair.
For both applications there is a digitizing and programming workstation available, which has the ability to scan the actual surface structure as given by the worn out part and to adjust the working regime and control of the entire laser equipment.

CAD → CAM



Repair coatings



Generation of 3D solid parts

Sinumerik 840 D

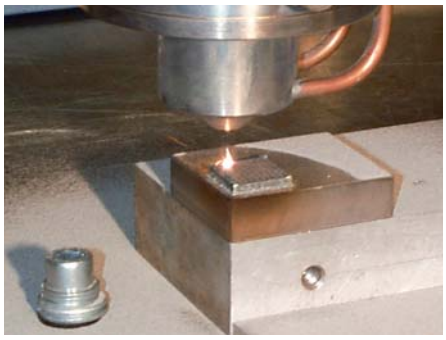
NC Program

N10 m 41	-laser on
N11 $A_OUTA [1] = 4000	-laser power
N12 X10 Y15 Z0,3	-track setting
…	

CAD workstation

- Design, import of 3D data (STL...)
- Scanning of the actual contour (planes, point clouds …)
- Determination of the difference between actual and desired contours
- Slicing of the difference volume or the total volume
- Processing strategy for plane cuts
- Simulation of processing
- Post processing to generate NC programs with process parameters (laser power, amount of powder, speed)

5 axis NC laser machine, equipped with 2kW CO_2 laser, 3 kW Nd:YAG laser and 1,4 kW diode laser



Cladding process with laser powder welding head

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Advantages

- Direct build up of completely dense and failure-free individual parts made of steel, Co and Ni hard alloys with a hardness between 30 and 54 HRC
- Surface protection of free formed planes and tool repair with metallic hard alloys and carbide-metal composites
- Manufacturing of part/coating geometry directly from the 3D CAD data without intermediate technological steps
- Minimum post processing required due to matching contours and high surface quality

Technical Parameters

Laser:

- Affordable CO_2 or Nd:YAG laser with ≤ 1 kW power are mainly sufficient

Welding additions:

- Commercially available steel, Co, Ni base powders as well as hard material powders (WC, Cr_3C_2, VC)

Accuracy:

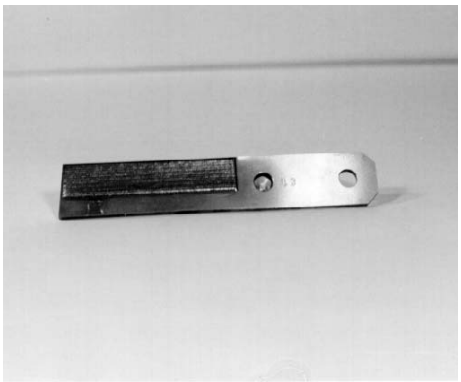
- Minimum wall thickness about 0,5 mm
- Form deviation max ± 0,1 mm
- Surface roughness (material and geometry dependent) R_z = 20 - 200 µm

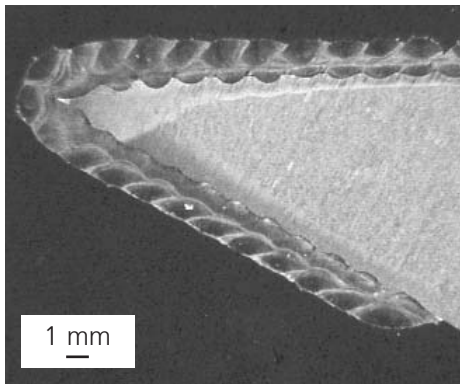
Productivity:

- Build-up rate (material and geometry dependent) with 1 kW CO_2 laser: 15 - 75 $cm^3\ h^{-1}$

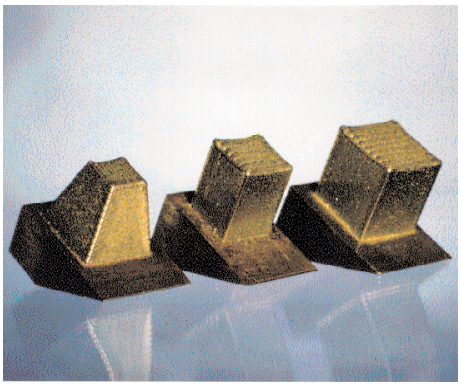
Applications

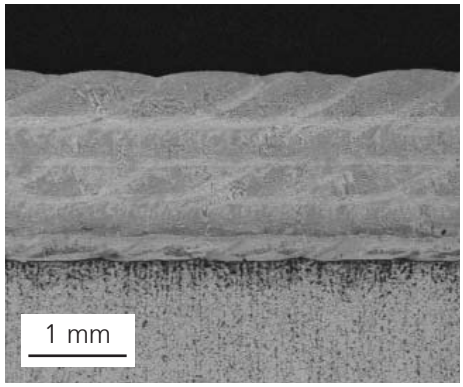
Repair of a paper knife: building up of stellit 6 on the cutting edge





Laser generated forms made of stellit 21: Application for injection molding





Press stamp made of C45: direct generation of the active tool part due to multilayer contour conforming build-up of WC-NiCrBSi