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## PROCESS MONITORING DURING HARD CLADDING OF INTERNAL PIPE SURFACES

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### Task

A growing field of application for laser cladding technology (Laser Metal Deposition, LMD) is the armoring of highly loaded interior surfaces of, e.g., bearings, housings or cylinder bores. Thanks to specially developed internal coating optics, an armoring and repair technology has been developed for components whose inner surfaces were not previously accessible with standard processing heads. Thanks to the integration of sensors and systems for coaxial process monitoring, the machine operator can observe the process online and, therefore, control it.

### Method

The development and the dimensioning of INCLAD optics were carried out in consultation and cooperation with the system supplier and its industrial users. To transfer the process safely, the system configuration is being conceptualized and operated according to the industrial user's requirements. The technological maturity (Technology Readiness Level, TRL) and the production-acceptance test will be carried out both at the supplier as well as the industrial user.

### Result

So far, the design has been tested using inner coating optics with a length of 800 mm. Through an optical fiber, the optics is connected to a high power laser with a rated output of 4 kW and an emission wavelength of 1085 nm. A dichroic deflection mirror between the collimator and the INCLAD optics enables the coaxial measurement of temperature radiant flux emitted by the process as well as the process visualization by means of a CMOS camera.

### Applications

The LMD process can be used to repair expensive components whose surfaces only allow limited access and which place high demands upon stress and corrosion, such as drilling tools in the oil and gas industry, extruder barrels or sliding bearings in machine tools.

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### Contacts

Dr. Alexander Drenker  
Telephone +49 241 8906-223  
alexander.drenker@ilt.fraunhofer.de

Dipl.-Ing. Peter Abels  
Telephone +49 241 8906-428  
peter.abels@ilt.fraunhofer.de

*3 INCLAD optics for the interior coating  
of drill holes with a depth of up to 800 mm.*