FRAUNHOFER INSTITUTE FOR LASER TECHNOLOGY ILT

EFFECTIVE PROTECTION AGAINST WEAR AND CORROSION WITH THE "EHLA PROCESS"

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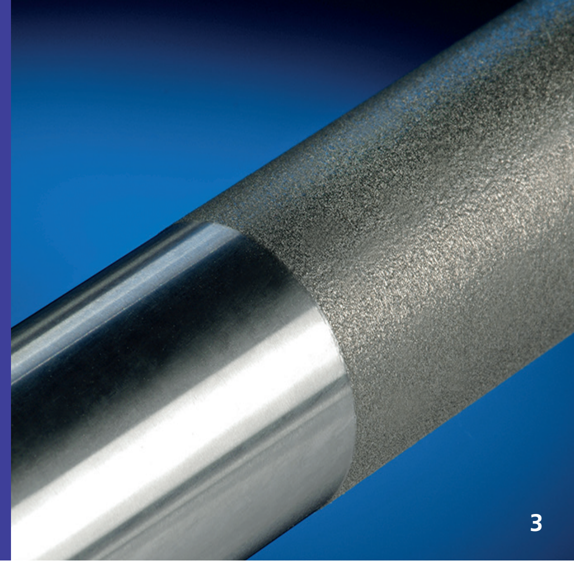
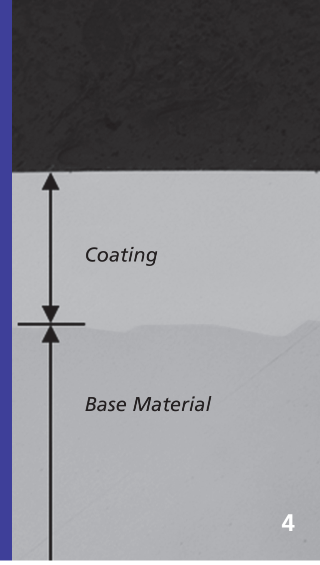
Fraunhofer Institute for Laser Technology ILT

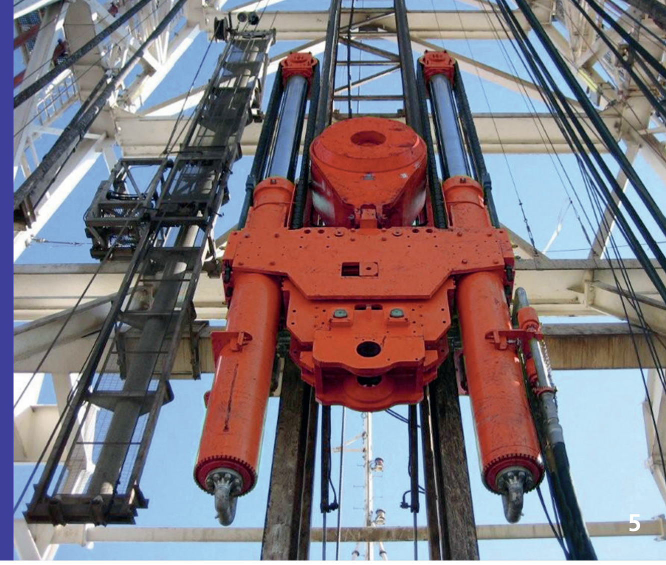
The Fraunhofer Institute for Laser Technology ILT is one of the most important development and contract research institutes in laser development and application worldwide. Its activities encompass a wide range of areas such as developing new laser beam sources and components, laser-based metrology, testing technology and industrial laser processes. This includes laser cutting, ablation, drilling, welding and soldering as well as surface treatment, micro processing and additive manufacturing. Furthermore, Fraunhofer ILT develops photonic components and beam sources for quantum technology.

Overall, Fraunhofer ILT is active in the fields of laser plant technology, digitalization, process monitoring and control, simulation and modeling, AI in laser technology and in the entire system technology. We offer feasibility studies, process qualification and laser integration in customized manufacturing lines. The institute focuses on research and development for industrial and societal challenges in the areas of health, safety, communication, production, mobility, energy and environment. Fraunhofer ILT is integrated into the Fraunhofer-Gesellschaft.

Subject to alterations in specifications and other technical information. 06/2017.







EFFECTIVE PROTECTION AGAINST WEAR & CORROSION WITH THE "EHLA PROCESS"

Hard chrome plating, thermal spraying and laser material deposition are ways of protecting components against corrosion and wear. However, all these processes have significant drawbacks. For example, as of September 2017, hard chrome plating using chromium(VI) will require special authorization. The new extreme high-speed Laser Material Deposition process, developed by the Fraunhofer Institute for Laser Technology ILT and RWTH Aachen University and known by its German acronym EHLA, eliminates these drawbacks in an effective and economical way.

The process – Applying thin Layers in a Resource-efficient Way

Protecting components against wear and corrosion is no simple matter. Standard processes, such as hard chrome plating or thermal spraying, have drawbacks. Laser Material Deposition has been used only sporadically in this field. With the extreme high-speed Laser Material Deposition EHLA, researchers at the Fraunhofer Institute for Laser Technology ILT and at RWTH Aachen University have now developed an alternative, patented process to overcome shortcomings of the conventional processes for coating technology and repair. This makes it possible to quickly apply layers measured in tenths of a millimeter to large surfaces in an economical, resource-efficient way. It also opens up entirely new opportunities in terms of material pairings and additive manufacturing.

Economical Alternative to Hard Chrome Plating

One common process for protection against corrosion and wear is hard chrome plating, but it consumes a lot of energy, and the hexavalent chromium it uses is harmful to the environment. This is why, starting in September 2017, it can be used only with a special permit.

EHLA constitutes the first economical alternative. Chemical-free application makes the process very environmentally friendly. The coating is firmly bonded to the base material and, unlike hard chrome layers, will not delaminate. And while hard chrome plating layers exhibit pores and cracks, layers produced using EHLA are non-porous and offer more efficient protection over a longer period.

More Sparing of Resources than Thermal Spraying

Thermal spraying, too, has disadvantages. This process consumes a lot of material and gas because only about half of the material used ultimately coats the component surface. In addition, the resulting layers bond only weakly to the substrate. Due to their porosity, it is necessary to apply several layers, each roughly 25 to 50 micrometers thick, on top of each other. The new EHLA process uses about 90 percent of the materials. Not only are the individual layers non-porous, but they also bond firmly to the substrate. This makes the process far more sparing of resources and notably more economical than thermal spraying.

Faster and More Versatile than Traditional Laser Material Deposition

Laser Material Deposition can apply high-quality coatings to components using a variety of different materials. However, this process is too slow for large components, which is why it has so far been used only sporadically for corrosion and wear protection. A further drawback of the process is that it requires high heat input into the component: the surface is locally melted, while a nozzle directs the powdery additive into the melt pool.

With EHLA, the laser melts the powder particles while they are still above the melt pool. This means drops of liquid material fall into the melt pool instead of solid powder particles, the layer is purer and smoother – roughness was reduced to just one-tenth of what it was previously.

A significant advantage lies in the low heat input. While the heat of conventional Laser Material Deposition affects a zone measured by the millimeter, EHLA's thermal effect on the material is merely in the micrometer range. EHLA thus makes it possible to coat heat-sensitive components, which had been impossible up to now because of the resulting unwanted brittle phases. This process can also be used for entirely new material combinations, such as coatings on aluminum-base alloys or grey cast iron.

Laser Material Deposition achieves feed rates of between 0.5 and 2 meters per minute; in contrast, EHLA reaches between 50 and 500 meters per minute – which is 100 to 250 times faster than before. It also solves the problem of layer thickness. Until recently, layers typically had to be 500 to 1000 micrometers thick. The new EHLA process allows for layers that measure just 25 to 250 micrometers.

Major Potential in Additive Manufacturing

Looking beyond coatings, EHLA offers some highly promising potential in areas such as the hybrid-additive approach to manufacturing volume elements on existing, conventionally produced components. Traditional manufacturing techniques are often characterized by a subtractive approach that frequently sees up to 90 percent of the original component machined away. EHLA has much to offer here. For instance, to manufacture flanges or seal seats by conventional means, a blank must be machined on a rotary shaft for several hours. Producing the same component using a hybrid-additive approach with EHLA takes just a few minutes, and subsequent turning is also completed in a matter of minutes.

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Cover: Coating a rotary shaft for offshore use.

1 Extreme high-speed Laser Material Deposition EHLA.

2 Coaxial powder nozzle with changeable tips.

3 EHLA coated and post machined piston rod.

4 Cross-section of the Cobalt-base alloy Stellite 6. Layer thickness approx. 150 µm.

5 Hydraulic cylinder for offshore applications (Source: IHC Vremac B.V.).