VarioClad - Laser Metal Deposition with Variable Spot Sizes

Fraunhofer Institute for Laser Technology ILT

With over 420 employees and 11,000 m² of useable space, the Fraunhofer Institute for Laser Technology ILT, founded in 1985, is one of the most important contracting research and development institutes of its sector worldwide. Its experts develop and optimize laser beam sources and laser processes. In close cooperation with its clients, it uses laser technology to solve tasks for production, measurement technology, environment, energy, medical technology and biotechnology, all done in real life situations. The Fraunhofer ILT is part of the Fraunhofer-Gesellschaft with 67 research units, 23,000 employees and an annual research budget of 2 billion euros.

Reis Lasertec GmbH

Reis Lasertec is a subsidiary of the Reis Robotics Group. The main activities of RLT include the development and manufacturing of beam guiding systems, sensors and processing optics for laser material processing. Reis Lasertec has its own test laboratory with different laser and handling systems for implementation and development of laser systems. In addition, it has access to various test and pilot equipment of Reis Robotics. Thanks to the close cooperation with the Fraunhofer ILT, RLT can use various up to date and high power beam sources.

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The Fraunhofer ILT together with Reis Lasertec GmbH have developed a compact laser metal deposition head that combines flexible optics with a coaxial powder feed nozzle. Laser metal deposition (LMD) with powder additive materials is used to repair highly sensitive components as well as to protect against wear and corrosion in the areas of tool and die making, turbo-engine engineering, automotive industry and mechanical engineering.

**LMD Process**

Laser metal deposition (LMD) offers a number of advantages in comparison to conventional procedures like TIG (Tungsten Inert Gas) and PTA (Plasma Transferred Arc) welding as well as spraying techniques. These advantages include improved metallurgical bonding of the layer and the substrate, low heat transfer to the workpiece, and the possibility of depositing layers of varying thickness from 1/10 mm to several mm by utilizing multi-layering techniques. The filler material is melted using the laser beam and fused with the base material. Usually the filler material is added in form of powder. The LMD process allows a high precision of the material deposition, an outstanding controllability of the process and a low thermal and mechanical load on the components. Damage or wear on turbo-engine components, machine parts, tools, molds and components can prove enormously costly. The parts affected often have to be replaced, in which case repair by LMD proves a viable option. Given the material and accuracy requirements, as well as the safety considerations associated with engine technology, LMD is an appropriate method for repair and restoration as well as for wear and corrosion protection.

Based on a three-dimensional data model of the virgin part or tool, the laser beam deposits the original material on the damaged parts using a powder feed nozzle, in a highly precise, layer-by-layer process. For the deposition of different materials and layers, suitable powder feed nozzles and highly flexible optics capable to deliver variable spot sizes are required.

**Coaxial Powder Feed**

Coaxial powder feed involves dispensing the powder along the axis of the laser beam. A distinction is made between discrete and continuous powder feed. With the discrete feed at least three powder gas streams running coaxially to the laser beam generate a »powder-gas beam focus«, which has a core diameter of 2 - 3 mm. This »three-jet powder nozzle« is particularly suitable for depositing layers with higher laser power (> 2 kW) and also depositing 3-D contours even in constrained locations. With continuous powder feed, the powder is distributed in a conical ring-shaped cavity, forming a hollow powder cone which encloses the laser beam. This »coaxial nozzle« allows the powder-gas beam focus to be reduced to under 0.2 mm, thus enabling laser metal deposition to be applied with optimum precision and efficiency even with a small laser beam diameter.

The motorized cladding optic is equipped with a compact housing including an integrated direct linear drive. The system uses a moving lens packet in combination with a coaxial powder feed nozzle. The zoom optics provides the means to adjust the beam diameter on the fly during processing without any modification to the working distance and thus any complex adjustments. The use of a direct drive also allows for high dynamic operation during processing (e.g. rapid geometry changes). The optic is designed to be operated with laser powers up to 6 kilowatts and cover track widths from 0.7 mm to 4 mm. The range depends on the beam quality of the laser source. The design will be adapted to different wavelengths and beam qualities, depending on the customer’s demands.

**Control**

The motorized cladding optic is delivered with its own control system, which enables a fast and simple connection of the motorized optic to a handling system. The motorized cladding optic is also equipped with a stand-alone motor control and a CANBus interface to connect to a handling system. The use of an alternative bus system is also possible.

**Services**

- Consultancy
- Feasibility studies and customized LMD process development
- LMD process installation at customers site and training
- System technology for laser metal deposition in cooperation with several plant providers

**Alternatives**

Alternatively a modular optic (MO) can be used. The MO, as its name implies, can be built up from different functional components (modules), like camera or pyrometer coupling, cross-jet etc., according to the customer’s needs. In combination with a coaxial powder feed nozzle, a compact and functional system has been designed by Reis Lasertec and Fraunhofer ILT that can be adapted in a short amount of time. Based on the basic MO unit including a drawer for an interchangeable lens, this special design enables the cladding of different track widths by only switching between different pre-assembled lens drawers.

1 Laser Metal Deposition on a flat sample.
2 Powder gas flow of a coaxial nozzle.
3 Powder gas flow of a three beam powder nozzle.
4 VarioClad - Moving Optics.
5 VarioClad - Modular Optics (MO).
6 Control panel.