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Modern Gantry System for Laser Cladding and Additive Technologies at Our Laser Center of Competence in Switzerland

In last decade there is a strong industrial interest observed for surface engineering technologies and coatings in general. laser cladding is one of the most promising technologies in the modern world of surface engineering and the attention given by both the scientific and industrial community grows steadily. In addition to high quality deposits with a metallurgical bond to the substrate, a key reason for its success is related to the multi-function capability of the process.

By Arkadi Zikin, Oerlikon Metco AG. (Originally published in Swiss Engineering, April 2021)

In last decade there is a strong industrial interest observed for surface engineering technologies and coatings in general. laser cladding is one of the most promising technologies in the modern world of surface engineering and the attention given by both the scientific and industrial community grows steadily. In addition to high quality deposits with a metallurgical bond to the substrate, a key reason for its success is related to the multi-function capability of the process.

Laser cladding has existed in the market already for more than 40 years, but still can be called one of the youngest methods for applying an engineered surface. It was not so commonly used in the past due to the expense of lasers and related components compared to other deposition methods. Also, the main applications were in high-cost markets. However, in the last decade, the situation has significantly changed, and the technology is now one of the most promising deposit methods, combining reasonable cost and quality benefits.

The development trends in three main directions — high-speed deposition, high-power deposition, and/or build-up of 3D structures. For example, due to high-speed deposition velocities, where deposition rates already go in a direction of over 5 m^2/h [54 ft^2/h], Laser cladding can successfully compete with processes like thermal spraying or hard chromium plating.

While it is also possible to build 3D structures layer by layer directly on the surface of components, changing their design, which has resulted in the assignment of laser cladding into the additive manufacturing group of direct energy deposition (DED) processes. This direction opens new horizons for additive manufacturing and production or repair of complex multi-dimensional components. With the market demanding “first-time-right” components for AM processes, there has been a huge leap in the development of tailored system technology and process monitoring tools.

Fundamentals of Laser Cladding

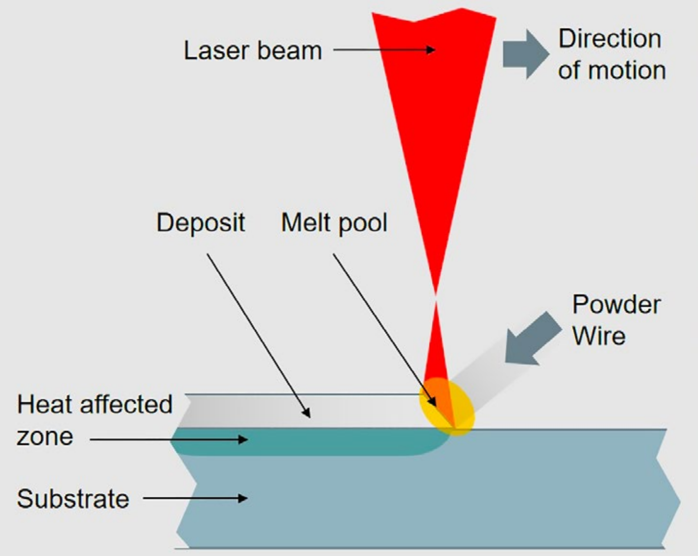
In laser cladding, with the help of the laser source, a laser beam is produced and transferred to the substrate surface. The laser beam creates a spot on the surface, where the heat will be introduced. The main benefit is that with the help of optical components (fibers, lenses, collimators) the geometry and dimensions of a produced spot can be defined and controlled.

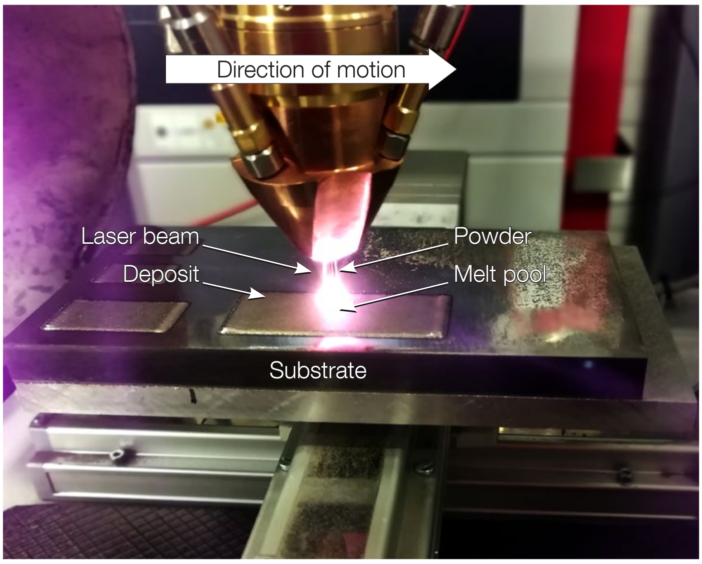
- Low HAZ [a] (heat affected zone).
- Low dilution [b] with the substrate (approximately 5%), resulting in better coating properties.
- Metallurgical bonding, which leads to the highest impact resistance.
- Low heat input, resulting in negligible distortion.
- High process reliability and repeatability.
- High deposition efficiency [c] by working with powder feedstock materials (80% to 95%).
- The high variety of deposition options.

In the area of the spot, a melt bath is produced on the surface of the substrate. In parallel, feedstock material in the form of

Why Choose Laser Cladding?	Five Key Points About Laser Cladding
■ Metallurgical bonding by low dilution ■ Low heat input and low distortion compared to other welding and cladding processes ■ High deposition efficiencies and various spot deposition combinations ■ High process control and repeatability ■ Offers multi-functional surface technologies: high speed, high power, additive manufacturing, hardening, etc.	■ Laser cladding is a precise process and requires trained and qualified operators ■ Laser cladding requires safety environment of Laser Safety Class 4 ■ Laser is an energy source and any reputable supplier of laser cladding systems can be selected for the laser cladding process ■ In laser cladding, powders and wires can be used as a feedstock material. ■ In laser cladding the control of process and parameters plays a significant role

[a] HAZ is the resulting changes in the properties of the base material (microstructure, hardness, etc.), due to heat introduced during cladding process.
[b] Dilution describes how much of base material is mixed with deposited overlay, causing changes in the composition of the overlay. Higher dilution leads to decreased properties of the overlay. For example, a classical welding overlay can have up to 50% dilution in the first layer, which requires multilayer deposition to achieve better properties of coating and compensate for dilution.
[c] Deposition efficiency (DE) indicates how much percentage of used powder will land in the melting pool, by building a coating. Lower DE means less efficient material consumption. For example, thy typical DE for processes like thermal spray is below 60%.





The basics of laser cladding.

powder or wire is transferred into the melt pool area where it melts, and builds a deposit on the surface of the base material. As the process happens during the motion of a part or working head, we build so-called welding seams of defined size on the surface (the width is typically equal to the spot size of the laser beam). For applications that require coverage of a larger surface, those seams have to be overlapped with the next passes, building multiple beads.

Another driving factor for the technological success is related to the multi-functionality of laser cladding. Below are some of examples of the various deposition options as to how you may apply laser cladding.

- **Wire cladding**. The main benefit here is 100% deposit efficiency, resulting in full consumption of the material. In some industries with restrictions on operating with toxic powders, wire cladding can be a promising alternative. The latest developments in wire cladding have also opened new horizons for additive applications. With the help of the coaxial wire-feeding principle, 3D geometries with high precision and excellent process control can be achieved.
- **Additive Manufacturing (AM).** AM of metals has become very popular in recent years. However, not everyone knows that laser cladding can also produce 3D structures via a process called LMD (laser metal deposition) or DMD (directed metal deposition). In these processes, it is possible to build structures layer by layer directly on the surface of components, changing their design. Wire and powder feedstocks can be used.
- **High-speed Laser Cladding.** This is a newly developed method also known as EHLA (Extreme High-speed Laser Application). The unique concept of the process lies in its ability to melt the powder before it interacts with the surface, where over 80% of laser energy goes into melting the powder. This allows for the production of thin coatings with low surface roughness and excellent properties. Due to high deposition velocities for rotation of symmetrical bodies and deposition rates already going over 2 m^2/h [21.5 ft2/h], EHLA competes with processes like thermal spraying and hard chromium plating. Another advantage of high-speed cladding is its deposition efficiency of approximately 90%.

The installation of a new gantry system with multi-functional process options enables Oerlikon to strengthen its coating shop and R&D activities in the field of laser cladding. The high precision of its 7-axis capability, combined with its multi-functional selection of laser processes — including, wire cladding, EHLA and additive manufacturing. Oerlikon commenced operating this system at our facility in Switzerland in March 2021 to enable testing of new generation materials, new applications and provide surface solutions for customers. ■■■

Oerlikon Metco EHLA gantry system in Wohlen, Switzerland

About Oerlikon Metco

Oerlikon Metco enhances surfaces that bring benefits to customers through a uniquely broad range of surface technologies, equipment, materials, services, specialized machining services and components. The surface technologies such as Thermal Spray and Laser Cladding improve the performance and increase efficiency and reliability. Oerlikon Metco serves industries such as aviation, power generation, automotive, oil & gas, industrial and other specialized markets and operates a dynamically growing network of more than 50 sites in EMEA, Americas and Asia Pacific. Oerlikon Metco, together with Oerlikon Balzers and Oerlikon AM, belongs to the Surface Solutions Segment of the Switzerland-based Oerlikon Group.

Information is subject to change without prior notice.

TP-0016.0– Laser Cladding Gantry System

www.oerlikon.com/metco
info.metco@oerlikon.com