

Metallisation

Thermal spray equipment and consumables



Equipment Specification

MET-CLAD Laser Cladding System

INTRODUCTION

The following specification introduces the process of laser cladding and details the scope and function of the Metallisation MET-CLAD, laser cladding system.

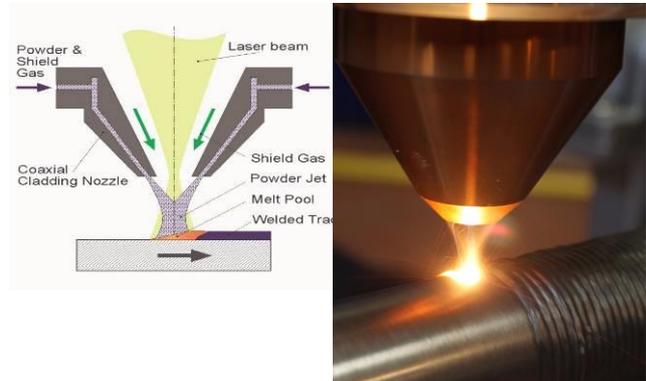
WHAT IS LASER CLADDING?

Laser cladding falls into the group of processes commonly known as hard-facing.

The laser cladding process is a method of applying a fully dense, metallurgically bonded and virtually pure coating which can be used to increase the wear resistance, corrosion resistance or impact performance of metallic components. In some cases, all three of the properties can be improved.

The process utilises a precisely focussed high power laser beam to create a weld pool into which a metallic powder is applied. The powder, which is carried by a stream of inert shielding gas, is blown coaxially through the laser beam.

The highly accurate nature of the laser beam allows fully dense cladding with minimal dilution (<5%), yet with a perfect metallurgical bond. Numerous coatings can be applied, the composition of which can be designed to combat the failure mechanisms associated with each component.



FUNDAMENTALS OF LASER CLADDING

- ✦ Typical single layer thickness: 0.2 - 2.0mm (multiple layers possible)
- ✦ Heat input to part: low to moderate
- ✦ Dilution with substrate material: variable with parameters but can be <5% gives a very pure coating with the desired coating properties.
- ✦ Adhesion: full metallurgical bond
- ✦ Density: fully dense (<0.1% porosity)
- ✦ Coating materials: WC/Ni alloys, Ni alloys, WC/Co alloys, Stellite 6, Inconel625, FeCrB,

BENEFITS OF LASER CLAD COATINGS

One of the major benefits associated with laser cladding is the ability to finely control the heat input to the substrate and the coating material. This allows the ability to deposit a two phase Metal Matrix Composite structure. In simple terms, the coating can have a softer, lower melting point material (the matrix) in which a harder wearing, higher melting point material (the hard phase) is suspended.

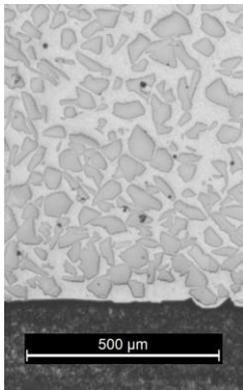
The matrix material is typically a nickel based alloy. This matrix provides toughness, ductility, and impact resistance whilst being wear resistant at elevated temperatures.

A reinforcing hard phase is typically a tungsten carbide but can also be titanium nitride / carbide, chromium carbide etc.

The fine control of the heat input allows the matrix to be completely melted, alloyed and bonded to the substrate surface, whilst at the same time, the carbide particles remain un-melted and are distributed evenly throughout the matrix. This is demonstrated in the adjacent coating section. This results in an extremely wear and impact resistant coating.

TYPICAL EXAMPLES OF VERY DENSE, FULLY BONDED LASER CLAD COATINGS

Coarse WC in a Ni Matrix



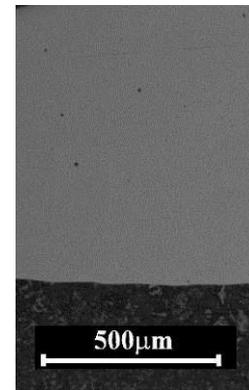
Hardness:
Matrix: 500–600 Hv
Carbide 2000–2500 Hv

FeCrB



Hardness:
900 - 1100 Hv

NiCrMo (similar to Inconel625)



Hardness:
300 Hv

COMPARISON OF COATING PROCESSES

The following table gives a broad comparison of coating processes. The data shown is based on typical applications and parameters. There can be exceptions to the below data, based on specific applications and parameters.

	HVOF thermal spray	PTA	Laser Cladding
Heat source	Flame (liquid or gas)	Electric arc	Laser beam
Coating thickness (typical)	0.05 – 1mm	0.5 – 5mm	0.2 – 2mm
Typical Deposition rates	≤ 5 kg/hr	≤ 10 kg/hour	≤ 5kg/hr
Dilution	0	5-15%	≤ 5%
Type of bonding	Mechanical	Metallurgical	Metallurgical
Bond strength	≤ 80 MPa	≤ 800 MPa	≤ 800 MPa
Heat input	Low – medium	High	Low - medium
Porosity	≤ 1%	< 0.1%	< 0.1%
Comparative capital cost	Medium	Low	High
Comparative running cost	High	Medium - Low	Low

TYPICAL APPLICATIONS (COATING MATERIALS)

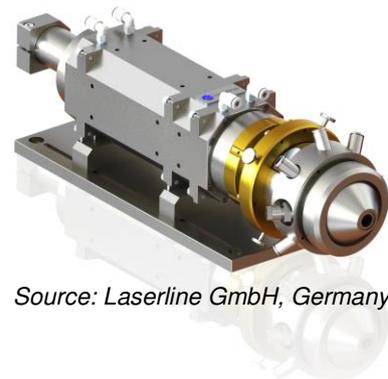
- ✦ Down hole stabilisers (WC/Ni)
- ✦ High temp process rolls, hardness & corrosion resistance, valve lips and seats (Cobalt 6)
- ✦ Valve balls/seats, process rolls, waste incineration boiler parts, oil refinery process plant (NiCrMo)
- ✦ Coal and ore crushing hammers / wear plates / sand valves (WC/Ni)
- ✦ Valve balls/seats, process rolls, boiler components, waste incineration boiler parts, hydraulic rods, down hole stabilisers (FeCrB)

LASER HEAD

Part No.	Description
MET-CLAD-HEAD-L8	MET-CLAD laser cladding head with ring slit powder feed.
MET-CLAD-HEAD-L11	MET-CLAD laser cladding head with 16mm wide cladding nozzle.
MET-CLAD-HEAD-L12	MET-CLAD laser cladding head with multi-stream nozzle for horizontal cladding.

TECHNICAL OVERVIEW

- ✦ Powder feed through conical co-axial ports to maximise precision, quality and efficiency of cladding.
- ✦ Laser focus point by simple adjustment in the head.
- ✦ Laser / powder feed head easily interchanged.
- ✦ Water cooled parts to ensure longevity.
- ✦ Optional internal camera to view the weld/clad region during processing.
- ✦ MET-CLAD-HEAD-L8 – Allowing a broad spectrum of applications in all power ranges.
- ✦ MET-CLAD-HEAD-L11 – Specially designed for use with rectangular scanned line laser spots. Ideal for high power, high deposition rate cladding processes.
- ✦ MET-CLAD-HEAD-L12 – Four separate powder streams are directed onto the working point so nearly any desired contour can be generated.



Source: Laserline GmbH, Germany

Technical data (based on MET-CLAD-HEAD-L8)

Description	Characteristics
Weight	13kg
Width	203
Depth	139
Height	499

Typical performance figures for various materials

Material	Typical hardness (Hv)	Typical throughput (g/min)	Coverage (kg/m ² /mm)
WCNiCrB	Matrix = 500-600 Carbide 200-2500	70	13
Cobalt6 (similar to Stellite6)	550	35	9
NiCrMo (similar to Inconel625)	300	40	9
FeCrB	900-1100	50	9

All data provided is an approximation and is offered as guidance only as performance can vary depending on application and parameters.

Typical throughput rates are based on using a 3kW laser and would increase with a larger laser. Other materials can be used – please contact Metallisation to discuss your specific application.

SUPPLIES PACKAGE AND REGULATOR

Part No.	Description
MET-CLAD-SUP	MET-CLAD 10m supplies package
21239	Argon regulator

STANDARD SUPPLIES PACKAGE INCLUDES

- 1 x 10m Argon input hose from supply regulator to console
- 1 x 10m Argon output hose from console to laser head (coaxial feed)
- 1 x 10m Argon output hose from console to laser head (auxiliary feed)
- 1 x 10m water hose – console to laser head feed
- 1 x 10m water hose – laser head to console return
- 1 x 10m Argon output hose to powder feeder
- 1 x 10m powder feeder data communication cable
- 1 x 10m powder feed hose from powder feeder to laser head

Note: input supplies from the chilled water supply are not included but can be quoted when the distance from the supply is known.

Argon regulator is suited for UK style bottle fittings. Others can be provided – please specify.

CONTROL SYSTEM

Part No.	Description
MET-CLAD-CTRL(2kW)	MET-CLAD Laser Cladding control console with 2kW laser
MET-CLAD-CTRL(3kW)	MET-CLAD Laser Cladding control console with 3kW laser
MET-CLAD-CTRL(4kW)	MET-CLAD Laser Cladding control console with 4kW laser
MET-CLAD-CTRL-RLP	MET-CLAD Laser Cladding Control Console to control a Remote laser unit via Profinet.



The MET-CLAD Laser Cladding control console is the heart of the system. It provides integration and control of the complex component parts of the laser cladding system.

The operator interface is via a 17" touch-screen panel. The operator experience runs on the familiar Windows platform and is designed to be intuitive and simple to use.

Repeatable operations are easily programmed and actioned for day to day operation or can be linked to barcode systems for even simpler programming.

The system can also be used for more in-depth coating and parameter development, still with simple and intuitive interface.

The control console can be provided with a 19" rack mounted 2kW, 3kW or 4kW laser or as a control console capable to interface with other larger capacity lasers via Profibus (usually not 19" rack size but in a separate enclosure).

TECHNICAL OVERVIEW

The control console includes:

19" rack mounted diode laser system consisting of the following (MET-CLAD-CTRL- 2kW, 3kW or 4kW only):

- ✦ Supply unit - diode laser head, control unit, power supply for laser head, cooling unit and U/I.
- ✦ Diode laser head – water cooled diode stacks (3kW or 4kW), beam shaping and enclosure. Horizontal fiber-coupling unit and 10m fiber-optic cable (other lengths possible).
- ✦ Control unit – monitors the system and operational parameters, with 2 level warning / shutdown system.
- ✦ Cooling unit – integrated water/water heat exchanger.

19" rack mounted control module consisting of the following:

- ✦ Mass flow controllers for the control of the coaxial and auxiliary gases.
- ✦ Control PLC with i/o as required (control is by PLC but interface by PC).
- ✦ Control valves and switching for the safe operation of the system including operation and monitoring of the cooling water flow and temperature.
- ✦ Interlocks to inhibit and halt unsafe system operation.

- ✦ E-stop circuit with external interface to integrate into process equipment safety circuits.
- ✦ Robot interface via Ethernet or Profibus.

PC control unit consisting of:

- ✦ Industrial PC running MS Windows O/S in wall mountable, variable position enclosure.
- ✦ 17" touch screen operator interface with integrate E-stop button
- ✦ Ethernet connectivity to control PLC's and also for external interface for remote operation or integration into company network.

OPERATION

The following section highlights the mode of operation of the system. The general principle is to make the complex integration and operation of the system as simple as possible for the user. Repeatable coatings are ensured by the use of mass flow controllers for all gas flows.

The system is operation in 3 basic modes: Manual; Recipe or Barcode.

Manual mode

In manual mode, the laser cladding parameters (co-axial gas, shielding gas, laser power, powder feed rate and carrier gas) are all selected manually from a touchscreen HMI.

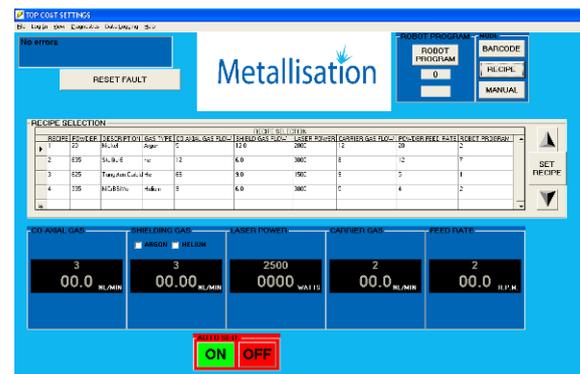
The robot program can also be programmed manually and if there are a number of cycles of the program to be specified, then these can also be programmed.



Recipe mode

In recipe mode, the system can be programmed with an unlimited number of definable recipes. By selecting a recipe, all of the parameters will automatically program the system. This will include all parameters as mentioned in the manual programming.

If programmed in such a way, the recipe system can prompt the operator to confirm that they have the correct type and quantity of powder for the required job. It will also interrogate the weigh scales on the powder feeder and ask for an override before allowing to start if there is insufficient powder to complete the job.



The formatting of the recipes is easily programmed, so you can title each recipe based on a job number, title of component, type of coating or anything as you wish.

Barcode mode

The barcode mode works similarly to the recipe mode but selection of the recipe is linked to a barcode. The system can be programmed with a lookup table to link barcodes and recipes. This functionality is possible but will require additional hardware and programming.

Integration

Once the manipulation is programmed and the laser parameters are set, the system can be operated in two modes – manual sequence or auto sequence.

In manual sequence, the operator can step through each of the processes by pushing buttons on the touch screen. The system has interlocks for critical items to ensure that you cannot start a process out of sequence, e.g. you cannot start the laser without the coolant flow and temperature running. But non-critical items can be selected as you wish, e.g. you can start powder feed before or after the laser is running.

In automatic sequence, once the parameters are set, the operator presses one Auto Sequence button and the following sequence will start.

- a) Operator confirms correct powder in feeder and interlock of suitable available powder quantity.
- b) Coolant on and confirmed within parameters.
- c) Move robot to pre-start position.
- d) Start shielding gas and powder feed.
- e) Move robot to start position.
- f) Start laser.
- g) Start robot sequence.
- h) When complete, robot sequence confirms finish
- i) Laser, powder feed and shield gas off.
- j) Return robot to home position.

Cladding interruption

Dependent on the type of robot used, it is possible to interrupt and restart the cladding process with the minimum detriment to the coating. When cladding, it may be required to interrupt the process to change powder for example. When the interrupt button is pressed, or if the system detects an issue that would stop the cladding process, the precise location of the robot is noted by the system. Once the issue is resolved, it is possible to resume cladding. If the robot were to return to the exact position, a dip would be formed in the cladding that would require manual touch-up after. With our system and certain brands of robot, the robot will return to a position just before the interrupt, ensuring that the clad coating is complete.

Monitoring

During the cladding process, all parameters are monitored. The system is programmed with preset warnings if parameters stray outside of acceptable ranges. These ranges can be varied and the actions selected appropriately, for example if the coaxial gas flow strays by 2%, an amber warning will be given advising the operator of a possible issue but at 2%, it is not likely to affect the coating. If the flow strays by 5%, the system will shut down. Restarting will follow the same process as with cladding interruption.

Diagnostics

Full on-screen diagnostics is included. Checking and adjustment of gas-flows for calibration and setup of the system.

Data logging

All parameters during operation can be data-logged at specified intervals and output as a .csv file via USB or Ethernet for storage and SPC purposes.

Powder trending

The powder feeder can have integrated weigh scales (2007MF-PF-HC). They will weigh the contents of the hopper before and during cladding. The system can be programmed to inhibit operation of the system for known job sizes if there is not enough powder. For particularly large jobs, the system will predict and approximate time of when the powder will run out.

MET-CLAD System requirements

Description	Characteristics
Input Power Requirements	380/440V 50-60Hz 3 Phase
Control Input Power Requirements	220/240V 50-60Hz 1 Phase / 13A fused
Fusing Required	16A/Phase (440V input)
Max Power Consumption	12 kW
Argon gas	20-90 l/min
Chilled water supply	12°C supply/19°C return, 1,200 l/hr @ 3 bar (de-min. water)

POWDER FEEDER

Part No.	Description
2007MF-PF-HC	Mass flow powder feeder with scales - 4.7L hopper
2007-MF-PF(3.35)-QR	Mass Flow Powder Feeder, 3.35L quick release hopper.
QRPFH-3.35	3.35L Quick release powder feed hopper.
QRPF-BRKT	Quick Release Powder Feeder Hopper Support Bracket for 2 Hoppers
MET-TROL	Metallisation Ancillary Trolley



The 2007MF-PF-HC powder feeder is a positive displacement feeder which uses an offset disc that rotates and collects powder in small holes. At a certain point powder is blown from the holes into the powder feed line where the Argon gas carries the powder through the powder feed hose to the required point of exit.

The Powder feed rate depends upon the size of holes and number of holes per minute i.e. RPM. This system cannot pack powder if blocked unlike screw type powder feeders.

A weigh scale is used, under the canister frame work to enable logging of the rate of powder used and the amount of powder remaining in the canister. This data can then assist in determining the running time before the powder requires refill, thereby preventing any unexpected powder filling stoppages during the process operation.

Powder feeder is shown on optional trolley.

Other powder feeder options are available such as a smaller capacity, interchangeable hopper powder feeder without the weigh-scales.

TECHNICAL OVERVIEW

- ✦ Mass flow control of the carrier gases = repeatability.
- ✦ Volumetric feed via hopper and rotating disc design, Positive displacement.
- ✦ Feed disc rotational speed is controlled via a closed loop AC inverter for improved feeding accuracy.
- ✦ Powder weight feedback through serial or Ethernet interface, identifying rate of use and remaining powder in canister. (2007MF-PF-HC only).
- ✦ Two disc variants to allow optimum feeding of a wide range of powders.
- ✦ Easy to fill, empty and clean – tilting hopper.
- ✦ Argon carrier gas (Others on request).
- ✦ Contains PLC for control and integration to the main PC control system.
- ✦ Multiple power feeders can be integrated into the system.
- ✦ Parameters displayed on the powder feeder and outputted via the interface.
- ✦ Safety interlocks to prevent running without carrier gas.
- ✦ Out of range feedback on gas flow- detects blockage or gas shortage.
- ✦ Out of range feedback on powder feed disc rpm.
- ✦ Mechanical tamper to ensure consistent filling.
- ✦ Pressure gauge and relief valve.

Specification and supply requirements

Description	Characteristics
Canister capacity	4,700cc as std (2,750cc, 3,350cc on request)
Electrical supply	240/110V 1ph, 5A*
Weight	45kg approx
Dimensions (mm)	W-500 x D-400 x H-860
Carrier Gases	Argon
Carrier Gas Pressure	4 bar (60 psi) Maximum
Carrier Gas Flow	2 – 10 l/min
Typical Maximum Feed Rate	250 g/min WC powder or 150 g/min Ni based powder~

* Specify at the time of Order.

COMMISSIONING / TRAINING / CONSULTANCY

COMMISSIONING & TRAINING

Typical installation and commissioning period for just the cladding system would be around one week, assuming an un-interrupted access to site, availability of site services and local trades as required. Pricing can be given based on the site location.

Training on the safe operation and programming of the parameters would be included in the one week period.

Integration with process automation (robot, manipulator etc.) is not included in this scope and would be assessed and quoted separately.

BASIC CLADDING TRAINING

A week long introductory training in laser cladding can be offered. The cladding training is given by a tutor with 4 years practical experience in setting up and producing practical coatings for various industries. During this cladding training, the user will be guided on the extended use of the equipment and on the basics of parameter and coating development.

CONSULTANCY

Further to cladding training, coating development will be required for new coatings. Consultancy packages can be offered to meet your specific requirements.

TURNKEY SOLUTIONS

Metallisation can offer tailored, turnkey solutions for your laser cladding installation. This would typically include any or all of the following: a process room; chilled water supply system; extraction; part manipulation and robot. Each projects specific requirements will differ depending on the specific parts to be coated. Metallisation will be pleased to discuss and prepare an offer to meet your individual requirements.



Safety: The equipment quoted will produce levels of high intensity light and dust that will require safety measures to be taken by those using the equipment. It uses pressurised gases. Careful consideration should also be given to the positioning of this equipment. It is the responsibility of the user to ensure that all appropriate measures are taken to ensure safe operation in accordance with local requirements. Metallisation will be pleased to advise as appropriate.

Metallisation

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