Closed-loop laser power control system for Cladding and Laser Metal Deposition processes

Continuous monitoring and measurement of the melt pool geometry

- Ensures quality and repeatability
- Compatible with most of laser heads and powders
- Easy mechanical integration
- Quick configuration

Winner of the Innovation Radar Prize 2018, category 'Industrial & Enabling Tech', awarded by the European Commission
System components and dimensions

- Water block with inlet/outlet connectors
- Multi I/O connector
- Lens with locking counterthread
- GigE connector
- C-mount thread
- All dimensions in mm

Mechanical integration

- On-axis optical system monitoring melt pool geometry
- Laser head optical path needs IR transmission (>1.1 um)
- Compact system – Embedded IR camera, processor and control
- Integration in the laser head using an existing optical port

System operation

- Continuous melt pool measurement
  - Accurate closed-loop control of the laser power
  - Alarm indicator
- Configuration S/W friendly user interface
  - Easy process setup
  - Advanced configuration
- Process compatibility
  - LMD, cladding
  - Continuous, single tracks
  - Manual (constant power), automatic control & melt pool size monitoring
- S/W Indicators
  - Melt pool width
  - Laser power
  - Infrared image
  - Laser status
Operation of CLAMIR with LMD processes

**Continuous control of the laser**

avoids overheating of the part under process and allows a continuous and high quality manufacturing process

**Use of CLAMIR**

reduces rates of defective parts, material reduction cost up to 60% and saves 50% more energy than uncontrolled processes

Laser power is closed-loop controlled in REAL-TIME using the infrared image of the melt pool

Constant laser power causes overheating and lack of adherence to the base material

Operation of CLAMIR with Cladding processes

Reduces damage to the base material due to excess of laser power application (average reduction of dilution: >40%)

Allows continuous processing of large cladding lengths
### Specifications

| Components | Sensor head with real-time processing electronics and connectors  
|           | Imaging lens, multi I/O cable (3 m)  
|           | Software for system configuration  
|           | Infrared emitter for optical calibration |
| Process compatibility | LMD process (Laser Metal Deposition)  
|                   | Cladding |
| Optical compatibility | Transmission of infrared signal (above 1.1 um) from the process area to the optical port is required* |
| Material compatibility | Steel powder, Stainless steel powder, Stellite powder, Inconel, others |
| Laser power control | Analog signal output for laser power control, 0 VDC - 10 VDC |
| Dimensions (mm) | 88 mm x 60 mm x 92 mm |
| Weight | 0.5 kg |
| Power supply | 5.9 VDC, 10W |
| Imaging lens | CaF2, f=50mm with manual focus mechanism (other focal lengths available) |
| Mechanical enclosure | IP67 rated mechanical enclosure with embedded heatsink  
|                   | Embedded waterblock for air / water cooling |
| Mechanical interface | C-mount thread with counterthread for tight adjustment |
| Field of view | Dependent on the optical system installed in the laser head and diameter of the nozzle |
| Resolution per pixel |  |
| Infrared camera | VPD PbSe camera, 64x64 pixels (pixel size: 50 microns)  
|                   | MWIR response (1 -5 um), frame rate 1000 images per second |
| Communication interface | Gigabit Ethernet (RJ-45) |
| Software | CLAMIR Acquisition and Configuration SW v.1.1  
|           | NIT Visualization SW v.2.1 |
| Minimum requirements | PC with processor i5, RAM memory: 8 GB  
|                   | Hard disk available: 1 GB, O.S.: Windows 10 or later (32/64 bits) |
| Process configuration | Selectable process configuration: Tracks, Continuous  
|                   | Initial laser power, track length (Tracks mode)  
|                   | Laser ON delay & autodetection  
|                   | Feedback control parameters |
| Indicators | Melt pool width, Laser power, Infrared image, Laser status |
| Other features | Laser ON/OFF digital input  
|               | Monitoring alarm digital output  
|               | Process data logging, Region-Of-Interest (ROI) |

*The performance of the system may be limited if additional optical components are installed in the optical path.*