



# Reliable and Flexible Laser Processes

## Measuring and Control Systems for Laser Hardening and Laser Cladding

Laser hardening and laser cladding are technologies that are well established in industrial practice for the surface refinement or repair of components. The system technology developed at Fraunhofer IWS allows to easily monitor, control or regulate sophisticated laser processes as well as to adapt them to the requirements of the respective application. A main focus is the realization of precise temperature control as a basis for reproducible industrial processes. For process and quality control, a range of systems is available.

### LOMPOCpro: Operator Software for Temperature Control

The software controller LOMPOCpro is the basis of the Fraunhofer IWS measurement and control systems. Depending on the application, different temperature acquisition systems can be connected to control the laser power in processes such as hardening, brazing, tempering and DED-processes (Direct Energy Deposition) for cladding and additive manufacturing. LOMPOCpro is particularly suitable for fast laser processes. The software provides both a manual operating mode and a fully automatic self-regulating mode. During the process, all data is displayed graphically and stored in a customer-specific data repository.

Communication with machine controllers occurs through standard industrial interfaces (e. g. Profinet or direct I/O). A wide variety of temperature recording systems such as thermal imaging cameras and pyrometers can be connected. The individual setting of the control behavior and the special consideration of the conditions at the process start grant the user a high flexibility.

### Emaqs: Camera for Temperature Detection

Emaqs is a camera-based temperature detection system for demanding measurement tasks, developed as a low-cost alternative to conventional thermography systems. The Emaqs

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camera enables the monitoring of temperature-sensitive processes and is used in particular for laser beam hardening and laser cladding. The camera is capable of determining various characteristic data from the thermal image in real time, which is suitable for quality monitoring or process control. Using modern evaluation algorithms and freely adjustable Areas of Interests (AOI) – such as circle, rectangle, ellipse, donut or box matrix – the system generates information on peak temperature, temperature distribution, key-hole geometry and position as well as spatter frequency and distribution.

### Efaqs: Pyrometer for High Speed Processes

With the fast pyrometer Efaqs, Fraunhofer IWS has developed a measuring device for high-speed thermal processes that detects temperatures from about 160°C with sampling times of up to 50 microseconds. Therefore, Efaqs suits various high-speed processes such as laser soldering, welding, and hardening. Various adjustable imaging optics allow the measurement spot to be adapted to the size of the processing zone. The device is usually used with the LOMPOCpro control system.

### LASSY: Dynamic Beam Shaping System

The dynamic beam shaping system LASSY enables flexible reaction to a wide variety of component geometries during laser material processing. A 1D scanner optics shapes the laser beam transverse to the treatment direction. The energy distribution in the laser spot

can be adjusted by controlling the scanning speed either with or without tracking the laser power. This allows for homogenous hardness and penetration depth to be achieved despite locally varying heat dissipation conditions. Additional options allow rotation of the scanned lines as well as precise and highly dynamic control or regulation of the temperature fields. LASSY is suitable for various laser material processing methods such as hardening, remelting, cladding or alloying.

### LEDS: Calibration System for Temperature Measurement

For a precise surface temperature measurement with the Emaqs camera, the system needs to be accurately calibrated by a functionally adapted calibration source with simple and intuitive operation. The Fraunhofer IWS calibration system uses a high power LED array with a matched wavelength range. This creates precise reference temperatures between 750°C and 1500°C within seconds. A software tool fully automates the calibration process. Connected to a control panel, the LEDS system alternatively functions as a stand-alone system for checking existing calibrations.



Top  
COAX powder nozzle with Emaqs camera: Temperature field measurement in the melt pool for precise laser powder cladding.

Bottom  
LEDS head with operating unit: Calibration of Emaqs NIR cameras for high temperatures range up to 1500°C.

Characteristics	Emaqs	Efaqs
Measurable temperature	>750°C	>160°C
Measuring frequency	Up to >2 kHz	Up to 20 kHz
Measuring wavelength	NIR (typically 740 nm)	VIS to NIR (depending on application)
Measuring field	Approx. 1 x 1 mm <sup>2</sup> to 100 x 100 mm <sup>2</sup> , adaptable by interchangeable optics	Flexibly adaptable via imaging optics
Other features	Typical image resolution: 160 x 112 px to 728 x 544 px Visualization, graphical display and storage of temperature and process data when used with LOMPOCpro software	Pyrometer optics with optical fiber