BUSINESS UNIT
THERMAL SURFACE TECHNOLOGY

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AUTOMATED MEASURING SYSTEM FOR POWDER FLOW ANALYSIS

THE TASK

Metrological standardization and qualification of powder gas flows in different cladding nozzles is for the laser powder cladding technology (LPC) a long-term R&D focus at the Fraunhofer IWS. Since the requirements of the users from industry and projects with public funding are ever growing, it is necessary to develop automated and, for specific functions, also standardized measuring equipment able to replace previously typical analog photographic documentation (Fig. 1). The goal of the metrological qualification of a cladding nozzle is to derive quantitative information about the powder beam including the real position and dimension of the powder focus.

OUR SOLUTION

The groups of Additive Manufacturing (Sensors & Software Implementation), Buildup Welding (Design & Development), in collaboration with other departments, such as PLC and Electronics, engineered an automated, completely autonomous powder nozzle measuring device to obtain quantitative data for the valuation of powder flows in powder processing heads.

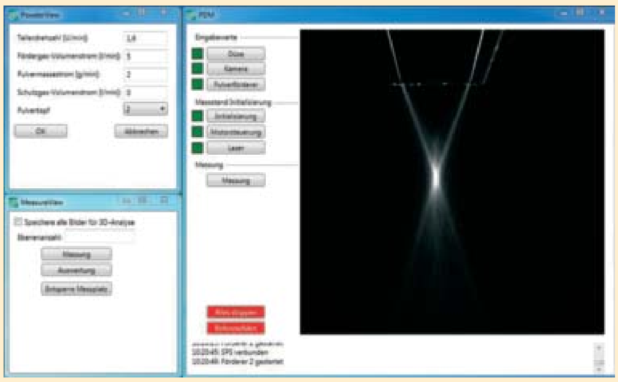
This powder nozzle measuring device (Fig. 3) consists of three main assemblies:

- a powder gas flow measuring device, in robust, lockable housing, with exhaust and collection bucket,
- a standardized powder feeder and
- a PC workplace with the newly developed "PDM" software to analyze the powder-gas flow.

The central "measuring device" component consists of high-precision linear units, which are moving through the powder cladding nozzle in XYZ direction with a vertically aligned line laser in automated mode. Figure 4 explains the internal measuring setup with the carrier rotating unit, on which the line laser and the camera – offset by 90 ° in cladding nozzle direction – are positioned. This rotating unit makes it possible to measure the powder beam path of nozzles with annular gap, multi beam and, in the future, also nozzles for wide beams in various throw-on positions.

During the laser light section measurement the powder is collected in a bucket fixed approximately 900 mm below the nozzle and can be recycled; it can be randomly exchanged depending on the grain fraction. An exhaust for the finest powder particles in the room is run constantly. An automatic door lock, inserted laser protection windows and a machine traffic light indicating the equipment status, as well as a complex switch cabinet with emergency-stop function are fully integrated.

PC-based analysis software "PDM" to measure powder flow in powder nozzles for laser powder cladding



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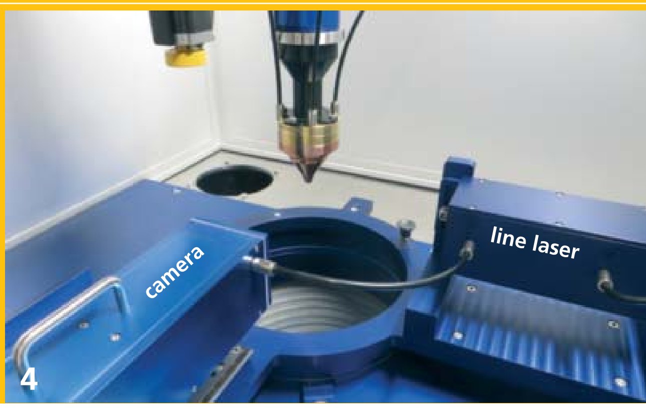

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RESULTS

Intelligent image processing algorithms are used to analyze the specific working distance of the nozzle and the extension of the powder focus. The distribution of the particles in the powder focus can provide conclusions regarding the powder beam's homogeneity and symmetry. During measurement, the PC-based analysis software "PDM" (Fig. 2) communicates with the test stand control via powerful Ethernet-based field bus technologies. In this communication, in addition to the data exchange itself and transfer of control commands, diagnostic functions are also made available. The measurement consists of several steps, including

- input of nozzle parameters,
- transfer to the test stand and its periphery,
- fully automated adjustment of system components,
- calibration of brightness,
- measuring in a parametrizable resolution and
- documentation of measured values in a standardized data format.

The "PDM" software can be used to input and test several variants of cladding nozzles, camera objectives and the associated powder feeder parameters, such as powder mass flow, carrier gas flow and shielding gas flow (Fig. 2). With the automated initialization of the system, the corresponding cladding nozzle is positioned by the linear axes in XYZ so that the powder density distributions are measured by means of brightness intensities.

The measured results of the powder feeder parameters are stored in standardized image and table formats and can be represented and optimized in the form of a histogram (2D curve diagram) and 3D powder intensity distributions for detailed analysis and diagnostics. The recorded diagrams consider the powder intensity distributions with the working distances from nozzle tip- bottom edge to the powder focus diameter.

1 Powder flow of a COAX14-V5 powder nozzle - closeup

3 Powder nozzle measuring device QM-COAXn developed by the IWS Dresden to characterize powder nozzles for laser powder cladding

4 Rotating table unit with line laser, as well as camera and linear unit with COAX14-V5 powder nozzle

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