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CAMERA BASED PROCESS CONTROL SYSTEM "E-MAQS" – NOW ALSO AVAILABLE FOR LASER BUILDUP WELDING

THE TASK

Laser buildup welding processes are widely used to repair, for example, large tools and to protect expensive wear parts. Compared to other processes laser buildup welding achieves better properties. A key reason for this performance is the minimal but very constant melting of the substrate material. To maintain this melting zone proves difficult since the local heat sinking conditions at the substrate surface may frequently change. For example, small workpiece generally heat up during the process. To maintain optimal deposition conditions it is therefore necessary to constantly adjust the process parameters. The goal was to develop a suitable process control system.

OUR SOLUTION

The solution was to use a camera based temperature control system, which was originally developed for controlled laser hardening applications. The system consists of a CCD camera, which is sufficiently sensitive in the near infrared spectrum. Narrow bandpass filters are applied to correlate temperatures with the gray scale values in the image of the surface. The system achieves a lower temperature threshold of 600 °C.

The system is installed in a dustproof and robust case to deploy it in the industrial environment (Fig. 1). The casing houses a pneumatic linear motion unit, which places the filters in front of the optics, when it receives commands via CNC or control software user interface actions. Without filters the camera can be used in the visible spectrum, which is used for adjustments of processes. The system can be attached to the laser optics via a coupling cube for coaxial process observation. To capture the heat radiation from the process it is separately mounted to observe the process from the side.

The calibration of the system is performed using a blackbody radiator. The software stores nonlinear characteristic curves, which help to achieve a very wide detection range from 600 °C to the melting temperatures of metals. Experiments showed that it is not necessary to keep the temperature of the melt constant during laser buildup welding. A constant size of the melt pool proves more important for achieving reproducible process result. This control variable depends on a number of process parameters such as the powder mass stream, the laser spot dimension, the powder material etc. It has to be determined for each specific application. During operation the laser power is regulated to accommodate for the locally differing thermal conditions and to maintain the melt pool size at all locations.

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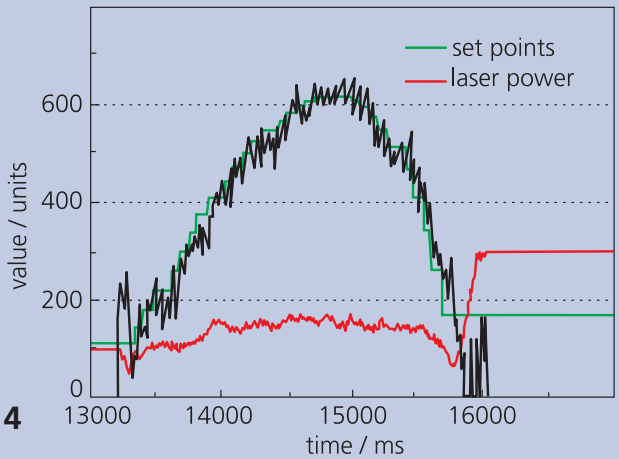
APPLICATIONS

Among the several existing applications for laser buildup welding is the repair of jet engine components. The particular difficulties of this application are the need for very fine buildup welds and the dynamic requirement for the control variable due to the shape of the component (Fig. 3). First, the camera optic is adapted so that it captures a smaller sized area to make finer welds clearly visible. Secondly, the NC based change of the size related control variable is integrated into the control software. The data are transmitted via Profibus from the machine controller. The control variable itself is calculated by an offline programming system, which determines the values based on the measure workpiece contour dimensions and integrates it into the NC code.

Another application lies in the area of large tools for car body making. Since mid 2010 Audi AG in Ingolstadt has been using such a system to process forming tools (Fig. 2, 3).

Process behavior of "LompocPro" controlled cyclical laser buildup welding with variable set points, green: set points, black: actual value, red: control variable laser power



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1 System "E-MAqS" with robust aluminum case

2 Operator panel of a laser buildup welding system with integrated process controller "LompocPro"

3 "E-MAqS" integrated in a laser buildup welding module in the tool making section at Audi AG Ingolstadt during startup

CONTACT

Dr. Steffen Bonß
phone +49 351 83391-3201
steffen.bonss@iws.fraunhofer.de