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PROCESS MONITORING DURING LASER BEAM WELDING OF NONFERROUS MATERIALS

THE TASK

Laser processing of nonferrous metals requires a high level of process control. Especially for the medical device industry, the welding of titanium components requires high precision and high strength joints. Joining processes for materials with medium or low melting points are well established including process analytics. However, currently it is challenging to monitor the welding processes for nonferrous materials with high melting points.

It is important to exactly determine the parameters which lead to process deviations. Measuring the thermal radiation emitted from the joining zone is difficult as it strongly depends on the emission coefficient of the material. The emission coefficient in turn is a function of material surface conditions, the uniformity of the material structure and the wavelength. Processing of titanium materials may also form oxides on the surface (tempering colors), which create optical and structural disadvantages.

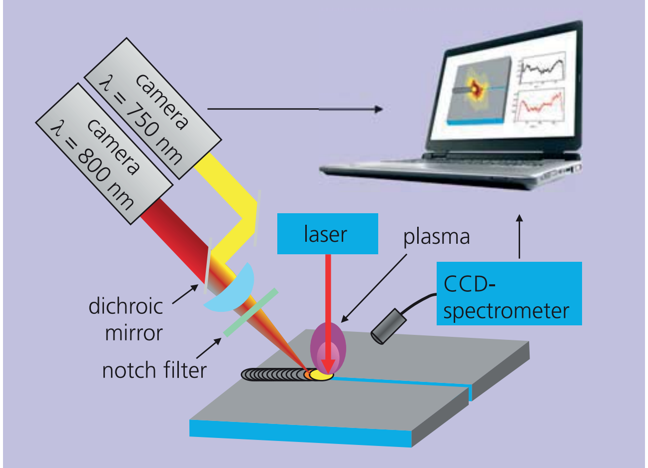
The aim of the project was the development of a camera online process control system that is based on spatially resolved pyrometer measurements of the material's surface temperature. Inhomogeneous temperature profiles were expected to correlate with defects in the joining process.

OUR SOLUTION

The spatially resolved measurement of temperatures up to 2500 °C is implemented with special CMOS camera sensors. It is important to capture very high as well as very low intensities. Two independent camera systems were used so that very high intensity temperature information could be captured from the processing zone.

The pyrometer aligned two cameras of type UI-512SE to detect radiation over well defined wavelength ranges. One camera filters the thermal radiation at 800 nm, the other at 750 nm. The ranges were selected so that the cameras are very sensitive and capture a large number of photons coming from the processing zone over a wide temperature range.

Camera based online process control system to join titanium alloys



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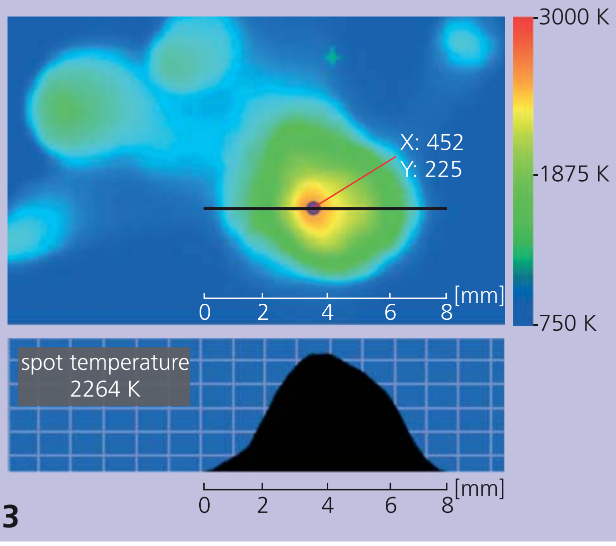
RESULTS

The radiation emitted from the sample is focused through imaging elements and then split to reach both cameras. This pyrometer setup measures the thermal radiation independent from influencing factors of the studied object. Prior to each measurement a calibration is performed. An initial sample weld is performed to adjust the system to the anticipated intensities. The software has a location correction algorithm for the captured intensity information and overlays the images of both cameras.

Figure 3 shows the user interface at the analysis computer. The picture presents a welding process which developed weld beads on the surface of the seam due to an error with the delivery of the shielding gas. The live image of the pyrometer system shows ejections from the welding process.

Principle of spatially resolved temperature profil to detect anomalies during spot welding of titanium



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By capturing these events it is possible to not only control the process but to also perform quality monitoring. The central temperature of the processing zone is measured via spot detection. The measured temperature profile shows a homogeneous heat affected zone. The system can be integrated with machine control systems to perform real-time testing and controlling of the welding process of nonferrous materials.

The camera pyrometer has the following parameters:

- control of pyrometer adjustments,
- real-time measurements,
- semiautomatic calibration,
- imaging scaling with up to 3:1 magnification,
- 50 images per second to record at corresponding welding speeds,
- online analysis of the welding region with spot and line measurements.

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