



AI-BASED PROCESS ANALYSIS IN ABSORBER-FREE LASER TRANSMISSION WELDING

Task

In absorber-free laser transmission welding of plastics, pyrometry is used to measure the temperature to monitor the process. However, the measurement signal is merely an indicator of the temperature, so while thermal damage is recorded as signal peaks, conclusions cannot be drawn about the type of damage, such as bubble formation or burning. Furthermore, since the emitted thermal radiation is spectrally attenuated by various optical components, detecting the radiation is more challenging as the weld becomes smaller.

Method

Imaging techniques are used to extend 1-dimensional pyrometry. Images or objects captured by cameras can be automatically identified and classified with multilayer convolutional neural networks. For this, a camera was first coaxially integrated into the beam path of the processing optics and used to take images of the welding process at different welding parameters to generate the data set. Semantic segmentation was used to analyze the images. Here, each image pixel is evaluated and assigned to a class defined at the beginning. In this way, both the weld seam and damage in the component can be identified and evaluated in the camera image. Subsequently, suitable network architectures were selected and trained with the data set.

Results

The work carried out illustrates the great potential of an AI-based process analysis. The trained convolutional neural network is able to reliably classify thermal damage such as burns or bubble formation. All examined models show an intersection-over-union (IoU) value > 0.9 . In addition to classifying the welds, the system can also be used to determine the seam width or the size of the thermal damage.

Applications

Absorber-free laser welding of plastics is particularly suitable for applications in which transparent plastics are to be joined in a selective, contact-free and reproducible manner. Typical applications are medical technology or biotechnology. However, AI-based process analysis can also be implemented in other applications, such as in the laser welding of metals.

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3 Weld seam with blistering.

4 Classification by neural network.