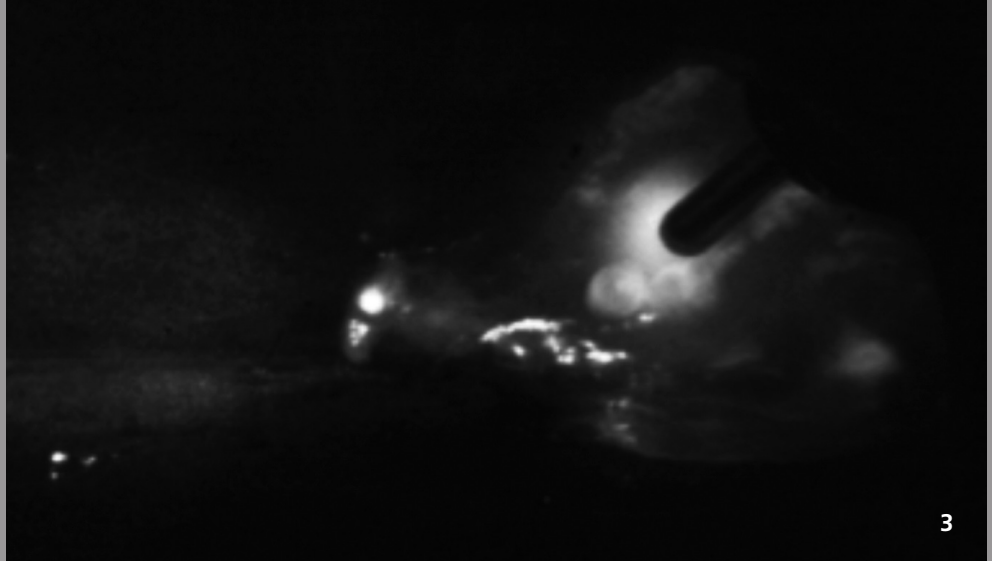

ONLINE-QUALITY DIAGNOSIS FOR LASER-ARC HYBRID WELDING IN SHIPBUILDING

Task

The shipbuilding industry increasingly requires thin three-dimensional structures. To join such structures cost efficiently, laser-assisted remote stitching and hybrid welding show great promise. Due to their low thermal distortion they are profitably employed for joining of thin 3D structures (t = 4 mm to 10 mm). But new methods are required to evaluate the process to meet quality demands regarding reliability and fatigue strength. The process monitoring task is solved with the help of the CPC system, developed at Fraunhofer ILT. The CPC system is integrated into a demonstrator plant for remote stitching and hybrid welding.

Method

During laser hybrid welding, intensive radiation is emitted from the process zone across the full optical spectrum (UV, VIS, NIR). For non-contact optical process monitoring, imaging sensors as well as spatial integrating photo detectors are employed. The CPC system consists of a coaxially mounted high speed CMOS camera which acquires images from the process zone through the laser beam focussing optic. A laterally mounted super pulse diode laser with a wavelength in the NIR spectrum provides the required flash light illumination. The image acquisition and the simultaneous flash light illumination is synchronized and delayed with respect to the current pulses of the arc welding current source to prevent images from over exposure by the radiation emitted from the electrical arc during its high current pulse phases. The intention is to monitor online the stability of the hybrid welding process.

Result

Due to their synchronous acquisition, the images show the melt pool and the joint groove very clearly. Figure 3 shows a single image from a sequence recorded with the CPC system. Since the camera is mounted coaxially, the laser-induced key hole is positioned exactly in the centre of the picture. The joint groove on the left is illuminated by the super pulse diode laser. On the right side there is the filler wire tip, the hot melt pool and the electrical arc generated by a base current of 80 A. The drop of filler material flying from filler wire tip towards the melt pool was molten with 500 A-current pulse 2 ms before the picture was taken. When the arc welding process runs stable, the molten drops are generated periodically. Due to the stroboscope effect the molten drop always occurs at the same position in the synchronously acquired pictures. This effect is used to evaluate the stability of the monitored laser-based joining processes for applications in shipbuilding industry, tank construction and tube manufacturing.

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3 CPC-image taken during laser-arc-hybrid-welding.