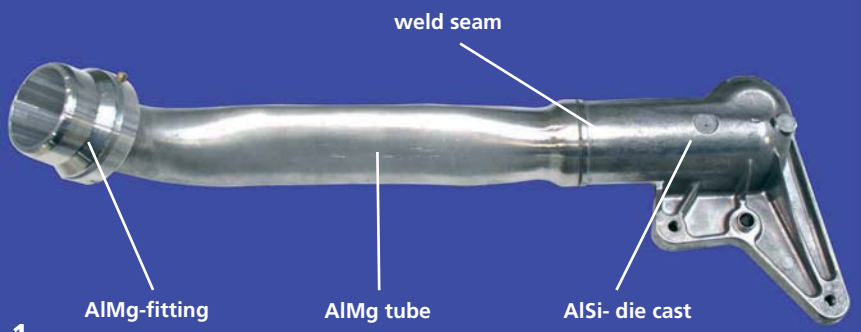


1

TIGHT-WELDING OF DIE CAST MATERIALS WITH FIBER LASER

THE TASK

Die cast aluminum is an exceptional material to cast and thus finds many applications in the automotive industry and in particular to make parts with thin-walled cross sections. Such cast components often need to be connected to profile or tube shaped parts. The weld seam quality needs to be highly reproducible and yield pressure-tight joints. High quality joints are an essential condition for industrial use. It is also necessary to use a welding process free of distortion to meet the tolerance requirements for assembly and fitting.

So far, melt based beam welding processes have not been suitable to produce such demanding joints for die cast components. Pressure casting naturally generates high pressure pores in the material, which cause unstable welding process conditions. Additional difficulties originate from the release agents that are used for die casting and lead to non-uniform weld seams. The weld material has more pores and the material stochastically ejects during the welding process. Conventionally produced die cast components are usually considered to be almost unweldable.

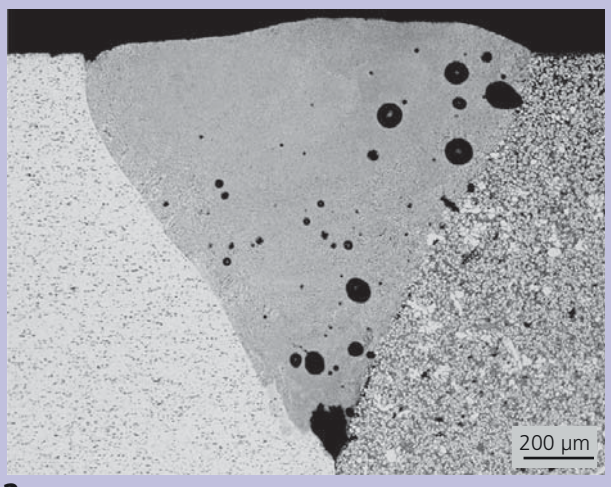
The development of new melt-based welding processes is necessary to tight-weld die cast components with minimal distortion. This process should have significantly reduced ejection probabilities and thus produce less splatter. The melt should be able to outgas.

OUR SOLUTION

To firmly join die cast aluminum parts with an aluminum tube (Fig. 1) Fraunhofer IWS engineers developed a novel welding process. This process utilizes beam sources of highest quality in combination with high frequency beam oscillation.

Geometric keyhole formation is controlled with the scanning frequency in the kHz range. The melt pool dynamics can be adjusted to the materials and allows for a controlled outgassing and homogeneous solidification of the melt. The number of gas inclusions in the weld metal is significantly reduced. The high process stability also increases the yield of welded components.

Laser welded joint produced through high frequency beam oscillation (left: AlMg tube, right: conventional AlSi pressure casting)



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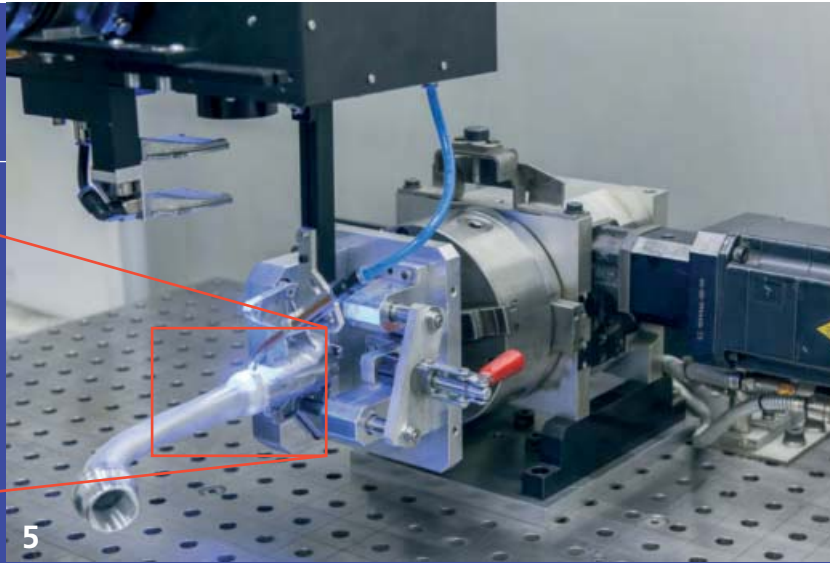

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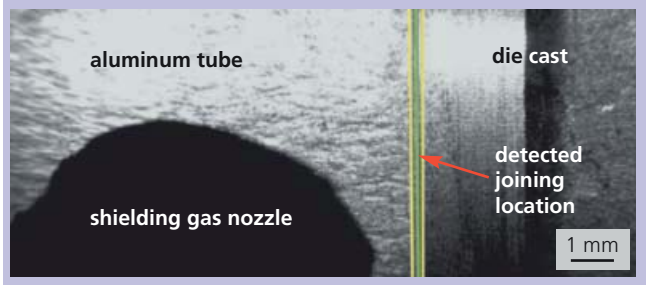
RESULTS

Welding experiments with die cast components in the laboratory showed that high frequency beam oscillation stabilizes keyhole formation. The process runs in a steady and stable manner. The typical ejections and splatter that are observed when welding die cast materials, are suppressed.

The metallographic analysis confirms these observations. The microscope image reveals that the remaining number of pores in the weld metal is low (Fig. 2) and that these are concentrated on the side of the die cast part. Parts were tested under 2.5 bar pressure and weld seams proved stable and pressure-tight.

Due to the low energy deposition (laser power < 1 kW) the 3D-formed part is dimensionally accurate and distortions are barely measurable. Complex assembly situations are therefore possible without the need for additional alignment steps. Welding tests with larger batches of prototypes proved that the process is suitable for series production yielding the desired properties.

Camera view of the joining location for detection and position of the laser beam via the scanner optics. The camera is coaxially aligned with the laser beam path.



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The Fraunhofer IWS service offer included materials analysis, designing the joining location, process development and the characterization of the joint properties.

Based on the obtained results, IWS engineers transferred the welding process into series production at an automotive supplier plant (Fig. 3 and Fig. 5). This step included the technology transfer and also the integration of hardware such as laser, welding optics and an integrated weld seam recognition system into an existing welding machine.

An application specific software was developed to control the scanner optics and to provide automatic image recognition (Fig 4). The software was also integrated into the welding machine. The specially developed welding process in combination with automated image recognition and scanner control software as a package offers a series production-ready solution also for other applications.

1 Laser welded die cast cooling pipe component
3 Laser beam welding process
5 Technical setup at the customer with IWS welding head (above) and active image recognition (right)

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