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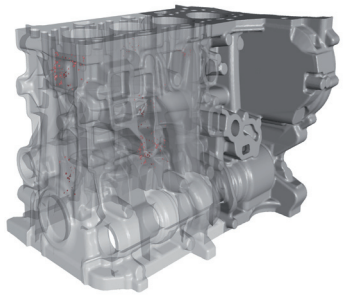

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1 *Aluminum-fiber composite connection manufactured using low-pressure casting. © Fraunhofer IFAM*
2 *Three-dimensional illustration of a crankcase with automatically detected defects. © Fraunhofer IIS*

NONDESTRUCTIVE MONITORING OF THE QUALITY OF HYBRID CASTINGS

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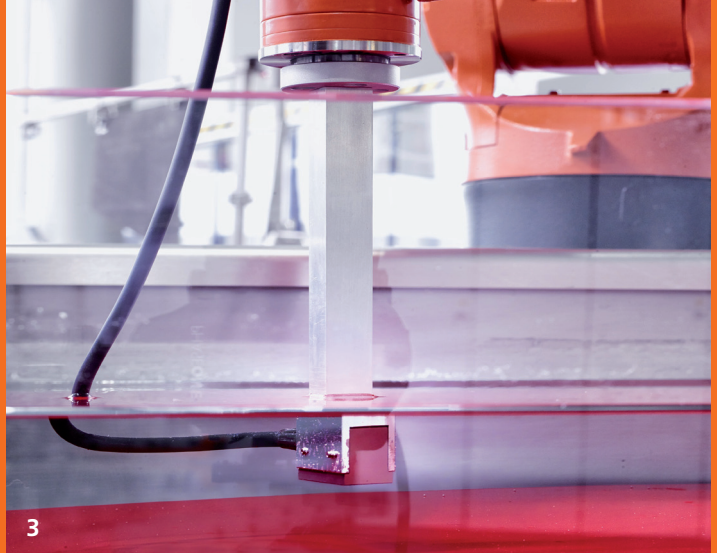
Light construction is increasingly making use of trend-setting hybrid designs comprising fiber composite materials and light metals, thus combining the advantages offered by both materials in a hybrid material. In the current state of technology, such connections are either glued or riveted. However, over the last few years Fraunhofer IFAM has been developing a novel joining technology for various hybrid connection types formed using high-pressure casting, even as far as series-readiness. Now, with the aim of the safe use of such hybrid components, three institutes of the Fraunhofer-Gesellschaft are working together to research test concepts for industrial series production.

Initial Situation

The combination of high-pressure alloys and fiber materials or wires opens up new possibilities for components in light construction. There is increasing demand for such components for applications in various fields – particularly in the automotive and aerospace industries. However, so far, no process has been developed that would enable the nondestructive monitoring of the quality of such hybrid components, a requirement for industrial use. Therefore, within the scope of the project "HyQualty – Hybrid Production with Standardized Quality Assurance" the Fraunhofer Institutes IIS/EZRT, IZFP, and IFAM are contributing their respective competencies in order to develop appropriate methods to this end. The aim hereby is to develop production-integrated and nondestructive inline testing methods that allow various types of defects in hybrid



components to become visible and thus examinable.

Nondestructive Monitoring – an Intelligent Look into the Component

The precise determination of the contact area between the fiber, the wire and plate reinforcement, and the casting matrix as well as the evaluation of its quality require imaging technology that shows the material in as high a resolution as possible. X-ray technology, computer tomography, and thermography are three such technologies that could be used in this context.

Industrial x-ray technology and particularly computer tomography offer effective monitoring for the three-dimensional examination of components. They enable the interior of objects to be seen and thus are eminently suitable, making even the smallest defect inside the material become visible. The Fraunhofer Development Center X-ray Technology EZRT is an international leading research and development center in this field of technology and has its core competencies in the field of nondestructive monitoring throughout the entire product cycle. An essential focus of development is the production monitoring in foundries using inline CT systems, which are able to detect deviations from the optimum production processes at an early stage.

In addition to x-ray processes, thermographic, acoustic, and magnetic testing processes are also used within the scope of the project through the Fraunhofer Institute for Nondestructive Testing IZFP in Saarbrücken. The so-called active thermography enables fast and simple automatic error detection, such as the detection of delamination and fiber breakage in CFRP components as well as crack detection. Hereby, depending on the component, optical impulses, ultrasound, or induction are used as activation. With resolutions of approx. 15 mK and an image frequency of 20 kHz even the smallest fluctuations, for example due to defects, can be detected in the heat flow. Similarly promising is the testing using high frequency ultrasound in a water bath, whereby the reflections of the sound waves at frequencies between 5 MHz and 15 MHz enable the detection of defects at various layers of depth. This selection is complemented by the implementation of multi-frequency eddy current testing. Through activation with frequencies of 100 Hz to 10 MHz, the structural differences in the metal can be detected, as can layer separations and cracks.

Aim of the Research Project

The development team aims to evaluate all processes in regard to the production-integrated inline testing of hybrid castings. In order to determine the suitability of each nondestructive testing method and to conduct a scientific comparison, the samples and components manufactured in the project are subsequently destroyed. The results of the destructive test hereby serve as reference results and are used in a comparison with the results of the nondestructive test.

3 *US-testing of CFRP.*
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