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»SENSING« COMPONENTS MANUFACTURED WITH LASER-BASED ADDITIVE PROCESSES

Task

The collection of component condition data such as thermal and mechanical stress forms the basis for predictive maintenance, Big Data and AI approaches. For this purpose, components must be equipped with suitable sensors. Additive manufacturing methods such as laser powder bed fusion (LPBF) offer a wide range of possibilities for producing application-adapted components. Laser-based coating approaches can be used to additively manufacture sensors directly on component surfaces, e.g. through the wet-chemical deposition of electrically insulating and conductive materials; subsequently laser radiation is used for thermal post-treatment of the printed layers. Fraunhofer ILT combines these additive manufacturing methods to equip printed lightweight components with printed sensors.

Method

As early as the design stage, the topology can be optimized to save material and reduce component weight. In this way, even complex bionic structures can be made for lightweight applications. To additively attach the sensors, the researchers at Fraunhofer ILT print the necessary layers and structures made of different materials directly onto the component layer by layer and then functionalize them using laser radiation. In the case of strain gauges, the insulation layer, the measuring grid and the encapsulation are applied one after the other. The wireless telemetry system on a compact circuit board is finally attached to the component and connected to the electrical contact pads.

Results

By combining LPBF with digital printing and laser post-treatment processes in an innovative process chain, Fraunhofer ILT is paving the way for the production of »sensing« components from the printer. Conventional sensors no longer need to be applied manually. When installed, the fully digitally manufactured component enables users to permanently monitor the component, document component load and detect overload conditions.

Applications

Such components can be used in classic areas such as drive or gear technology, large machines, power generation, rail vehicles and aerospace, in which predictive maintenance is already being used. By producing component and sensor in one step, research will be able to open up new fields of application – such as automotive, consumer electronics and toolmaking – in which condition monitoring was previously too complex or too expensive.

The demonstration device was produced in cooperation with i4M technologies GmbH.

Contact

Dr. Christian Vedder, Ext.: -378
christian.vedder@ilt.fraunhofer.de

Dipl.-Ing. Simon Vervoort, Ext. -602
simon.vervoort@ilt.fraunhofer.de

3 Fully additively manufactured, sensor-integrated component with wireless telemetry.

Fraunhofer Institute for Laser Technology ILT, www.ilt.fraunhofer.de
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