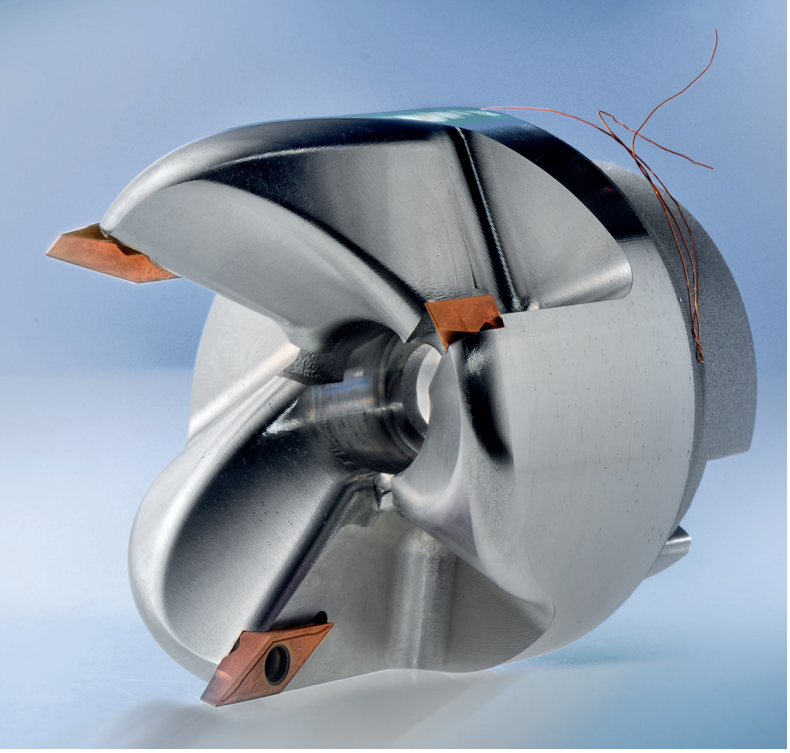

1 Component produced by the LPBF process with integrated sensor technology. 2 Printed strain gauges in incomplete AM component.

Laser-based integration of printed sensor technology in AM components

In the context of megatrends such as Industry 4.0 or the Internet of Things, companies increasingly have to analyze the condition of machines and components in all phases of their service life. To accomplish this, however, a comprehensive sensor infrastructure is required, one that can be realized by using additive manufacturing processes. Currently, sensors are only manually applied to the component surfaces in most applications. However, the optimal sensor position is often directly in the stress zone inside the component. If the functional printing of sensors is combined with 3D structure printing processes such as the laser powder bed fusion (LPBF) process, printed sensors can be integrated directly into the components in the course of inline production.

Multi-stage process for smart components

Fraunhofer ILT has developed a multi-stage process on the basis of a cutter head for a milling tool. Structural printing using LPBF is interrupted to integrate printed strain gauges using a digital functional printing process (e.g. aerosol jet printing) and laser-based thermal post-treatment (Fig. 2). Finally, the structural printing process is continued and the construction of the smart component is completed (Fig. 1).

Potential through high degree of individualization

By combining structural and functional printing with laser-based post-treatment processes, the institute has shown that it can additively manufacture a component with integrated sensor technology. This innovation enables the sensor to be optimally positioned for condition analyses such as load measurements in inaccessible places or near-contour measurements of the component temperature as well as protection of the sensor technology from mechanical and environmental influences. The sensor geometry can also be adapted to individual components. In addition to temperature or strain measurement sensors, further functional elements such as integrated heaters or similar can be implemented in the future. Since this combination process can be customized to such a high degree, a wide range of potential applications are possible, such as in toolmaking and mechanical engineering, in the automotive sector, and in energy or aerospace technology.

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