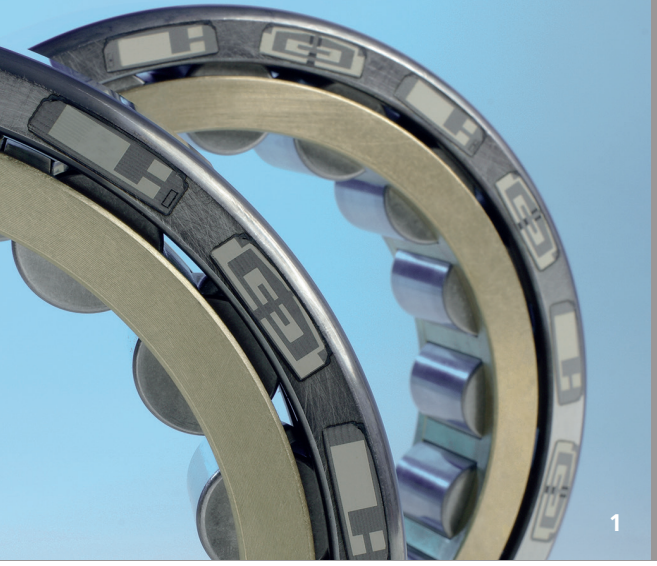

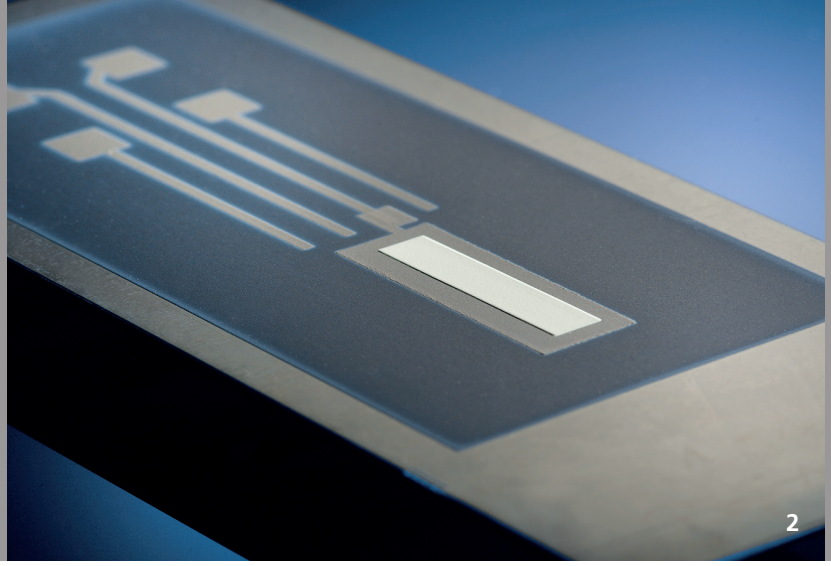

ADDITIVE LASER-BASED MANUFACTURE OF THICK-LAYER SENSORS FOR COMPONENT MONITORING

Task

The service life and the function of mechanical components are impaired, in particular, by influences such as super-elevated temperatures or static as well as dynamic overloads. To prevent greater damage to massive structural components, such as wind turbine bearings or turbine blades, Fraunhofer ILT is developing printed and laser-functionalized sensor systems for structural health monitoring (SHM) of solid, metallic components in temperature ranges of up to 500 °C. The project is part of the Fraunhofer joint project »INFUROS« in cooperation with Fraunhofer Institutes IKTS (responsible for material development) and IZM (responsible for electronics development).

Method

The metallic structural components are cleaned in a first step by means of laser pretreatment in order to adapt the surface properties for the subsequent coating process. Furthermore, the mechanical and chemical adhesion properties are improved by surface roughening and by local surface oxidation, respectively. In the next step, the thick-film paste is applied with layer thicknesses of 10 to 40 µm for the production of the first electrical insulation layer. The layer is then selectively post-treated by laser radiation to create an adhesive and electrically insulating layer. Subsequently, the steps of deposition and laser post-treatment of further insulation, conductor, resistor or piezoelectric layers are repeated until the multi-layer sensor structure is completed.

Results

In addition to reducing process times to a few seconds per pass – compared to conventional furnace-based post-treatment processes from several minutes to hours – this new process can now be used to additively produce multilayer-based sensor structures. These include strain gauges on rolling bearings, also on previously non-processable temperature-sensitive steels (hardened, e.g. 100Cr6).

Applications

The additive, inline-capable approach makes it possible to provide massive structural components with thick-film sensors. Areas of application include temperature, strain or body sound sensor monitoring of temperature-sensitive, or high-temperature structural components (e.g. wind turbine bearings or turbine blades).

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1 Rolling bearing with printed and laser-functional strain gauges in different finishing stages.
2 Additively manufactured piezo body sound sensor under construction.

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