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ELECTRONIC MULTI-MATERIAL SYSTEMS FOR COMPONENT-INTEGRATED SENSORS

Task

The service life and function of mechanical components can be impaired, in particular, by excessive temperature increases or static and dynamic overloads. To prevent greater damage to massive structural components such as wind turbine bearings or turbine blades, Fraunhofer ILT, along with Fraunhofer IZM and IKTS, has developed printed and laser-functionalized sensor systems to monitor massive, metallic components in temperature ranges up to 500 °C within the research project »INFUROS«.

Method

In addition to developing adapted evaluation electronics, suitable materials and deposition techniques, Fraunhofer ILT focuses on developing a laser-based method for high-resolution, substrate-gentle and inline-capable post treatment of printed functional layers such as isolation and PZT piezoelectric layers and of resistor and conducting tracks. After a laser is used to pretreat the surface to increase its mechanical and chemical adhesion, thick layers are applied from μm -sized particles and sintered/melted by means of laser radiation. On the first layer for electrical insulation, other functional layers follow for the production of sensors for measuring temperature, expansion, or structure-borne sound.

Result

By means of pulsed laser radiation, oxidized surface roughness can be generated on 100Cr6 steels with a property that promotes wetting. The laser-melted electrical insulation layers are adherent and exhibit a dielectric strength of 50 kV/mm. Thanks to laser radiation, debinding and sintered PZT layers are adherent and exhibit better dielectric properties (ϵ_{33} , R_{150}) because of much lower diffusion times during heating (ms range) in contrast to oven-sintered layers. The structure can be generated both with printing as well as with a laser-based process. This way, any geometry of a temperature-sensor can be functionalized with lasers.

Applications

This process can be used in the sectors of temperature, expansion, or structure-borne sensor monitoring of temperature-sensitive as well as high-temperature structural components (e.g. wind turbine bearings, turbine blades, etc.). The project »INFUROS« is funded by the Fraunhofer in-house program »MAVO«.

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- 3 Printed and laser-functionalized temperature sensors before (rear) and after cleaning (front) on steel.
- 4 Detail of sensor structure.