Thermal spraying group at Fraunhofer IWS

For coating components made of steel, light alloys, ceramics, concrete and other materials with metals, hard metals and ceramics, atmospheric plasma spraying (APS), with one and three-anode technology, and high velocity spraying (HVOF and HVAF), with both powders and suspensions as feedstock, are available at the IWS.

Our range of services:

- development of systems components
- user support in technology and system integration,
- design of tailored coating systems
- development of coating solutions from material to coated component.

Fig. 5: Thermal spray process (HVOF)

Kontakt

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Fraunhofer IWS

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THERMALLY SPRAYED MULTILAYERED COATINGS FOR CERAMIC HEATING ELEMENTS

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Task

The multiple combination options of multilayer coatings enable a variety of surface functionalization; and thus provide a wide range of applications. Scientists of the Fraunhofer IWS have developed a thermal spraying procedure to produce heating elements; the particular feature of this process is the combination of electrically conductive and insulating heating layers, which are directly applied onto the component's surfaces. The advantages of these multilayer coatings are their low height, their ability to heat large-scale components and their direct contact to the substrate, conducting the heat into the component (Fig. 1). The implementation of ceramic materials provides a better resistance against thermal and oxidative stresses than conventional metallic heating coatings do.

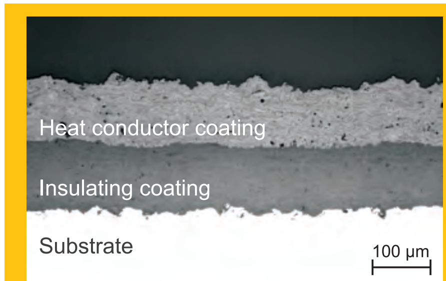

Fig. 1: Cross-section of a multilayered coating, thermally sprayed onto a metallic substrate.

Our solution

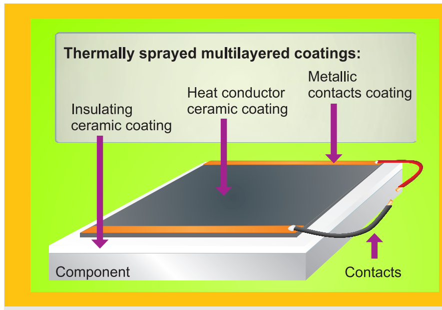

Fig. 2: Schematic presentation of a multilayered coating for an electrically heated component.

For electrical insulation between the heat-conducting layer and the component, coatings of aluminum oxide or spinel are used. Oxide ceramics, such as titanium sub-oxide (TiO_x) were selected for thermally sprayed heat-conducting coatings. Thanks to its high resistivity, complex structuring can be avoided and a homogeneous heating of the component is achieved. An optimal electrical contact is obtained by soft soldering the contacts onto the thermally sprayed copper layers (Fig. 2). The electrical resistance of the heat conducting layer can be tailored to the component's size by varying coating thickness, material or composition (e.g. TiO_x with 10% Cr_2O_3).

Results

Long-term cycle studies of TiO_x heat-conductive coatings show that after a short running time, at room temperature as well as at 300 °C, a constant resistance value is reached (Fig. 3).

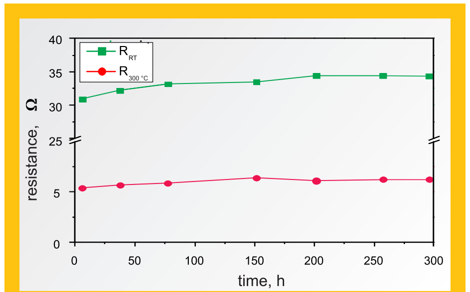

Fig. 3: Long-term cycle tests of a TiO_x heat-conductive coating at room temperature and at 300° C

Above 300 °C an oxidation of the titanium sub-oxides occurs. As a result, the resistance increases gradually and the operating temperature in an oxygen rich atmosphere is limited. Further results show that materials with a perovskite structure are a suitable choice for higher temperatures.

Potential applications

With thermal spraying, components of any size, geometry and of different materials can be functionalized with a heating element coating. Potential applications can be found in components where heat should be added or dispensed to the surface, including:

- tools for the plastics industry,
- rolls for drying processes in the paper industry (Fig. 4),
- pipes for simultaneously carrying and pre-heating gases, liquids or powders
- components with integrated protection against icing.

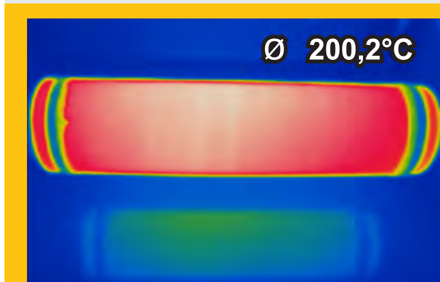

Fig. 4: Electrically heated roll with a ceramic heating element.