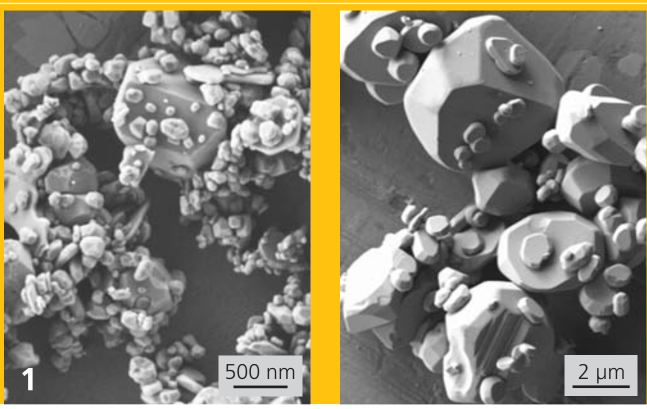

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CR$_2$O$_3$ HIGH PERFORMANCE COATINGS BY THERMAL SPRAYING WITH SUSPENSIONS

THE TASK

Chromium(III)oxide (Cr_2O_3) is a widely used coating material, in particular for printing, paper, pump and textile industries, as well as in mechanical sealing systems. Cr_2O_3 coatings are very hard and highly resistant to wear and corrosion; they also have good frictional and sliding properties and can be well structured by laser.

Cr_2O_3 coatings are mainly made by atmospheric plasma spraying (APS). Deposition efficiency ranges from approximately 30 to 40 percent. The APS coatings show a porous structure, which is unfavorable for some applications. Denser coatings can be produced by high velocity oxygen fuel (HVOF) spraying. Since this spraying technique achieves only a low deposition efficiency (< 10 percent), it is not widely used in industrial coating spray jobs. Consequently, the Fraunhofer IWS is developing high density Cr_2O_3 coatings with higher deposition efficiency.

OUR SOLUTION

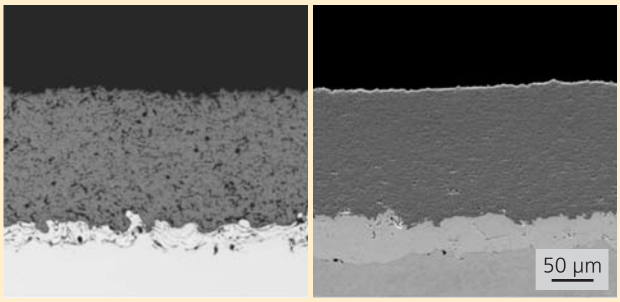
The scientific-technical approach is based on thermal spraying techniques with suspensions. The coatings are sprayed with suspensions made of submicro- or nanopowders (Fig.1), which are finely dispersed in liquid, instead of coating powders with particles from 5 to 50 µm size. Using stable suspensions with a low viscosity is crucial for the long-term reliability and efficiency of the processes. For this purpose, concentrated aqueous Cr_2O_3 suspensions with a solid content of up to 40 weight percent were developed and tested in collaboration with the Fraunhofer IKTS.

The hardware components specifically needed to spray the suspensions were engineered at the IWS and customized for conventional APS and HVOF spraying systems. The suspension HVOF spraying tests were performed by means of a Top Gun HVOF using ethylene as fuel. The suspension was supplied by means of a pressurized suspension feeder (Fig. 2) and axially injected into the modified combustion chamber. During spraying, the suspension feed rate and pressure are continuously controlled and monitored.

RESULTS

The SHVOF coatings microstructures (Fig. 3) are denser than those of traditional APS coatings. The typical crack-like structure of conventional coatings could not be observed in the SHVOF coatings.

Cross-section micrographs of an APS-Cr_2O_3 coating (left) and a SHVOF-Cr_2O_3 coating (right)



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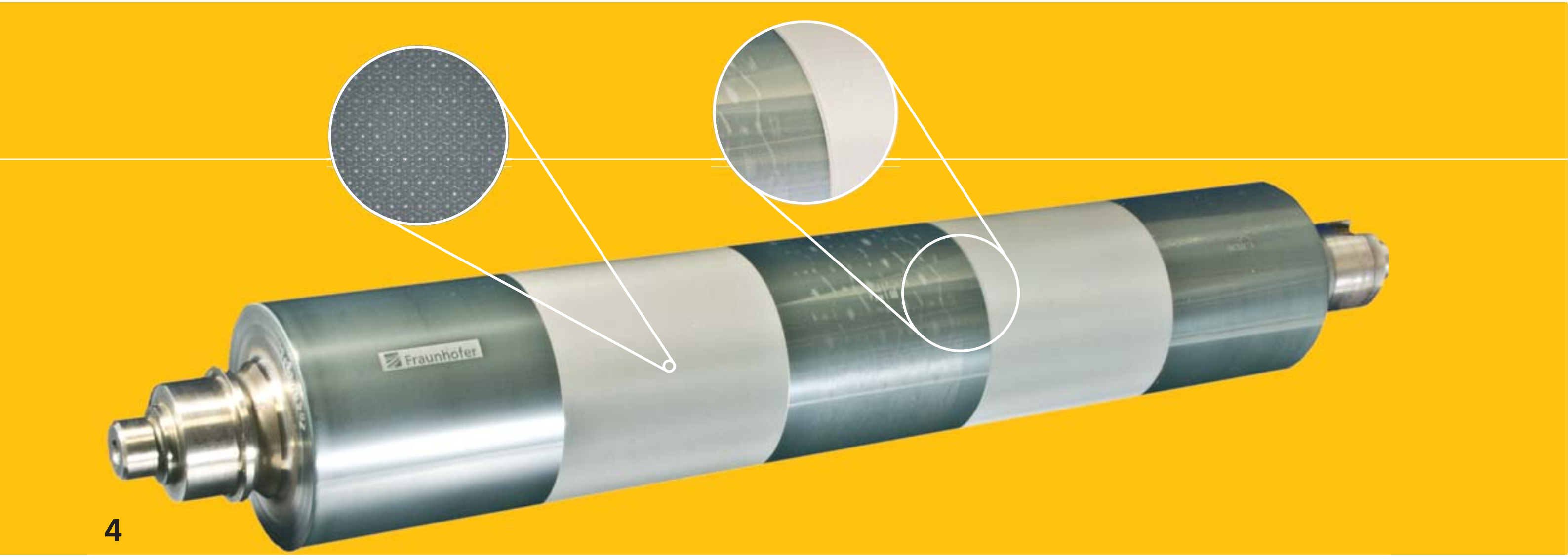

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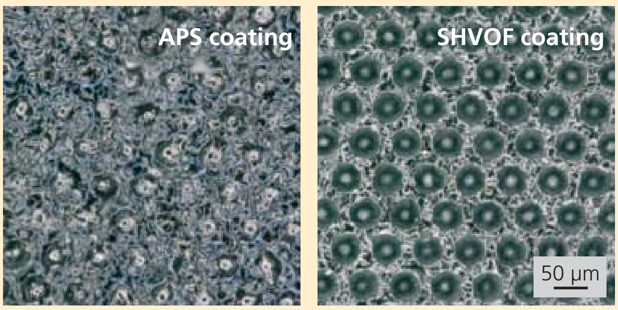
For suspension coatings, hardness values from 1200 to 1500 HV 0.3, which outperform the values of conventional APS coatings, were measured. Using finer particles clearly enhances the mechanical properties. The Young's moduli of the SHVOF coatings exceed 135 GPa, whereas those of the APS coatings lie just at approximately 75 GPa. SHVOF coatings provide similar wear coefficients, but lower roughness values than conventionally sprayed coatings. The SHVOF coatings show higher resistance to corrosive media thanks to the higher density of the microstructure. When Cr_2O_3-based surfaces using the SHVOF technique are sprayed, deposition efficiencies from 30 to 35 percent were achievable, which corresponds to an improvement of more than 300 percent in comparison with Cr_2O_3- HVOF powder coatings. Another advantage of the SHVOF coatings is the smooth surface. Roughness values (R_a) of suspension-sprayed coatings of 1 - 3 µm were clearly below those of the powder-sprayed coatings (R_a > 5 µm). This makes subsequent grinding and polishing of the suspension coatings cheaper and saves time. Figure 4 depicts the surface topographies of the laser-structured APS- and SHVOF coatings. In comparison with the conventional coatings, the SHVOF coatings provide excellent, finer laser structuring even without subsequent machining. The fine patterns also serve as a lubricant reservoir for tribological applications.

Topography images of a laser structured APS coating (left) and a SHVOF coating (right). Laser structuring was carried out on as-sprayed coatings.



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SHVOF-Cr_2O_3 coating on an aluminum shaft, polished, laser structured and laser engraved

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The superior coating properties make the SHVOF-Cr_2O_3 coatings ideal for application on components subject to heavy corrosion and wear, such as printing rollers and shafts (see Fig. 4 and 6).

The findings introduced here were developed in collaboration with the Fraunhofer IKTS in the IGF project 18.154B / DVS-No. 02.094, which was funded by Forschungsvereinigung Schweißen und verwandte Verfahren e.V. of the DVS.

1 *Morphology of fine Cr_2O_3 powders for suspension fabrication*

2 *Suspension feeder with three pressure tanks*

4 *Printing roller (demonstrator): SHVOF-Cr_2O_3 coating, polished, laser structured and laser engraved*

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