A Powerful Duo: Diamond And Ceramic

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Diamond is a material with outstanding features: It is extraordinarily hard, conducts heat well and is practically inert to chemical substances. Ceramics - particularly high-performance ceramics - are likewise able to demonstrate special qualities: It is robust and withstands extreme temperatures. Scientists from four Fraunhofer institutes, together with partners from industry, succeeded in producing a new composite material and in making it useable for applications. The composite material, „diamond-coated ceramics DiaCer®," combines the best of both materials. Any place where components and tools are subjected to heavy strain - such as in pumps or forming and shaping dies - DiaCer® offers maximum wear-resistance coupled with low values of friction. In recognition of their achievement, the interdisciplinary team is bestowed the Stifterverband Award for Science.

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The basis is a silicon-nitride or carbide ceramic, which researchers of the Fraunhofer Institute for Ceramic Technologies and Systems IKTS in Dresden modified for the diamond coating. Their mission was to find out how to craft the ceramics so that the diamond coating adheres firmly and evenly to the base body. That is quintessential to the lifecycle. Colleagues at the Fraunhofer Institute for Materials Mechanics IWM in Freiburg provided important insights on this through simulations with the materials and components; additional insights were gained from the investigations on ceramics processing by colleagues from the Fraunhofer Institute for Production Systems and Construction Engineering IPK in Berlin. „We then worked on the coating, and designed the systems," says project coordinator Dr. Lothar Schäfer of the Fraunhofer Institute for Surface Engineering and Thin Films IST in Braunschweig. Components and tools are initially placed in a vacuum reactor for the hot wire chemical vapor deposition (CVD) technology applied for the coating process. Next,

the researchers add methane and hydrogen. In order for the diamond coating to grow, wires are spread at intervals of just a few centimeters across the objects that were going to be coated. The wires are heated until they reach incandescence. This activates the gases; carbon is deposited on the surface in crystalline diamond form. „Using our process, we can apply a diamond layer of up to a half square meter in size," says Schäfer. „There's nothing else like it in the world."

Two examples demonstrate the advantages: With axial face seals that EagleBurgmann Germany inserted in pumps for critical environments, like the conveyors for oil, sand and gas mixtures, the diamond coating extends the durability for each application by a factor of 4 to 1,000. Drawing dies are a forming tool used in the production of wires. The unique feature here: the inner coating, which is possible through a modification of the process. This means that drawing dies can be coated for various diameters, allowing very thick wires to be realized, along with wires that are not circular at the cross-section. The test tools, which are used in production at the Elisental wire plant for example, were barely worn after several tons of wire had been produced.

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Axial face seals for pumps have since been coated with diamonds by Condias GmbH, and marketed by EagleBurgmann in a variety of complex applications. Many other applications are also conceivable. „Ultimately, DiaCer® is of interest for all components in machine construction that need strong resistance to wear," summarizes Schäfer.

SOURCE [4]

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