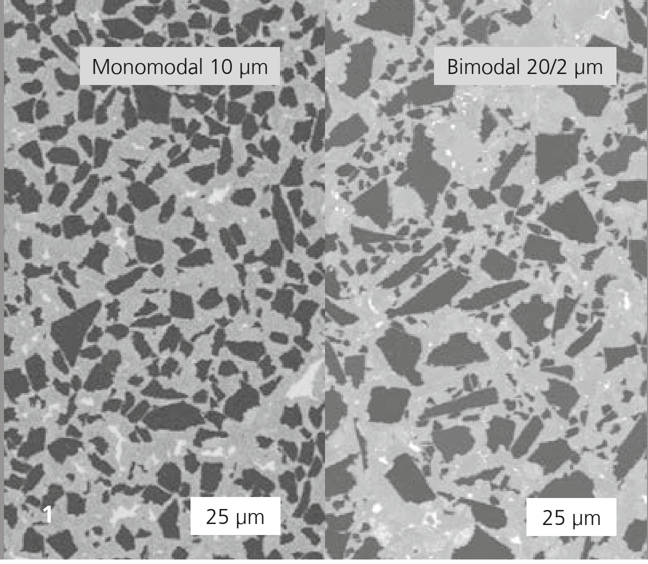

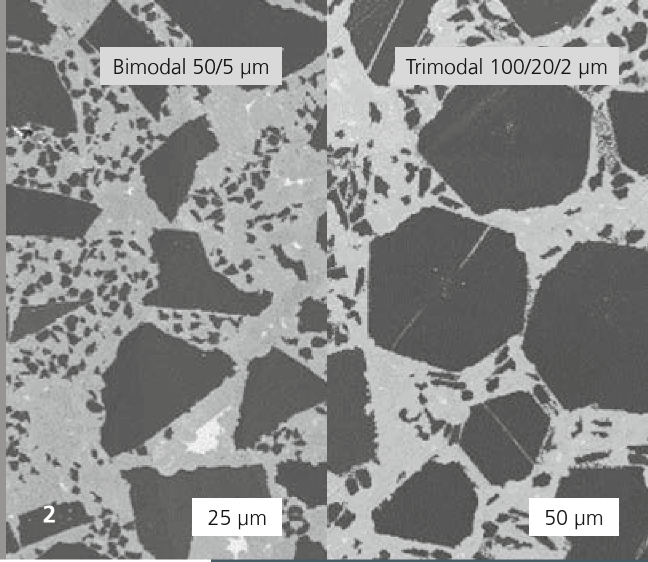

SILICON CARBIDE-BONDED DIAMOND MATERIALS WITH HIGHEST WEAR RESISTANCE

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In deep-sea mining down to 6000 m, as well as for oil and gas production at sea, the durability and freedom from maintenance of all materials and components over timespans of 10 to 30 years is essential. Achieving this is next to impossible with conventional materials – specifically, for example, with regard to wear components in pumps. For this field of application, Fraunhofer IKTS, in collaboration with its Fraunhofer AdvanCer Alliance partners, is developing superhard, wear-resistant SiC-bonded diamond materials with diamond contents of approx. 50 % by volume.

These materials can be prepared pressure-free as compact components through the silicon infiltration of diamond preforms. Moreover, SiC components with locally placed diamond-SiC composite in wear areas can also be realized. Even large-scale complex components, such as pipe segments, bearings or nozzles, are manufactured effectively. The microstructures of the materials can be adjusted across a wide range (Figure 1). This allows the production of components with customized properties.

The materials thus developed are characterized by a solid chemical integration of the diamonds into the three-dimensional SiC framework, which is formed by reaction of diamond with silicon during infiltration. As a result, the materials have a higher strength than silicon-infiltrated SiC material (SiSiC) (HK2 up to 48 GPa against more than 20 GPa, or a biaxial strength above 450 MPa against approx. 280 MPa, measured in ball-on-3-balls tests). The silicon content of less than 5 % by volume is considerably lower than in conventional SiSiC materials. As a result, in contrast to SiSiC materials, the materials show a high corrosion resistance in basic media and under hydrothermal conditions.

Tribological tests show that these materials have a wear behavior similar to that of superhard polycrystalline diamond (PCD): in contrast to PCD they can be produced in almost any dimensions and shapes. Moreover, their wear resistance is ten times higher than for commercial boron carbide material. Depending on the microstructure design, thermal conductivity can be increased to more than 500 W/mK, which offers potential e.g. for heat exchangers [1; 2].

The new SiC-bonded diamond materials open up new possibilities for cost-effective, wear-resistant components of different geometry and dimension for a vast variety of areas.

Services offered

- Technology development
- Development and testing of sample components
- Characterization of microstructures and properties of superhard materials

Literature

[1] B. Matthey, et al. J. of Materials Research, 32, (2017), 3362–3371.
[2] B. Matthey, et al. J. Eur. Ceram. Soc., 37, (2017), 1917–1928.

1 *SEM image of different microstructures of SiC-bonded diamond materials.*

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