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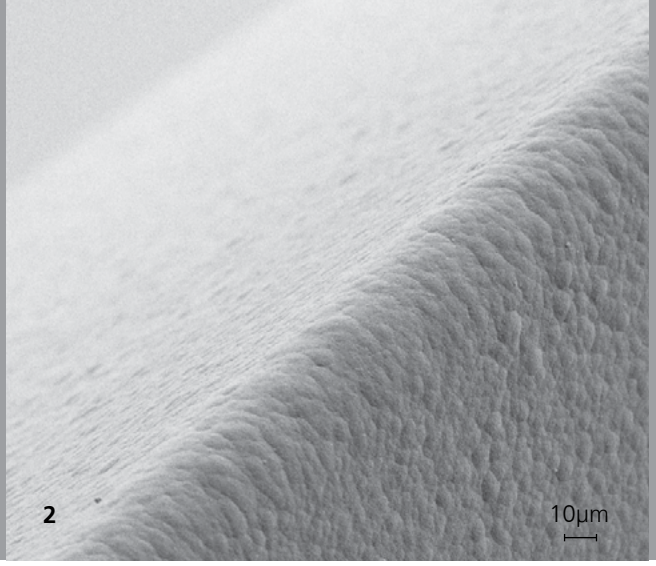

2

INTERLAYERS FOR THE DIAMOND COATING OF CEMENTED CARBIDES

Diamond-coated carbide tools are eminently suitable for machining graphite, fiber-reinforced plastics and aluminum alloys. At the Fraunhofer IST interlayers are being developed as alternatives to a process which has to date been essential: etching pretreatment of the cemented carbide base body. With these new coatings, weakening of the boundary zone of the cemented carbide body can be avoided.

Currently hot-filament CVD diamond coatings on tools and components made of cemented carbide are only possible on a few types of cemented carbide and also require a costly pretreatment of the cemented carbide by etching. Without a chemical pretreatment of this kind, which removes the cobalt binder from the surface of the cemented carbide substrate, the diamond coatings would not adhere to the tool. However, pretreatment also at the same time weakens the flexural strength and the edge stability of the base body. But if interlayers are to replace a pretreatment of this kind, they must satisfy the following requirements:

- Suitability as a barrier against cobalt diffusion
- Good adhesion to different types of cemented carbide
- Ensures a stable attachment of the CVD diamond layer
- Thermal stability to approx. 900 °C

Hot-filament CVD interlayers on a silicon basis

The advantage of interlayer deposition by the hot-filament CVD process is that there is no need of a change of the deposition process for the subsequent diamond coating. In recent years the Fraunhofer IST has conducted fundamental research primarily into silicon carbide (SiC) interlayers and tested their adhesive strength. In later tests at the Institute for Machine Tools and Factory Management (IWF) of the Technical University of Berlin, extensions of the tool path were achieved not only in the machining of abrasive aluminum-silicon alloys but also in milling CFRP boards which were comparable with diamond-coated tools pretreated by etching.

Detailed thermal investigations indicated however that at the usual coating temperatures for diamond deposition the SiC interlayer reacts with cobalt and therefore does not have the required stability. The substrate temperature has to be lowered to a maximum of 700 °C to prevent the heat-activated reaction of the silicon carbide with cobalt from the cemented carbide substrate.

In addition to SiC interlayers, silicon nitride interlayers have also been investigated at the Fraunhofer IST. These are chemically stable at the CVD diamond deposition temperatures of 800 to 900 °C which are usual in industry. Until now SiN_x intermlayers of this kind have not been tested on tools but in the sandblasting adhesion test they are reaching service lives comparable with etched diamond-coated references.

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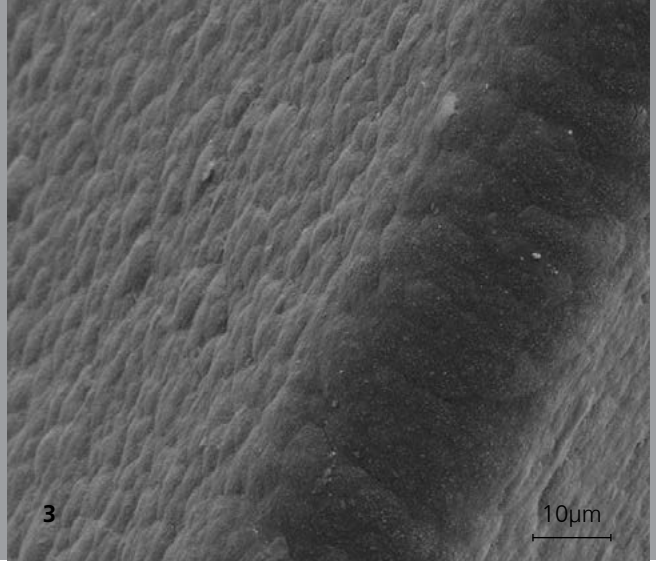

1 *Diamond-coated milling tool with tungsten interlayer in use in graphite machining.*

2-3 *Scanning electron microscope image of the coated cutting edge before (2) and after (3) use: nanocrystalline CVD diamond film with tungsten interlayer on a milling tool with 10 % cobalt in the cemented carbide.*

PVD tungsten interlayers

Another alternative to etching pretreatment are tungsten interlayers, which are deposited by magnetron sputtering. Tungsten is admirably suitable as a stable cobalt barrier. However, ground cemented carbide surfaces do need to be pretreated by sandblasting to enable a strong mechanical connection of the diamond coating to the interlayer. What is important in the pretreatment of tools with a defined cutting edge is for the roughening process not to reduce the cutting-edge geometry excessively. By a suitable selection of the pretreatment parameters and subsequent tungsten coating, success has now been achieved in applying a CVD diamond coating to milling tools with 10 % cobalt in the cemented carbide with no etching pretreatment, and then using the tools successfully in machining graphite.

Outlook

Further development work aims at extending diamond coating to a large variety of cemented carbide types, tool and component geometries. Here three promising interlayers are already currently available at the Fraunhofer IST. The challenge lies in the individual adjustment of the process parameters to the tools to be coated and in demonstrating cost-effectiveness.

KONTAKT

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