

Extract from the annual report 2019  
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## TEXTURED CVD DIAMOND MICRO ABRASIVE PENCILS

In collaboration with the Institute of Machine Tools and Production Technology (IWF) at the Technische Universität Braunschweig, Fraunhofer IST has developed novel CVD diamond micro abrasive pencils for particularly demanding grinding operations in which special precision and the highest possible surface qualities are required. The innovation of the presented tool concept lies in the combination of a polycrystalline CVD diamond layer as abrasive layer with the incorporation of additional grooves in the tool surface in order to create additional chip clearance. As a result, the supply of cooling lubricant is improved and consequently the performance capability of the tools is enhanced even further.

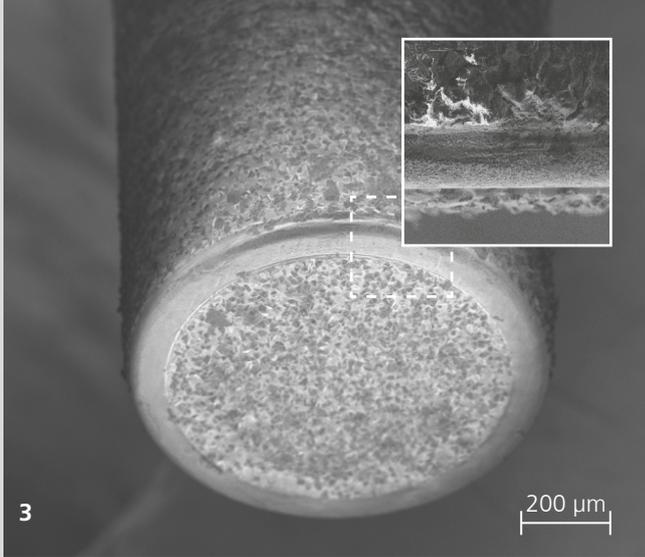
### CVD diamond as high tech grinding layer

Due to their material properties and intrinsic surface topography, polycrystalline diamond coatings produced using hot-wire chemical vapour deposition (CVD) present an unsurpassed wear-resistant abrasive layer with extremely sharp and efficient micro cutting edges which seamlessly cover the entire tool surface. In contrast to conventional binder-based diamond abrasive layers, this abrasive layer consists entirely of diamond crystals with a very uniform size distribution. It is also possible to achieve any desired fine grain size without suffering the loss of bonding forces. As a consequence, CVD diamond abrasive layers are ideally suited for grinding operations in which the highest precision and quality of the workpiece surfaces is required with simultaneous low roughness and reduced sub-surface damage. Until now, the disadvantage of such fine abrasive layers had been that the CVD diamond layer provides very little space for the transport of cooling lubricant and the capture of chips. The solution approach at the

Fraunhofer IST is to generate additional chip clearances and lubrication pockets by creating spiral grooves or bowl-shaped-cavities, thereby improving the performance efficiency of CVD diamond abrasive layers even further.

### Concepts for adding additional surface textures

Two fundamentally different concepts for the creation of additional cavities were examined and realized. One was to incorporate cavities into the already finished diamond coating by using an Nd:YAG solid-state laser after the diamond-coating process. This method allows the practically freely-selectable introduction of almost any type of cavities even for abrasive pencil diameters of 0.2 mm and below (see Fig. 1). The second method entails machining the carbide base body by grinding-in e.g. spiral grooves and subsequently applying the CVD diamond layer (see Fig. 2). Both variants have been successfully implemented.



1 CVD diamond abrasive pencil after laser texturing.

2 CVD diamond abrasive pencil with ground spiral grooves after machining of zirconia ceramic.

3 Conventional diamond abrasive pencil with electroplated bond (D15) after machining of zirconia ceramic, with the abrasive layer completely worn away at the tip edge.

## Achieved improvements

The innovative textured CVD diamond abrasive pencils have been successfully utilized for the machining of quartz glass, zirconia ceramics and hardened 100Cr6 rolling bearing steel. Compared to electroplated diamond abrasive pencils with grit size D15, the roughness of the machined surfaces was significantly improved. Even with experimental parameters for which conventional diamond abrasive pencils exhibited considerable wear - particularly in the area of the tool tips -, the textured CVD diamond tools showed absolutely no signs of wear (see Figs. 2 and 3). This work is currently still ongoing. At present, the textured CVD diamond tools are being tested in industrial use by several companies from the project's user committee. The application of the described concept is not limited to micro tools; it can also be transferred to other grinding tools like grinding wheels or honing stones accordingly.

## The project

Gefördert durch:



aufgrund eines Beschlusses  
des Deutschen Bundestages

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