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Analysis of CVD diamond coatings on tungsten carbide tools and their ability to machine ceramic materials

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Milling tools made of tungsten carbides are coated with diamond to find maximum fields of application for protective films and used to machine ceramic materials. Such hard and brittle materials are difficult to machine. Grinding is the mainly used cutting process to finish the geometry of ceramic components. The application of milling tools with defined cutting geometry is highly advantageous because of the larger removal rate which reduces the processing time and hence also the machining costs.
In this project milling tools with a geometry normally used for high speed cutting (HSC) are chosen. Such tools are commercially available and have a relative huge wedge angle which stabilises the cutting edge. These tools were coated with diamond films by chemical vapour deposition (CVD) in a modified hot filament process developed by CarbonCompetence.
The diamond coatings are characterised by scanning electron microscopy (SEM) and Raman spectroscopy at different positions on the tool to obtain information about the morphology and the bonding structure of the diamond coating and the interface material. Local dependent X-ray diffraction (XRD) gives direct evidence for diamond in the coatings and allows the estimation of micro structure in the films.
As ceramic material, a carbon fibre reinforced ceramic with SiC matrix is used. During the machining process the forces on the work piece are recorded. After different lengths of application, the diamond coated tools were examined by using optical microscopy and SEM concerning wear.
It was found that machining of fibre reinforced ceramics with diamond coated tungsten carbide tools with defined cutting geometry is in principle possible. The influence of morphology and the composition of the diamond film on the tool life time will be discussed.

Keywords
diamond coating
XRD
Raman spectroscopy