

OR0802

Characteristics of Multi-Layer Diamond Coatings on Cemented Carbides with different pre-treatment seeding powders

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Diamond coatings on cemented carbide tools are well established in various industrial applications for machining of extreme abrasive materials like graphite, PCB (Printed Circuit Boards) or CFRP (Carbon Fibre Reinforced Plastics). For best cutting performances the tool geometry, cemented carbide composition and structure, tool pre-treatment, coating parameters and morphology and cutting edge roundness need to be matched. An excellent performance in many applications has been achieved with CemeCon's multilayer diamond coatings, which presents a sequence of micro- and nano-crystalline morphologies. Therefore these multilayer coatings combine the requirements of excellent adhesion and smooth coating surface. The different morphologies of micro- and nanocrystalline layers can be achieved by the variation of the total gas pressure, gas composition and gas flux.

For further improvement of the initial growth steps in the diamond deposition process we studied the nucleation and growth behavior of 3 pre-treatment powders with different diamond cluster sizes (0 - 4 nm, 0 - 250 nm and 0 - 500 nm average grain size). Deposition processes were carried out on polished tungsten discs to study the initial growth steps and on etched cemented carbide rods to evaluate the growth rate, the surface morphology and the adhesion of the diamond coatings.

The seeded tungsten discs were coated in a 12 min deposition process. With the 500 nm pre-treatment only few small crystallites can be found on the surface. The 250 nm powder shows a much higher nucleation density compared to 500 nm, but after 12 min of deposition the diamond film is not completely closed yet. With the 4 nm powder the diamond film is already totally closed on the whole surface.

The cemented carbide rods (6 - 12 % Co) are chemically etched before deposition to remove the cobalt binder. In long time deposition processes with low cobalt cemented carbides (6 % Co) the growth rate, the diamond surface morphology and the adhesion of the diamond films in the sand blasting test is the same for all 3 cluster sizes. For higher Co-binder contents (10% Co) the adhesion of the diamond coating increase with the decrease of the particle size in the seeding powder.

Keywords

Hot Filament

Diamond Deposition

Pre-Treatment

Abrasion