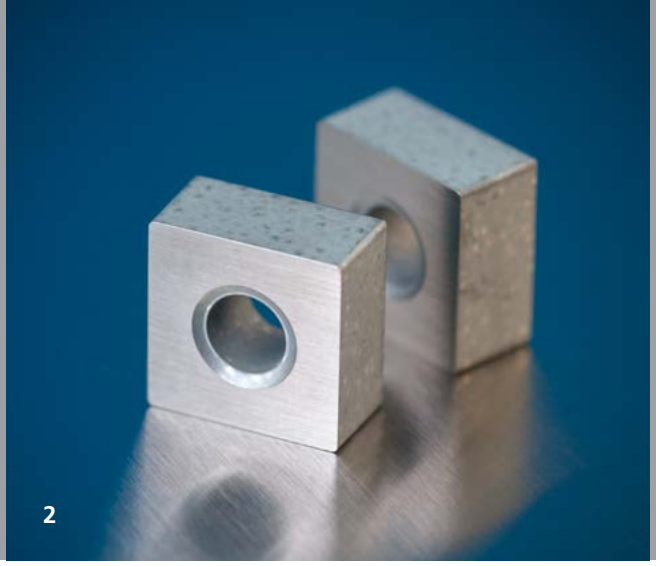
1



2

PROCESS CHAIN FOR THE PRETREATMENT OF TOOLS FOR PLASMA COATING

The application properties of hard material coatings on geometrically complex cutting tools directly depend on the surface cleanliness of the cemented carbide substrate surface before coating. To increase the environmental compatibility of an optimized cleaning process chain consisting of treatment steps with a subsequent fine plasma cleaning directly before coating, the Fraunhofer IST has developed a new process chain for the pretreatment of tools and evaluates this process chain relating to the application with industrial partners.

Cleaning process chain

In the manufacturing route, cemented carbide cutting tools pass a quite complex process, consisting of grinding and polishing steps that produce resistant residues on the surface, due to the process heat that occurs within these steps. For the most part these residues are still virtually impossible to detect after the final cleaning in production, even with a light-optical microscope. Nevertheless, they exert a negative effect on the integration, i. e. adhesion of the hard coatings. To increase the process reliability of the coating processes, the Fraunhofer IST combined the following ecological cleaning approaches and subsequently investigated their technological load-bearing capacity by means of service-life analysis:

- Aqueous cleaning with biodegradable cleaners
- CO_2 snow blasting for residue-free cleaning
- Plasma-electrolytic polishing with environmentally-compatible media
- Plasma supported cleaning under vacuum conditions with innovative generator concepts

Aqueous cleaning

The 15-chamber cleaning system available at the Fraunhofer IST is used as the reference equipment for a water based cleaning technique that is appropriate for the coating adhesion (see Fig. 1). The system is configured precisely for the needs of the IST, as a variety of substrate materials and substrate geometries – from flat substrates to complex tools – can be cleaned. Moreover, the applied cleaning media can flexibly be adapted to the cleaning task. A sophisticated bath monitoring and recipe control coupled with an expert system enable reproducible pretreatment processes. The system qualifies innovative, biologically safe, and degradable cleaners that are used efficiently with additional support in their cleaning effect via ultrasonic enhancement. The formulation of the special cleaning chemistry occurs on the basis of renewable and/or biologically degradable raw materials, such as tensides and/or other surface-active substances, such as glycosides.

Plasma supported cleaning

In the final step of the pretreatment all chemical compounds down to the nanometer scale are removed from the substrate surface under vacuum conditions via plasma-chemical

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and plasma-physical processes, and the substrate surface is chemically activated. This plays an essential role for the adhesion of subsequently applied coatings. Key factors are the distinct plasma conditions, which are modified in broad ranges through variation of the pulse geometry and acceleration tensions.

Evaluation

To verify the effectiveness of the newly developed cleaning process chain, a developed synthetic contamination is initially applied and afterwards removed from the sample component surfaces. These synthetic contaminants simulate the manufacturing process as precisely as possible or impose additional requirements on the process, through representation of massive film or particle coatings. Then in a second step, complex cutting geometries, such as drill or milling tools, are provided with wear protection coatings. Finally machining tests prove service live times that are required technologically as well as economically.

Industrial uses

The improved pretreatment process chain enables hard coatings with uniform quality. Moreover, the new procedure is far more cost-effective than classic wet-chemical or solvent-based process chains. On one hand, cost savings can be achieved through simultaneous reduction of the process residues in the cleaning procedure, on the other hand due to the intelligent linking of modern and more environmentally-friendly cleaning processes, significantly lower disposal costs and energy costs are incurred.

1 *Multi-chamber system at the Fraunhofer IST for aqueous cleaning with high reproducibility and flexibility in materials to be cleaned.*

2-3 *Testing tools used for the development of the cleaning procedure: (2) Cemented carbide inserts as references for simple geometrical requirements. (3) Drilling tools with high geometric requirements imposed on the cleaning process to be developed.*

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