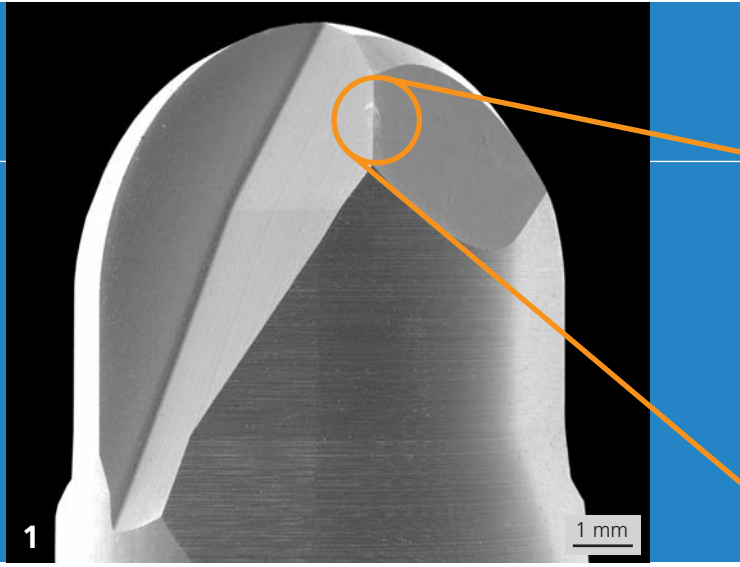


1

SHARP EDGES THANKS TO COATING

THE TASK

Deposition of thin coatings on an industrial scale has been widely used for years. Coatings that were produced by means of the PVD and CVD techniques are used, for example, as wear resistance coatings, for decoration, and to diminish friction. Contour-accurate coating of complex geometries, such as of tools (Fig. 1), is still a challenge. Consequently, the coatings generally used in industry are typically deposited to a thickness of just a few micrometers because edge rounding (Fig. 2, top), for instance, is still irrelevant in this thickness range.

If it were possible to coat complex geometries accurately to contour, it would also be possible to use thicker coatings, which would provide far better protection. Monolayer systems, such as of TiN, CrN, AlTiN or AlCrN, are not yet suitable for these coating tasks. The Fraunhofer IWS Dresden is developing and testing new coating approaches and suitable coating procedures for this purpose in collaboration with the TU Dresden.

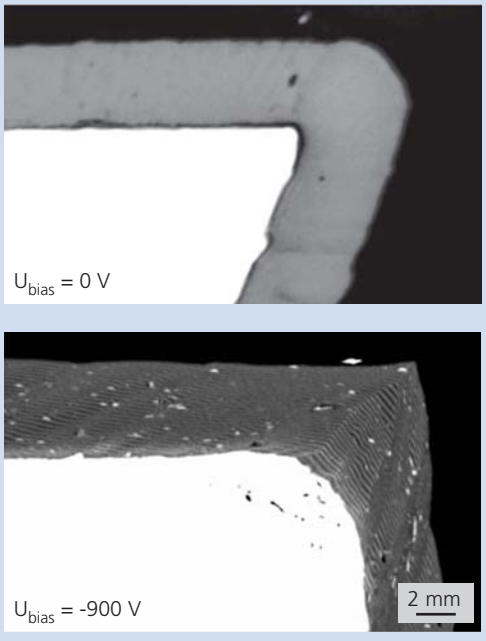
OUR SOLUTION

Research at the IWS is focused on the development of coating processes that provide better protection and with which complex components can be coated accurately following the contour and with constant layer thickness along the component.

The coating properties are typically improved by applying an electrical substrate bias potential. For complexly shaped components, however, the additionally applied electrical substrate bias potential results in heterogeneous electric field distribution, which, in turn, causes different layer thicknesses along the contour.

Optimization of the coating material helps to avoid multiple layer thicknesses caused by different deposition rates. Using the AlCrSiN/TiN coating system developed at the IWS, not only the typical edge rounding effect can be avoided but also, if necessary, edges can be sharpened (Fig. 2, bottom).

Transverse microsection of a monolayer coating, deposited without bias potential (top) and a multilayer hard coating, deposited with high bias potential (bottom)



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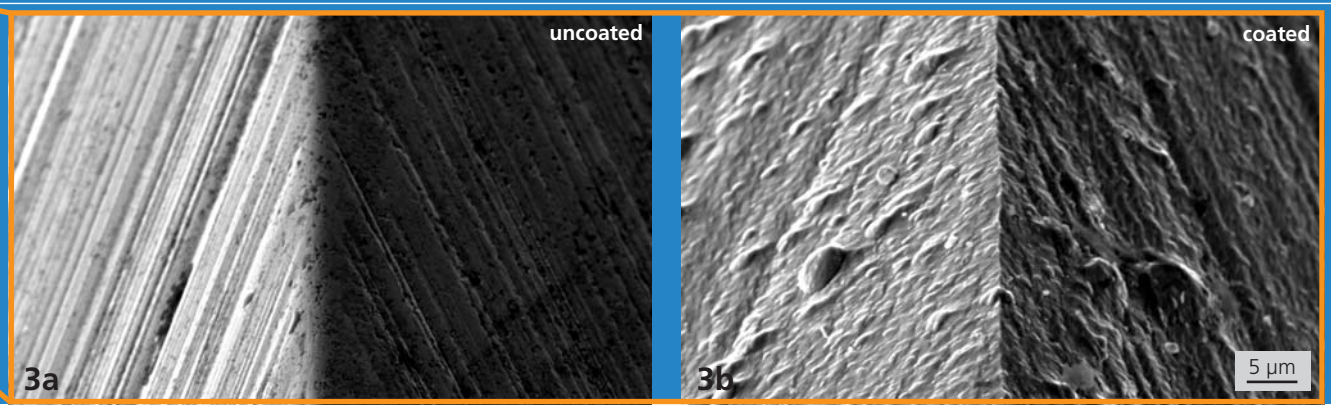
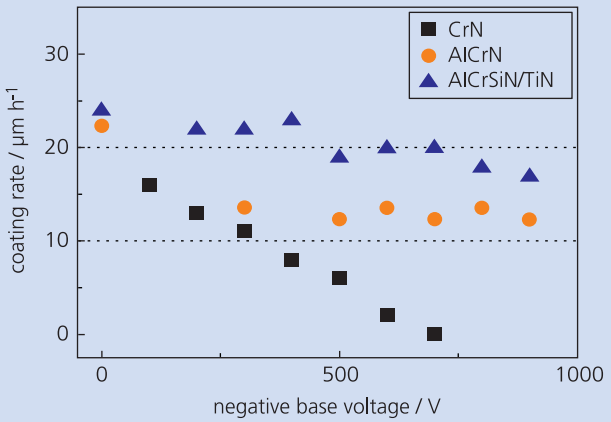


RESULTS

SEM images (Fig. 3) show the cutting edges in uncoated and coated state. Unlike the uncoated fillet-like edge, deposition of the AlCrSiN/TiN coating system sharpens the edge.

Due to the complex geometry of a tool's cutting edge, field effects during coating with bias voltage and traditional coating systems frequently result in growth defects at the cutting edges, such as uneven edge cover. The AlCrSiN/TiN coating system shows only slight changes in the coating rate over a wide range of the bias voltage (Fig. 4). This makes it possible to homogeneously coat even complex geometries with field effects occurring during the coating. New possibilities to coat edges subjected to extreme load/stress are opened up.

Coating rates for various layer systems (single-layers vs. multilayers)

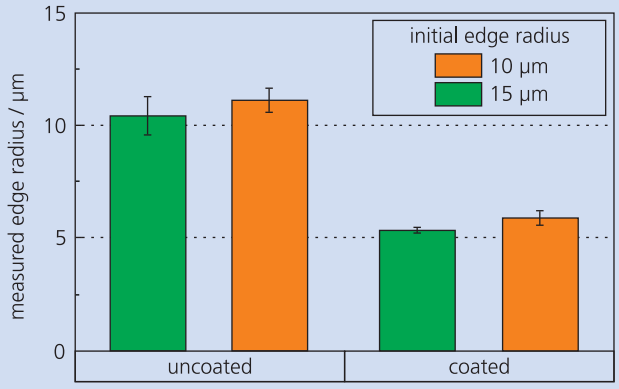


4

We also succeeded in bypassing edge rounding and even intentional edge sharpening when coating complex geometries (see Fig. 2 and 3).

Optical edge surveillance demonstrated that edge radius can be drastically reduced almost independent of the initial cutting edge radius by means of the coating process engineered at the Fraunhofer IWS (Fig. 5).

Edge radius before and after coating



5

As a consequence, edge sharpness can be adjusted by the coating parameters for each application and no longer depends on the initial contour of the uncoated tool. It is also possible to use coatings of much greater thickness than before, since edge radius increases as a function of the layer thickness is no longer important.

1 View of a tool cutting edge
3 Edge of an uncoated (a) and a coated tool (b)

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