TOOL WEAR IN HIGH SPEED DIAMOND MILLING

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The rate of surface generation in high speed diamond milling ($v_c > 1$ km/min) can be even higher than in non-circular diamond turning [1]. Hence high speed raster milling bears the potential of outranking fast tool servo and slow slide servo turning in the generation of free-form surfaces. The crucial question, however, is whether the wear rate of the diamond tools is acceptable in high speed raster milling.

We have measured the flank wear land FWL and the tool tip radius $r_\varepsilon$ of pointed diamond knives used for milling of V-grooves as a function of cutting distance at ordinary cutting speed ($v_c = 0.4$ km/min) and at very high cutting speed ($4.0$ km/min). The experimental set-up is shown in Fig. 1. After equal cutting distances the machining of the grooves was interrupted for evaluating the geometry of the tool tip with an atomic force microscope [2], cf. Fig. 2. The experiments were performed with three different materials, i.e. brass CuZn39Pb3, electroless nickel and aluminum AlMg3.

![FIGURE 1. Flycutting of V-grooves with an included angle of 90° on a Nanotech 350 FG. The path of the flycutter is indicated in the lower right insert. Depth of the grooves: 200µm.](image)

![FIGURE 2. AFM images of a new (left) and a worn diamond tool (right) used for flycutting of V-grooves.](image)

![FIGURE 3a. Measured flank wear land FWL vs. cutting distance $L_c$ for electroless nickel (blue) and brass (orange).](image)

Figs. 3a and 3b show the measured flank wear land FWL and tool tip radius $r_\varepsilon$, resp., as a function of the cutting distance $L_c$ for electroless nickel and brass.
Both FWL and $r_\varepsilon$ increase approx. linearly with increasing cutting distance. Interestingly, flank wear is significantly smaller for the high cutting speed $v_c = 4.0$ km/min, although the material removal rate was 10 times higher. (The total volume removed was equal). Also, the wear rates (slopes in Fig. 3a) are smaller for the high cutting speed. The observed wear reduction is reflected in the increase of the tool tip radius, at least for electroless nickel (cf. Fig. 3b), which is an important result regarding the fabrication of micro prisms [3]. Another observation asking for an explanation is the wear rate obtained for aluminum, which is an order of magnitude higher than for brass and electroless nickel (cf. Fig. 4).

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**REFERENCES**

