New tool electrode materials for high precision sinking EDM

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Abstract

The machining process electrical discharge machining (EDM) is applied to manufacture high precision features into hard to cut materials like hardened steels, ceramics or high temperature alloys. The different applications lead to different limitations for recently applied EDM technologies. The machining of cavities with high aspect ratios results in process instabilities due to insufficient flushing conditions. In micro-machining the very short discharge durations lead to higher tool electrode wear compared to macro-machining. This work presents recent research activities focussing on the application of new tool electrode materials. Tool electrode materials with excellent electrical conductivity and thermal conductivity along with a high mechanical strength shall be applied in order to assure an efficient process with short production times and low tool electrode wear.

In µEDM the application of boron doped CVD-diamond showed processing results with low relative tool wear $\vartheta \leq 3$ %. These tool electrodes enabled the machining of thin cavities with a width $w \leq 0.08$ mm and aspect ratios $a \geq 10$. The investigation of different tungsten carbide-cobalt materials showed the influence of the cobalt content and grain size on material removal rate (MRR) and tool electrode wear. The grain size showed an ambiguous effect concerning the process results. In contrast to that, lower cobalt content leads to reduced MRR, whereas the level of tool wear remains at a similar level. The experimental studies showed a general suitability of tungsten carbide-cobalt tool electrodes for EDM-processing, where the MRR is comparable to commonly used tool electrode materials.

The application of additively manufactured tungsten carbide-cobalt tool electrodes was part of further investigations. The appropriate integration of flushing channels, even for complex tool electrode geometries, improves process conditions during EDM in a variety of applications, leading to a higher MRR and reduced tool wear compared to machining without flushing.