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Towards development of a novel online tool wear compensation method for dry micro-electrical discharge milling

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Micro-manufacturing technologies play a vital role in the manufacturing industry with several applications involving generation of products offering advantages such as compactness, multi-functional capabilities and lower cost. Among micro manufacturing processes, micro electrical discharge machining has become an established process for the generation of complex 3D micro components. Micro-EDM milling is the micro-EDM configuration, which provides the highest flexibility and shortest setup time [1]. During processing, because the discharges remove material also from tool electrode, the tool electrode changes its geometry thereby affecting the achievable part accuracy. Tool wear is the single most important factor limiting the manufacturing accuracy in the geometry of the workpiece in micro-EDM [2]. Currently, kerosene-based mineral oil is one of the important dielectric fluids in micro-EDM, however the fumes generated during the process are hazardous to the environment and the oil disposal poses a potential threat to the environment. The gas dielectric-based EDM technology (dry EDM) is a potential eco-friendly alternative to the liquid dielectric-based EDM process. An earlier comprehensive experimentation on assessment of productivity and machined surface quality in dry EDM of SS304 workpiece using copper tool electrode showed few important results related to tool wear [3]. One of the most striking feature that is observed in the dry EDM is the tool wear rate close to zero. A predominant deposition of molten and eroded work material on the tool electrode surface instead of tool wear was evident. Statistical analysis of the tool wear rate (TWR) shows that pressure of the gaseous dielectric (*P*) is significant at 90% confidence level. An analysis of surface topography of electrode surfaces shows the formation of black patches of carbon on tool electrode surfaces (layer of carbon), which reduces the tool electrode wear in dry EDM. The metallurgical characterization of deposited material on the tool electrode using EDAX analysis shows that the elements Iron (Fe), Chromium (Cr) and Nickel (Ni) in workpiece act as catalysts for diffusion of carbon. Currently, the EDM research group in DTU Mechanical is actively involved in development of a robust, reliable and real-time method for compensation of tool electrode wear in liquid dielectric micro-EDM milling process. Therefore, it is envisaged that an adaptation of the novel online tool wear compensation method with enhanced capabilities for dry micro-EDM process, would provide few additional advantages such as: i) lower magnitude of tool electrode wear and, ii) environmental friendliness.

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