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Novel design and characterisation of surface modification in wire electrical discharge machining using assisting electrodes

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Abstract

Electrode and dielectric materials have been extensively studied for surface modification using traditional electrical discharge machining and wire electrical discharge machining (WEDM). This paper develops a new WEDM surface modification process with assisting electrodes arranged in a stack order and target workpiece material which transfers the preferred alloy elements to the target surface. The process involves material migration from the upper and lower stack electrode materials to the sandwiched workpiece material when the wire reciprocally moves in the vertical direction at a proper feed rate. The designs of the machine tool and of the function of the discharge circuit are reported in detail. Experiments using statistical methods in fractional factorial (Taguchi L_9) and full factorial (4×3×3) are performed to identify the dominant factors for the developed surface alloying process. The effectiveness of the element transfer was verified with optimal parameters, such as the hardness of the workpiece material, the thickness of the sandwiched electrode materials, gap voltage, peak current, pulse on-time, pressure, and the flow rate of the dielectrics and flushing strategies. The surface integrity in terms of roughness, micro-hardness and the associated microstructure is also investigated to advance understanding of the underlying mechanism of the WEDM surface alloying.