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PRODUCTIVITY OF ELECTRICAL DISCHARGE MACHINING ALUMINA USING SNO ASSISTING POWDER*

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The issues of microtexturing of working surfaces of critical engineering products made of difficult-to-machine materials and composites, including those based on dielectric oxide and nitride ceramics, have been the subject of theoretical and experimental research by leading scientific groups. For the first time, a group of domestic scientists proposed a method for electrical discharge machining (EDM) of dielectric superhard materials in the mid-80s [1]. Since then, progress has been made in the field of surface modification of silicon nitride [2] and zirconium dioxide [3], while alumina remains a problematic material [4-5]. It is primarily due to the specific thermochemical properties of aluminum, which exhibits a high affinity for oxygen under normal conditions and forms dielectric compounds in the presence of hydrocarbons during the thermal decomposition of the oxide [6] such as Al_4C_3 (steady up to 1400 °C, but unstable to water, oxygen or hydrogen).

Using a nickel-chromium coating applied by the PVD method [7,8] with a thickness of 10 – 15 μm and a SnO suspension of various concentrations fed directly into the processing zone is proposed to solve the problem of alumina's low machinability. The nickel-chromium coating was chosen due to the known affinity of nickel for aluminum to form conductive bonds [9]. The band gap of optically white tin oxide determines the choice of this dielectric powder to assist electrical discharge machining of dielectric ceramics. An analysis of the processing performance of alumina using techniques was carried out in an aqueous medium in the range of electric current pulse lengths of 1.0 – 2.7 μs and a pulse frequency of 10 – 30 kHz.

A slot (kerf) in the dielectric ceramics to a depth of 49.74 – 95.20 µm was formed using a brass wire tool. Spectroscopy and scanning electron microscopy demonstrated the diffusion of the auxiliary electrode and assisting powder materials in the form of secondary material on the ceramic sample surfaces, which is explained by the predominant binding of Zn of brass to oxides and its precipitation [10]. In addition, there was a significant increase in the material removal rate at a particle concentration of 150 g/l for pulse frequency 25 – 30 kHz. The experiments proved the effectiveness of the proposed combined approach in machining alumina for a depth of up to 95.20 µm using a brass wire tool. The maximum material removal rate of 0.001 mm³/s and the minimum interelectrode gap correspond to stable processing and uniform density of electric discharges. It was achieved at an electric current pulse frequency of 30 kHz, the SnO-suspension concentration (granulometry - ⌾ 10 µm) 150 g/l water-based when using an assisted coating electrode of 10 – 15 µm. The obtained data indicate that the developed method is superior to analogs by 2.12 times.

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