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MATHEMATICAL MODELLING AND OPTIMISATION OF SELECTED SERVICE PROPERTIES OF LASER-MODIFIED ELECTROSPARK COATINGS

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The origin of electrical discharge machining (EDM) dates back to 1770 when English scientist Joseph Priestly discovered the erosive effect of electrical discharges. During the 1930s, attempts were made for the first time to machine metals and diamonds with electrical discharges. Erosion was caused by intermittent arc discharges occuring in air between the tool electrode and workpiece connected to a DC power supply. These processes were not very precise due to overheating of the machining area and may be defined as „arc machining" rather than „spark machining" [1].

By controlling polarity, it is possible to remove or replace material. The process of material removal involving erosion of the stock subjected to electric discharges is called electrical discharge machining (EDM). The surface layer forming on the product improves its operational properties [2-4].

The process of material growth resulting from electroerosion is known as electrospark alloying (ESA) or electrospark deposition (ESD). The erosion of the anode and the spark discharges between the electrodes result in the formation of a surface layer with properties different from those of the base material [5, 6].

The processes of coating formation on metal parts including electrospark deposition involve mass and energy transport accompanied by chemical, electrochemical and electrothermal reactions [6]. Today, different electro-spark deposition techniques are used; they are suitable for coating formation and surface microgeometry formation [7-9].

The study examined the impact of laser machining on selected parameters (microgeometry, microhardness and coating melt zone) of electrospark deposited Mo coatings. In investigations, molybdenum wire ϕ1 mm in diameter was used as the coating material that was electrospark – deposited on C45 steel specimens, which were subsequently melted with a laser beam. Investigations included an experiment based on the static, determined, multi-factor, rotatable design with PS/DS-λ repetitions.

Statistical dependences (Ra, Rv, Rp, SPP as functions of laser machining parameters) obtained from the analysis of investigations performed in accordance with the designed experiment are significant and show a high correlation. They allow forecasting laser machining effects. An exception is inadequate mathematical model (moderate correlation) describing microhardness ($HV_{0.04}$) dependence on laser machining parameters (i.e. beam power - P and the specimen movement rate - V).

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