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Predicting the efficiency of high-speed diamond grinding of superhard materials using 3D models of macro- and micro-levels

ABSTRACT. The relevance of solving the title problem is dictated by the high labour intensity and low productivity of the process of diamond grinding of superhard materials (SHM) based on synthetic diamond (SD). The high consumption of expensive diamond grains leads to a high cost of processing. Reliability and quality of the SHM tool must be improved, without which it is impossible to use it in automated production. Creation and use of expert systems is a conceptual stage of technology development. At the heart of problem-solving in a particular subject area lies the principle of reproducing the knowledge of experienced specialists (experts). On the base of experience, experts analyse the situation and recognize the most useful information, optimize decision-making, abandon dead ends. The efficiency of the process of high-speed diamond grinding of SHM is largely determined by the properties of the tool (especially its diamond layer), which are established at the manufacturing (sintering) stage. The necessary properties of the tool, the sintering modes of the diamond layer, and the processing modes were studied on the basis of dynamic 3D models built at macro- and micro-levels. As a result of model experiments carried out using the finite-element method (FEM), it seemed possible to obtain a mathematical model (function) that approximately characterizes the sintering process of the diamond layer of a wheel for high-speed grinding in the expected range of variation of independent factors. At the stage of manufacturing of diamond wheels for high-speed grinding, the output indicator for the function is the reduced stresses in the "diamond grain–coating–metal phase binder" system. When studying the process of high-speed grinding, the output indicator for the function is the productivity and specific consumption of diamond grains in the working layer of the diamond wheel, calculated using dynamic 3D modeling at the micro-level. A 3D micro-level extended system "diamond grain–coating–metal phase binder–processed material" is considered.