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The Faculty of Mechanical Engineering and Aeronautics
Department of Manufacturing Techniques and Automation

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Summary of the doctoral dissertation

Title: Formation of surface integrity in the plunge grinding of cylindrical surfaces of EI961 and AMS6308 steel components after thermochemical treatment.

The doctoral dissertation concerns the analysis and modelling of the plunge-grinding process of cylindrical surfaces in aerospace components made of EI961 steel after gas nitriding and AMS6308 steel after carburizing. The main objective of the work was to determine the relationships between the grinding conditions, including the characteristics of the grinding wheel, the dressing method and the cutting parameters, and the condition of the technological surface layer. The surface layer was analyzed in terms of the micro-geometrical structure of the surface, the 2D and 3D roughness parameters, the profiles of the grinding forces and the morphology of the microstructure.

In the first part of the dissertation, a review of the current state of knowledge was carried out and key production challenges present in industrial practice were identified. These challenges included instability of grinding parameters, variations in the formation of the surface layer, difficulties in ensuring process repeatability and the risk of micro-defects such as white-layer formation and microcracking. A detailed research plan was developed. It included measurements of the components of grinding forces (F_t and F_n), assessment of grinding wheel wear, 2D and 3D surface topography measurements, microscopic analysis of microstructures and detection of grinding burns. An important part of the research was the assessment of how the type of grinding wheel affects the development of the active surface of the wheel and the stability of the grinding process. The study compared traditional fused alumina wheels with modern microcrystalline alumina wheels and revealed clear differences in cutting force dynamics and wear behavior. The analyses led to the development of mathematical models describing the relationships between the grinding parameters and the resulting condition of the surface layer. The results confirmed that the correct selection of machining parameters together with appropriate wheel conditioning makes it possible to avoid the formation of the white layer and uncontrolled changes in the microstructure. The dissertation provides cognitive value by expanding the knowledge of the mechanics of grinding materials strengthened by thermochemical treatment. It also offers practical value, as the results have been implemented in the aerospace industry. The findings create a foundation for further research on the modelling and optimization of the grinding process and on the design of manufacturing procedures that minimize the formation of micro-defects in the surface layer.

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