

Researches on the influence of parameters and conditions of the mechanical cutting process on local changes in the properties of lasere treated electrical sheets

Summary

The dissertation consists of seven chapters. The first chapter presents an introduction to the subject matter under consideration, the genesis of the work and a brief description of the processes of cutting metal materials. The second chapter contains an analysis of the state of the art, which describes the characteristic features of electrical sheets, methods of their processing using cutting techniques, a description of phenomena occurring during the process and characteristic technological parameters, current research problems analyzed by other authors dealing with cutting processes and current methods of modeling this process. It also presents the purpose, hypothesis and scope of the work. The third chapter contains a description of test stands and the results of research on material characteristics of the analyzed type of electrotechnical laser steel. The fourth chapter presents a description of the mathematical and simulation model of the cutting process. The updated Lagrange description was used to describe the phenomena at a typical incremental step, assuming a step-rotational coordinate system. The cutting process was analyzed as a geometrically and physically nonlinear boundary-start problem with boundary conditions that are unknown in the tool-workpiece contact area. The fifth chapter contains the results of simulation tests with the assumption of the occurrence of spatial stress states in the material for both plane strain states and spatial states. Using the developed FEM models, the influence of the main technological parameters and conditions of the cutting process on the values of equivalent stresses in the cutting zone, the width of the deformed zone, the distribution of the stress triaxiality coefficient and the formation of defects in the cut edge were determined. The sixth chapter contains a description of the stands for experimental tests of the cutting process, the plan of proper tests and the results along with the validation of numerical models. The results of the research were analyzed with the use of microscopes in order to observe in detail the characteristic features of the cut surface, such as: burr height, width of the slip fracture, condition of the insulating coating. The results were statistically processed to obtain models in the form of a regression function. Selected magnetic properties of the sheet metal after the cutting process were tested for the adopted processing parameters. In the final stage of the chapter, a multi-criteria optimization task was formulated and its solution for the cutting process of the analyzed electrotechnical laser treated sheet was presented. Chapter seven presents conclusions confirming the truth of the hypothesis, as well as cognitive and utilitarian conclusions as well as concerning the directions of further scientific and research work. The results of the author's own research presented in the dissertation are of both application and research character. They make it possible to correctly select the quantities deciding about the quality of the product depending on the technological conditions of cutting or to determine the optimal conditions of the process.