Abstract

This dissertation addresses issues related to research of the new group of gradient tool materials developed by means of the powder metallurgy method. In this method, the subsequent layers of mixtures of different-composition powders are passed through a closed die, and then sintered. The materials have been obtained from the mixture of tungsten carbide and cobalt powders. The analysis involves four-layer samples, where the subsequent transient layers were formed from the surface layer to the base layer. The volume fraction of the carbide hard phase in the transient layers decreased successively (surface layer 97%WC+3%Co; base layer 91%WC+9%Co). The analyses of the sintered gradient tool materials include structural analysis with scanning and transmission electron microscopes; X-ray microanalysis as well as density, hardness, porosity, abrasive wear and stress level K_{IC} tests. The results of the analysis show it is possible to obtain sintered gradient tool materials WC-Co of the desired structure and properties by means of the new powder metallurgy method. It has been established that the new sintered gradient tool materials WC-Co consist of the tungsten carbide phase WC and cobalt matrix. The cobalt matrix fills the space between WC grains, often as a thin layer between the vicinal tungsten carbide grains. Observation of thin films structures has revealed many net defects in the tungsten carbide grains, especially dislocation. It has been determined that the desired structure of material is obtained due to sintering in 1460˚C for 30 minutes.

This dissertation also uses the finite-element method to present modeling strain and stress patterns with reference to the temperature of sintering and tool operating conditions. On the basis of the model developed it has been established that thanks to the properly operated technological processes, it will be possible to produce compressive stresses in the surface layer, which means the material resistance to forming and propagation of cracks will increase.