Nanostructured surfaces

Obtaining nanostructured carbide-steels by spark plasma sintering of blend after high voltage discharge processing

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Industry nowadays is in need of constructional materials with high functional (such as wear-resistance) and physical-mechanical properties (hardness and strength). These characteristics provide the reliability of parts, assemblies, mechanisms. Creation of heterogeneous structure in material, which is a ductile matrix with solid inclusions, is a necessary condition for ensuring wear-resistance. Metal-matrix composites, particularly carbide-steels, obtained by methods of powder metallurgy, belong to heterogeneous materials.

The aim of present work is to research the processes of powder blend dispersion, solid phases synthesis during elemental powders mixtures treatment with high voltage electric discharge (HVED) in kerosene and to research structure formation of Fe–Ti–C–(B) system composite during spark plasma sintering for obtainment of nanostructured carbide-steels with increased functional properties.

Necessary conditions for powders dispersion and hardening nanosized phases synthesis during HVED treatment are established theoretically. Regularities of HVED treatment of powder mixtures parameters impact on a change in their dispersion and phase composition are experimentally found.

Possible mechanism of carbide phase synthesis during powders HVED treatment in hydrocarbon liquid is proposed. It includes destruction of hydrocarbon chains with synthesis of active nanocarbon of different allotropic forms, atoms of which are capable of implantation in metal’s crystal grid at conditions of high temperature and pressure, leading to formation of carbides. The dependence of the synthesized nanocarbon amount on integral processing energy is established, allowing to provide conditions for the synthesis of compounds of stoichiometric carbide.

Conducted theoretical and experimental studies lead to development of technological scheme for production of nanostructured materials with high wear resistance, hardness and strength. Obtained Fe–Ti–C system carbide-steel has hardness up to 56 HRC, flexural strength up to 1050 MPa and wear resistance under abrasive friction that is up to 20 % higher than of P6M5 high speed steel. Obtained Fe–Ti–B–C system composite has hardness up to 68 HRC, flexural strength up to 1350 MPa and wear resistance under abrasive friction that is up to 25 % higher than of P6M5 high speed steel.