MECHANOACTIVATED SYNTHESIS OF COMPOSITES FROM IRON TITANIDE – CARBON MIXTURES*

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Iron-based composite materials are widely used for parts operating under severe conditions of friction and abrasive wear. The structure of such materials consists of a steel matrix with uniformly distributed dispersed inclusions of refractory compounds. Cubical titanium carbide is most often used as a hardening phase in these composites, the inclusions of which have a rounded shape. That composites are widely used for the manufacture of cutting tools, dies, measuring tools, structural material for jaws, rollers, inserts and gears operating under dry friction conditions and exposure to aggressive environments.

Iron matrix composites with carbide hardening are obtained either by sintering (carbide steels) or by more complex ways by compaction of titanium carbide and iron (steels) powder mixtures. The most promising method in technological and economical way is self-propagating high-temperature synthesis (SHS).

To ensure a uniform volume distribution of carbide particles, powder mixtures are subjected to long-term mixing or treatment in planetary mills. However, for submicron and nano-sized carbide, it is not possible to achieve a uniform distribution of carbide particles due to agglomeration process.

Our research proposes an original production method of iron-matrix composites strengthened with submicron titanium carbide particles. The method consists of in-situ synthesis of titanium carbide in reaction mixtures of iron titanide with carbon (soot), subjected to preliminary intensive treatment in a planetary ball mill. As a result of the reaction $Fe_2Ti + C \rightarrow TiC + 2{\cdot}Fe$, iron is reduced from titanide by carbon to form an iron-matrix composite reinforced with submicron carbide particles. To get a large specific reaction surface of solid reagents (iron titanide and carbon), intensive modes of treatment in planetary mill are required where heating and adhesion of powders to the balls and jar walls occurs.

Further development of the proposed method for in-situ synthesis of titanium carbide in mixtures with iron titanide involves the application of liquid hydrocarbons (in our case, toluene) instead of solid carbon. It has been established [2, 3] that if carbide-forming metal powders are processed in hydrocarbon liquids, hydrocarbon molecules are degrading and so the freed carbon reacts with the metal. The application of liquid hydrocarbons instead of solid carbon has a double positive effect: it prevents powder adhesion and increases the reaction surface during in-situ synthesis of titanium carbide.

Our report presents the research results of iron-matrix composites with carbide strengthening, obtained by the method described above, including additional subsequent heat treatment. Structural studies were carried out using X-ray diffraction analysis, optical and scanning electron microscopy with local electron probe elemental analysis (EPMA). It is shown that composites consist of alpha-iron matrix with uniformly distributed titanium carbide inclusions with less than 1 μm in size.

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