FEATURES OF THE BEHAVIOR OF TI-SI POWDER MATERIALS DURING SINTERING

Korosteleva E.N. [a], *Korzhova V.V.*

Institute of Strength Physics and Materials Science SB RAS, Tomsk, Russia
[a]elenak@ispms.tsc.ru

In the last decade, technologies associated with the formation of complex multilevel heterogeneous and heterophase structures in materials and structures have received intensive development. Studies show that such structures provide the most preferred functional properties. Multicomponent metal-matrix composites (MMC), which include refractory compounds such as carbides, silicides, borides, etc., cause the greatest interest. Their use provides high physico-mechanical, chemical and tribological properties. Using different methods of obtaining the MMC from the same elements, it is possible to form a structure of a composite material with different characteristics. As a rule, powder mixtures of titanium, silicon, boron, and carbon are used as precursors of the metal-matrix composite. This can be either a mixture of elemental (monocomponent) powders, or a mixture with powders of ready-made refractory compounds. Among the technological processes of powder metallurgy, the self-propagating high-temperature synthesis (SHS) of multicomponent powder mixtures has received the widest use. As a result of SHS, a metal matrix structure can be formed with refractory solid phases formed directly in the synthesis process. The main condition in this case is the concentration of components, which provides exothermic reactions for the formation of simple or complex compounds (carbides, borides, silicides, intermetallic compounds) depending on the selected elemental composition of the powder mixture.

Production of metal-matrix composites based on titanium-refractory element systems from among Si, C or B by traditional sintering from mixtures of elemental powders comes up against difficulties associated with large volume growth due to the formation of a rigid framework from their compounds accompanied by significant heat generation. In order to reduce volumetric growth and obtain an acceptable porosity of the sintered material, the powder of the second component can be replaced by the powder of its refractory compound Ti_mA_n, which will make it possible to go from uncontrolled liquid-phase sintering to solid-phase sintering.

Additional interest in the presented materials is caused by the prospect of using them in additive technologies. In this case, a number of questions arise related to the behavior of metal matrix compositions under conditions of additional thermal processes (various types of surfacing, sintering, etc.), including the question of the stability or degree of transformation of a heterogeneous structure under such external influence.

The use of hardening additives in mixtures of powders or the synthesis of metal matrix structure directly in the process of product formation face additional problems that can be associated with a number of physicochemical characteristics of materials (wettability, different melting points and coefficients of thermal expansion, etc.). The use of synthesized composite powders with an already formed structure instead of mechanical mixtures makes it possible to eliminate segregation (separation) of powder components. At the same time, the microstructure and phase composition of the composite powder upon thermal exposure during the fusion process may change significantly. From the point of view of the additive production of products and parts, the process of layer-by-layer melting or “sintering” of composite powder materials plays an important role. In connection with this, it is of interest to study the behavior of metal-matrix powder composites under vacuum sintering conditions for various combinations of components.