EFFECT OF ALLOYING ON STRUCTURE AND PROPERTIES OF PARTICLE-REINFORCED ALUMINUM MATRIX COMPOSITES Al/TiC PRODUCED BY SHS IN ALUMINUM MELT[1]

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Aluminum matrix composites (AMCs), discretely reinforced with ceramic particles, are the most widely used because they have isotropic properties and are produced by more simple and cheap technology compared with fibrous and layered AMCs [1, 2]. In recent years, much attention is paid to the use of titanium carbide (TiC) as a reinforcing phase, because the particles of TiC can give to AMCs a complex of properties, surpassing all other discretely reinforced AMCs [3]. This is because TiC possesses the FCC crystal lattice, coincident with the α-Al crystal lattice with the closest size, higher strength, hardness, thermodynamic stability. Both methods of powder metallurgy with initial matrix aluminum in the form of a powder and casting methods with initial matrix aluminum in the form of a melt are applicable for the fabrication of Al/TiC composites. A significant place among them is occupied by methods based on the use of the process of self-propagating high-temperature synthesis (SHS) which gives such distinctive features as ease of performance and high efficiency at low energy consumption. SHS methods belong to in-situ methods, when the reinforcing particles, synthesized in the matrix, have clean uncontaminated surface, which is important to ensure strong adhesion with the matrix, they are thermodynamically stable and do not enter into chemical reactions with the matrix, they can have a smaller size and more uniform distribution in the matrix [3]. More development was given to casting methods of in-situ producing AMCs with carrying out the combustion synthesis of reinforcing phase TiC from elemental Ti and C powders (and sometimes Al) in the aluminum melt, which are characterized by simple equipment, the possibility of producing castings of more complex shapes and large dimensions [3]. The improvement of casting SHS methods goes in two directions: (i) obtaining a nanoscale TiC reinforcing phase with the most uniform distribution of TiC particles in the aluminum matrix and (ii) alloying the aluminum matrix with various elements: Cu, Mg, Zn, Si, Sn, Mo [3-6].

The aim of this work was to study the influence of alloying elements of Cu and Mn on the structure and properties of promising composite Al/10%TiC (hereinafter wt. %) fabricated by SHS of reinforcing phase TiC in the aluminum melt. This study is a continuation of our studies on the possibility of obtaining a cast nanocomposite of Al-10%TiC based on the melt of pure aluminum [3].

The salt Na_2TiF_6 was added to the SHS charge (Ti+C) in amounts of 5-10% by weight. The charge portions of mass about 6-8 grams were wrapped in aluminum foil with a thickness of 50 – 100 μm and were introduced alternately in the melt of matrix alloy of Al-5%Cu or Al-5%Cu-2%Mn at 900°C. The following results were obtained.

1) Introduction into the Al melt of alloying additive of 5%Cu and addition of 10%Na_2TiF_6 salt to the SHS charge (Ti+C) allows obtaining nano - and ultrafine particles of TiC with a more uniform distribution over the body of Al-5%Cu matrix than in the case of unalloyed matrix. The structure of the cast composite (Al-5%Cu)/10%TiC is characterized by low TiC particle agglomeration along the grain boundaries.

2) Sequential introduction into Al melt of alloying additives of 5%Cu and 2%Mn, and addition of 5%Na_2TiF_6 to the SHS charge leads to the formation of nano - and ultrafine particles of TiC which are uniformly distributed over the body of (Al-5%Cu-2%Mn)/10%TiC composite.

3) The alloying of aluminum matrix composites Al/10%TiC with Cu (5%) and Mn (2%) allowed us to achieve almost double strengthening (the ultimate tensile strength of 208 MPa) while maintaining a sufficiently high level of ductility (the elongation of 6%), that confirms the prospects of using alloyed AMCs of Al/TiC system as advanced engineering materials with improved mechanical properties.

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[1] This work was executed at financial support of RFBR under the project No. 17-48-630695.