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Thermodynamic simulation of the V-Al-N-C master alloy aluminothermic smelting

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Abstract

For microalloying of titanium with nitrogen and carbon, the V-Al-N-C complex master alloy is used. One of the main requirements presented by consumers of this ligature to its composition is oxygen content of less than 0.1 % mass. The use of elemental carbon (graphite) in the mixture for out-of-furnace aluminothermic smelting of the V-Al-N-C master alloy promotes the formation of aluminum oxonitrides in the melt, which, in the process of forming the metal and slag phases, can be stored in the alloy as separate inclusions. Since carbon in the master alloy is present in the form of $V_2Al_{0.96}C_{1.1}$ carbide, it is advisable to replace graphite in the composition of the smelting mixture with an alternative precursor containing carbide of this composition. The paper presents the results of thermodynamic simulation of phase formation occurring in the process of V-Al-N-C master alloy smelting using various carbidizers. The equilibrium temperature dependences were obtained using the HSC Chemistry 6.12 software, the database of which was supplemented by the missing thermochemical characteristics of vanadium aluminides (VAl_3, V_5Al_8, V_3Al_2) and V_2AlC carbide borrowed from published sources. Thermodynamic models that take into account the formation of these intermetallic compounds adequately describe the processes that occur during the interaction of mixture components for the aluminothermic smelting of V-Al-N-C alloys. The predicted elemental and phase compositions of the V-Al-N-C model alloys are in a good agreement with the data of chemical, XRD and EMPA analyzes of samples of real alloys. Models that take into account the formation of V_2AlC carbide and vanadium aluminides are applicable for calculating the compositions and thermality of mixtures, as well as for predicting the V-Al-N-C alloys smelting products. From the point of view of thermodynamics, replacing graphite in a mixture of the V-Al-N-C master alloy smelting with a precursor alloy V(70)-Al(23)-C(7), carbon in which is represented as V_2AlC carbide and vanadium carbides V_2C and VC, will not affect the carbon distribution over it phase component and will not adversely affect the technological performance of the smelting.

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