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Physicochemical properties of ternary Fe-Si-Nb and Fe-Al-Nb metallic systems

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Abstract

The Russian Federation has a sufficient number of promising deposits of niobium raw materials which can satisfy the niobium and tantalum demands of Russian metallurgical enterprises for many decades. Ferroalloy technologists are faced with the difficult tasks of developing from various types of ore raw materials not only effective processes for its processing but also new acceptable rational compositions of niobium-containing ferroalloys. The chemical composition of niobium ferroalloy should, on the one hand, correspond to the product obtained by benefication (concentrate) and, on the other hand, satisfy the requirements of steelmakers for ferroalloys intended for microalloying niobium steel. To develop rational compositions of new niobium-containing ferroalloys in this work the physicochemical characteristics (which include crystallization temperature and density) of alloys containing 10-50% Nb, 10-40% Si, and 5-30% Al were studied.

Two-component Fe-Nb metal alloys have a rational crystallization onset temperature (˂1400 ° C) only when the niobium content is not more than 10%. To achieve rational crystallization onset temperatures it is necessary to use complex alloys with silicon and aluminum.

Studies have shown that a decrease in the crystallization onset temperature of complex niobium alloys occurs when the niobium content decreases with an increase in the concentration of silicon or aluminum. Three-component alloys Fe-Si-Nb and Fe-Al-Nb with a content of 15-20% Nb, 32-40 Si% or 12-30% Al belong to the category of low-melting ferroalloys.

To achieve rational density values light metals such as silicon or aluminum must be introduced into a two-component system. The studied three-component alloys with a content of 25-40% Si or 15-30% Al have rational density values both from the point of view of their production and application to the processing of steel melt.

The best physicochemical characteristics providing high service properties are possessed by complex niobium (15-20% Nb) FeNbSi alloys with 32-40% Si and FeNbAl with 15-30% Al which are recommended for widespread use in ladle microalloying of steels.

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