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Fig. 1. Effect of silicon on the solubility of oxygen at 1600°C in iron-chromium melts. Black points indicate the results of determining the oxygen concentration in an Fe–Cr–Ni alloy (10% Ni). The numbers by the points are the silicon concentrations: 1 –0% Si, 2 –0.2% Si, 3 –0.5% Si, 4 –1.5% Si

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Abstract

Full Text

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THE EFFECT OF SILICON ON THE SOLUBILITY OF OXYGEN IN MELTS OF IRON AND CHROMIUM

This communication presents the results of an experimental study of the effect of silicon (up to 1.5%) on the solubility of oxygen in liquid melts of iron and chromium at 1600°C.

The method of investigation was described earlier ([1], [2]). Attainment of equilibrium was recorded by the distinct appearance of an oxide phase on the surface of the liquid metal. After this, samples of the metal were taken and the composition of the latter was changed by introducing chromium and silicon into it. The results of the experimental determinations are presented in Fig. 1.

Fig. 1. Effect of silicon on the solubility of oxygen at 1600°C in iron-chromium melts. Black points indicate the results of determining the oxygen concentration in an Fe–Cr–Ni alloy (10% Ni). The numbers by the points are the silicon concentrations: 1 –0% Si, 2 –0.2% Si, 3 –0.5% Si, 4 –1.5% Si.

On the basis of the data in Fig. 1, the following conclusions may be drawn:

1. The experimentally determined solubility of oxygen in melts of iron and chromium agrees well with previously published data ([3], [4]).
2. The addition of nickel (10%) to melts of iron and chromium does not lead to a noticeable change in the solubility of oxygen. This indicates the possibility of estimating the limiting solubility of oxygen in stainless steels on the basis of studying its solubility in binary melts of iron and chromium.

The addition of nickel leads to a smooth change in the oxygen concentration when the ratio between iron and chromium is changed. Apparently, this is explained by a change in the structure of the oxides formed in the range where the chromium content changes from 3 to 10%. According to published data ([4]), at the indicated chromium concentrations, spinels with a distorted lattice are formed in the iron–chromium system.

3. The presence of silicon decreases the solubility of oxygen in melts of iron and chromium.

4. The presence of chromium leads to a substantial decrease in the deoxidizing capacity of silicon in melts of iron and chromium. Thus, at 18% Cr

and 0.80% Si in the alloy, despite a twofold decrease in the oxygen content, the residual oxygen concentration is 0.020%, as against 0.005% oxygen for iron with the same silicon content.

5. At a constant chromium content (more than 10% Cr), an increase in the silicon concentration is accompanied by a decrease in the deoxidizing capacity of the latter. At 18% Cr, the residual oxygen concentration at 1600°C, as a function of silicon content, is expressed by the equation: $\lg[\%O] = -0.40[\%\mathrm{Si}] - 1.38$.

6. In the range of silicon concentrations studied (0.2–1.5% Si), the equilibrium oxide phase appearing as a result of interaction of the gas mixture with the liquid metal consisted mainly of silica.

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CITED LITERATURE

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Note: Figure translations are in progress. See original paper for figures.