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SHIFT OF THE EUTECTIC POINT OF THE Fe – C SYSTEM IN SPHEROIDIZING MODIFICATION OF CAST IRON

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The effect of spheroidizing modifiers on the shift of the eutectic point and the decrease of the temperature of the eutectic transformation in modified cast iron can be evaluated on the basis of the fact that a similar effect on these characteristics is exerted by the application of an omnidirectional excess pressure to Fe – C alloy in catalytic synthesis of diamond. It should be noted that in practical spheroidizing modification of cast iron this effect is equivalent to the application of a 1-GPa excess pressure to the melt [1].

In the present work[2] we studied the microstructure of modified white cast iron (Fe – 3.76% C) melted in an IST-006 induction furnace from commercial iron and chemically pure graphite. At 1400°C the melt was modified by metallic magnesium in an amount of 0.5%. Specimens 15 mm in diameter and 100 mm long were poured into sand-and-clay molds. Taking into account that the effect of the modification is retained by the alloy with the chosen chemical composition for a short time, the interval between casting the specimens was 3 min.

A metallographic analysis has shown that all specimens formed the structure of white cast iron. The amount of pearlite in the structure of the specimens was determined by the linear method, and the results of the measurements were processed mathematically to determine the empirical sampling variance S^2, the empirical sampling standard S, the coefficient of variation of the sample v, and the confidence interval of scattering of statistical estimates with a confidence level of 0.95. The amount of pearlite in the structure was used to calculate by the rule of segments the change in the eutectic concentration of carbon $[C]_{eut}$ in the cast iron caused by the modifying process.

The results of the investigation (see Table 1) indicate that the shift of the eutectic point of the Fe – C system is observed not only in hardening modified "gray" cast iron graphitized in the first crystallization but also in modified white cast iron. Thus, this phenomenon can be treated as a common feature of spheroidizing modification of cast iron. It becomes possible to estimate the nature of this effect of modification. It is known [2, 3] that the position of the eutectic point in alloys of the eutectic type is determined by the kind of localization of valence electrons in the system. In the region of low carbon concentrations these electrons are predominantly localized at the cores of atoms of the matrix of the alloy (iron), and at an elevated carbon concentration their density changes so that the electrons in the eutectic alloy are maximally delocalized, whereas in the hypoeutectic region the density of the electrons increases in the cores of atoms of the second component (carbon). In this case the shift of the eutectic point and hence the redistribution of the valence electrons of carbon are caused by intensification of the chemical interaction of the Fe and C atoms in the Fe – C system, specifically, by increased carbon dissolution in the modified melt. On the whole, the results obtained confirm experimentally the concepts of [1, 4, 5] that relate the mechanism of spheroidizing modification of cast iron to changes in the kind of atomic interaction in the modified alloy.

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TABLE 1

State of alloy	S^2	S	Plt, %	v	P, %	$[C]_{eut}$, %
Before modification	28.11	5.3	24	0.22	2.1	4.3
Immediately after modification	79.26	8.9	46	0.19	3.4	5.2
3 min after modification	96.16	9.8	44	0.23	3.7	5.0
6 min after	64.17	8.0	42	0.19	3.1	4.9
9 min after	42.28	6.5	41	0.16	2.5	4.8
12 min after	29.13	5.4	38	0.14	2.2	4.7

Notation. S^2) empirical sampling variance; S) empirical sampling standard; Plt) amount of pearlite; v) coefficient of variation of the sample; P) confidence interval of scattering of statistical estimates with the chosen confidence level equal to 0.95; $[C]_{eut}$) eutectic concentration of carbon.

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