UDC 669.111.2:669.162.624

V. Ivanov, doctoral candidate, c.t.s.

FEATURE OF SHAPING GRAPHITE IN SYNTHETIC CAST IRON AT VACUUM MELTING

Zaporiz'kij national technical university

A study of graphite forming in synthetic iron during vacuum melting was conducted. It is established that cast iron vacuum melting contributes its graphitization, has a positive action on the graphite phase, improving the shape and distribution of graphite in the metallic matrix. The saturation process of cast iron by carbon during vacuum melting is accompanied by intensive deoxidation and the CO development, which, together with low content of harmful impurities (sulfur, oxygen etc.) and high rate of crystallization, contributes to changes in the graphite phase morphology from lamellar to spherical.

Keywords: synthetic cast iron, graphite shape, vacuum, carbon, gas bubbles

Entry. The processes of melting, equalizing or pouring of cast-iron in a vacuum while did not find wide distribution in practice of castings workshops, without regard to the positive effect of such treatment: diminishing of content gases and inclination to blanching, increase of physical and mechanical properties and etc. The special personal interest is caused possibility of change here of morphology of graphite phase from lamellar through vermicular to the spherical form even without application of the special additions [1]. Therefore research of forming of graphite in cast-irons which smelt in vacuum furnaces with application materials of charge with the least of harmful admixtures is actual.

Review of literature and raising of task. One of repressing hypotheses of formation of focis of crystallization of graphite in cast-irons there is a heterogeneous theory of graphitization on non-metal disseminations. But results of research of alloys *Fe-C-Si* of high-purity, that were smelted in a vacuum eliminated possibility of heterogeneous formation of graphite disseminations in cast-irons [2,3]. Analogical results were got in more early researches [4]. It is shown that with cleaning of fusion there is a transition from lamellar to spherical morphology of graphite.

Purpose and task. Influence of vacuum on morphology of graphite disseminations is investigated in work and an attempt to explain such forming of graphite is pulled out. For the removal of influence of additional factors of research execute on synthetic cast-iron with the diminished quantity of harmful admixtures (phosphorus and sulphur) comparatively with industrial cast-irons.

Materials and methods of researches. As materials of charge for the making of synthetic cast-iron we used a littleash crucible graphite and specially metallic preforms as cylinders by diameter a 30 mm and in high 20 mm from powder of iron. Melting was executed in a high-frequency induction vacuum furnace of ОКБ-869 in alundum crucibless by diameter a 35 mm and in high 100 mm.

Base chemical composition of alloy (masses. part, %): 0.05 *C*; 0.05 *Si*; 0.04 *Mn*; 0.012 *P*; 0.005 *S*. The content of carbon was changed from 0.05 to 5.0 % by means of addition of littleash graphite (factions - 0.1-0.2 mm) with the purpose of making a hypoeutectic (3.5 % *C*), eutecticum (4.3 % *C*) and hypereutectic (5 % *C*)

cast-irons. A fourth variant of alloy was without additions and served as a control sample, in which set a platinum-platinumrhodium thermocouple, connected to the electronic potentiometer.

After melting of charge and achievement of temperature a metal 1450 °C alloys are equalizates 5 minutes and by means of the special mechanism a graphite block was destroyed from the area of inductor and cooled together with alundum crucibless under a vacuum to the room temperature.

The structure of cast-iron was investigated on the metallography microscopes of MIM-8, «*Zeiss Axiovert* 200 *MAT*». The estimation of structure of the experienced cast-irons was executed accordingly SOST 3443-87.

Results of researches. As evidently, in all samples cast-iron was got with a lamellar graphite. There are look a characteristic set hypoeutectic, eutecticum and hypereutectic cast-irones with different morphology of graphite. At hypoeutectic synthetic cast-iron look a mainly interdendritic graphite with the negligible quantity of eutecticum graphite. Almost fully the second sample had an eutecticum graphite. At hypereutectic cast-iron we looked the primary most large disseminations of graphite and formations of eutecticum graphite.

Discussion. Spherical disseminations appearance of which it is possible it was to expect almost were not educed in pre-production samples. It is sometimes possible it was to look single compact disseminations only. Probably it can be bound to the insufficient cleanness of charge materials, by a presence far of sulphur, phosphorus and, especially, oxygen. Except for that, how it was already marked, for formation of spherical graphite in cast-iron it is necessary to adhere to also high-rate of cooling.

During melting there were processes which caused the special personal interest and need additional elucidation. During melting of metal in a vacuum and presence graphite carburizator there was the intensive desoxydating of metal. The process of desoxydating of metal took place very vigorously and the more so, than greater quantity of graphite was in crucible.

Separate single spherical disseminations of graphite were educed, and also looked unfilled a graphite spherical shells. Similar глобулі were found other researchers, but reason of their appearance is not found [5]. In our view, it mediated can to confirm a hypothesis about formation of spherical disseminations in the bubbles of CO gas [6]. Such theory appeared either from the first in forming of spherical graphite [7,8] but it is had much as supporters so opponents.

Thus, results, making in work, confirmed possibility of making of spherical disseminations of graphite during melting of cast-iron in a vacuum on clean materials of charge.

Conclusions. Smelting of cast-iron in a vacuum substantially changes morphology of its graphite phase. Diminishing of quantity of admixtures and, first of all, oxygen and sulphur creates conditions for unimpeded formation of graphite disseminations, increase of their sizes and improvement of distribution in the metallic matrix of cast-irons. During melting in the vacuum of synthetic cast-iron the process of satiation by a carbon is accompanied by the intensive desoxydating, that in combination with high-rate of cooling can entail possibility of treason of morphology of form of disseminations of graphite from lamellar to spherical. Possibility of

formation of spherical disseminations of graphite is confirmed also in the *CO* blubs during melting in a vacuum, where desoxydating ability of carbon grows sharply.

REFERENCE

1. **Skaland, T.** Nucleation mechanisms in ductile iron [Text] / T. Skaland // Proceedings of the AFS Cast Iron Inoculation Conference, Illinois, 2005. – Pp. 13-30.
2. **Dhindaw, B.** Nodular graphite formation in vacuum melted high purity Fe-C-Si alloys [Text] / B. Dhindaw, J. Verhoeven //Metallurgical Transactions A. – 1980. – Vol. 11, No 6. – Pp. 1049-1057.
3. **Dhindaw, B.** Inverse chill and nodular graphite formation in synthetic cast irons melted and cast under vacuum [Text] / B. Dhindaw, J. Verhoeven //Transactions of the Japan institute of metals. – 1983. – Vol. 24, No. 2. – P. 71-80.
4. **Sadocha, J. P.** Mechanism of Graphite Spheroid Formation in Pure Fe-C-Si Alloys [Text] / J. P. Sadocha, J. E. Gruzleski // Proc. 2 nd Internat. Symposium on The Metallurgy of Cast Iron, 1976. – Pp. 443-459.
5. **Bhavsar, R. D.** Graphite Morphology in Vacuum-Treated Fe–C–Si Alloys [Text] / R. D. Bhavsar, M. Ghoreshy, R. W. Smith // Transactions of the Japan institute of metals. – 1987. – Vol. 28, No. 10. – Pp. 808-818.
6. **Theuwissen, K.** Etude de l'influence des impuretés et des éléments à l'état de traces sur les mécanismes de croissance du graphite dans les fontes : diss. – Toulouse, INPT, 2013. – Pp. 108-109.
7. **Ivanov, V.** Research of structure and formation of nodular graphite inclusions in ductile cast iron [Text] / V. Ivanov, V. Pirozhkova, V. Lunev // Eastern-European Journal of Enterprise Technologies. – 2016. – Vol. 3, No. 5 (81). – Pp. 31-36.
8. **Горшков, А. А.** Роль газов и паров в процесах модифицирования, демодифицирования и ремодифицирования при получении вісокопрочных чугунов с шаровидным графитом [Текст] / А. А. Горшков, Н. Г. Руденко // Газы в литом металле. – М. : Наука, 1964 . – С. 82-87.