UDC 621.74.045:669.162.275

I.A. Nebozhak[1], O.V. Derev'yanko[2], A.M. Verkhovliuk[1]

[1]Physico-Technological Institute of Metals and Alloys of the NAS of Ukraine, Kyiv

[2]Institute for Problems of Materials Science named after I.M. Frantsevych of the NAS of Ukraine, Kyiv

e-mails: nebozhak@ukr.net, alederevyanko@gmail.com, anatoliiverkhovliuk@gmail.com

RESEARCH OF THE POSSIBILITY OF OBTAINING A TWO-DIMENSIONAL CAST COMPOSITE MATERIAL OF "GRAY CAST IRON – STEEL – HEAT-RESISTANT CAST IRON" SYSTEM

In many branches of the Ukrainian economy the implementation of modern technological processes often requires metal products, the physical-mechanical and special properties of which would be heterogeneous in terms of surface or volume. This is caused, first of all, by the operating conditions of the part, its cost and some other factors.

Only products (castings) with differentiated and special properties (CDSP) meet such a complex of diverse, and in some cases, polar opposite requirements, since no single monolithic part can have all these properties at the same time. However, the production of CDSP by traditional methods is, in general, a complex, long and uneconomical process.

The production of CDSP by casting allows to avoid the specified disadvantages. The most promising method of manufacturing CDSP is the Lost-foam casting (LFC-process), since its main feature is the possibility of using a dispersed-filled gasifiable model (DFGM), which is not removed before filling the casting mold (CM) with metal, which determines the main advantages of this technological process in comparison with other casting methods. Physico-chemical and technological aspects of the LGM process [1], as well as modification of the melt of the matrix (iron-carbon alloys and non-ferrous metal alloys) into the "volume" of the CM by the LFC process [2–4], the production of cast reinforced structures (CRS) [5] and composite castings [4, 5] using CDSP [2–5] are described in numerous scientific works of foreign and Ukrainian researchers.

Based on these considerations, a sample of two-dimensional cast composite material (CCM) of the system [*СЧ300 – Ст3 – ЧХ3*] (system "*gray cast iron – steel – heat-resistant cast iron*") was obtained by the LFC process at the Physico-Technological Institute of Metals and Alloys of the NAS of Ukraine and its structure and mechanical properties were investigated. After cutting the composite casting into templates, it was visually established that the

diaphragm made of a 1-mm-thick galvanized sheet shrank a little, but was completely preserved.

The results of metallographic analysis (Fig. 1) and mechanical tests (Fig. 2) showed that the investigated cast sample has an optimal microstructure and nominal hardness of its functional layers. The presence of both sides of the diaphragm made of sheet steel of grade Ст3 DSTU 2651:2005, covered with a layer of *Zn* with a thickness of 6 ... 10 μm, blurred boundaries between adjacent phases and transition zones between functional layers with a thickness of 0.15 ... 0.18 mm indicates that the system "*СЧ300 – Ст3 – ЧХ3*" there is a diffusion relationship, and the graphical interpretation of the results of the conducted studies made it possible to find out that the hardness of the functional layers of the two-dimensional CCM system [*Ч300 – Ст3 – ЧХ3*] depends on the height of the composite casting.

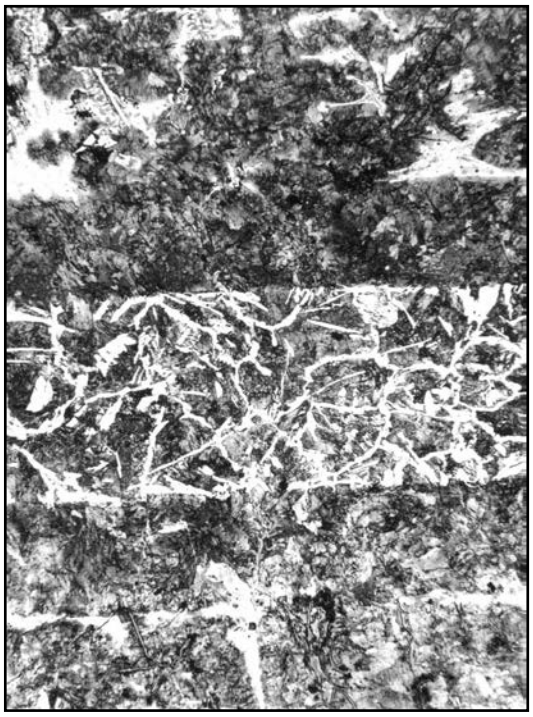

Figure 1 – Microstructure (×100) of two-dimensional CCM system [*СЧ300 – Ст3 – ЧХ3*]

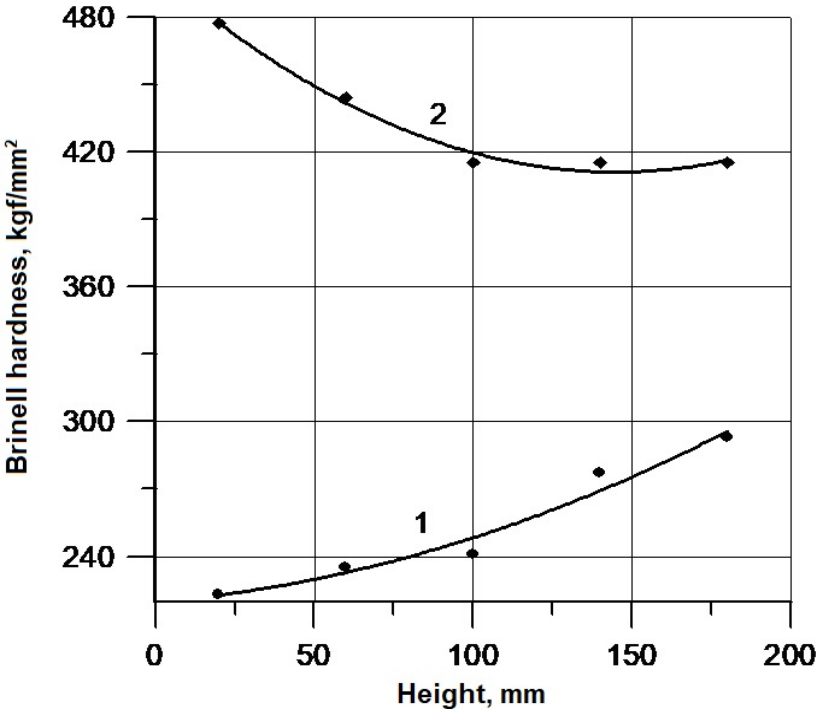

Figure 2 – Change in the hardness of the casting according to its height: 1 – gray cast iron of СЧ300 type; 2 – heat-resistant, wear-resistant cast iron of ЧХ3 type

This type of dependence (see Fig. 2) is explained by the fact that the hydrodynamics of the mold filling process and *grad T* circulation flows that occur in the "volume" of the casting mould (CM) affect the distribution of *Si* and *Cr* in the volume of the metal bath. Since *Si* is a graphitizing and *Cr* is a carbide-forming element, and their (layers) structure directly depends on their concentration in the material of each functional layer of the CCM system [*СЧ300 – Ст3 – ЧХ3*], when the matrix melt is fed into the "volume" of the CM directly, the

hardness of the gray cast iron grade СЧ300 DSTU 8833:2019 gradually increases, on the other hand, the hardness of chromium heat-resistant, wear-resistant cast iron grade ЧХ3 DSTU 8851:2019 gradually decreases along the height of the cast sample.

References

1. Shulyak V.S. Casting according to gasified models. St. Petersburg: SPA “Professional”, 2007. 408 p. [in Russian].

2. Kobayashi T., Maruyama T. Thermal decomposition behavior of expandable pattern including blended metal or alloy powder in evaporative pattern casting process of cast iron. Materials Transactions. 2003. Vol. 44, No 11. P. 2396–2403 [in English].

3. Nebozhak I.A., Sumenkova V.V., Shyns’ky O.I. Influence of technological parameters of the LFC-process on the efficiency of graphitizing modification of gray cast iron in the “volume” of the casting mold. Metal and casting of Ukraine. 2016. No. 5. P. 9–17 [in Russian].

4. Influence Of Microstructure Parameters Of [Al – FeCr] Cast Composite Material, Obtained In The “Volume” Of Foundry Mold Using Lost-Foam Casting Process, On Its Mechanical Characteristics / I.A. Nebozhak and others. Metal and Casting of Ukraine. 2023. Vol. 31, No 2 (333). P. 51–61 [in English].

5. Nebozhak I.A., Derev’yanko O.V., Verkhovliuk A.M. Research on the production of two-dimensional cast composite material of the system [СЧ300 – Ст3 – ЧХ3]. New materials and technologies in mechanical engineering: theses add. XV International science and technology conf. (April 27–28, 2023, Kyiv) / sub. general ed. Ph.D. R.V. Lutyi, Kyiv: KPI named after Igor Sikorskyi, 2023. P. 246–247 [in Ukrainian].