About computer calculation error of vermicular graphite share in microstructure of CGI

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Abstract. With each passing year, digital technologies are increasingly being used in industry, including for quality control of various materials. The article deals with the possibilities and problems of application of digital methods of microstructure control in CGI. The analysis of the main sources and grade of error of calculating the share of vermicular graphite in the microstructure of the CGI is made. The error remains unacceptably high for some material science tasks and requires further improvement.

1. Introduction

It is well known that graphite inclusions (GI), which are usually characterized by dimensional-topological parameters (size, shape, distribution and quantity), have a significant influence on the properties of cast iron. It is well known also that specific properties of CGI are achieved due to the presence of the so-called vermicular graphite (VG) particles in its structure. The particles in the microsection plane are elongated and arranged in random order as in grey cast iron, but at the same time they are shorter and thicker and have rounded edges [1], which provides unique properties of CGI.

Determination of microstructure characteristics of CGI in Russia is regulated by GOST 3443-87, which defines only three parameters of vermicular graphite - its form, distribution and share - by the method of comparative analysis of real microstructures with standart microstructures [2].

2. Body text

Domestic standard GOST 3443-78 was developed more than 30 years ago and obviously does not meet modern requirements of material science and mechanical engineering and requires updating. The analysis of world standards concerning requirements to cast iron with vermicular graphite, including those containing regulations for description of their microstructure, confirms it [3]. The analysis has shown that the first similar foreign standards was developed approximately at the same time as domestic standards - in the 1980s, but unlike domestic standards, they have been repeatedly updated to take into account constantly emerging new data on both properties and microstructure of CGI. Updating has been particularly active over the last 13 years. Initially, both in the USSR (Russia) and abroad, requirements to the properties and microstructure of a CGI were regulated by separate standards. However, in 2006 the first edition of the Specialized Complex International Standard on CGI "ISO 16112:2006 (E). Compacted (vermicular) graphite cast irons - Classification", which included both the requirements for the properties and microstructure of as well as a description of improved regulations for the control of the proportion of VG in the microstructure of a CGI. The standard was updated every 5 years, the last edition was released in
Modern metallographic complexes include automatic image analyzers (AAI), which allow simplifying considerably of metallurgists work, processing at the same time a large array of data and generating reports according to established requirements, etc. [8]. By the AAI it is possible to describe structural components with a larger set of parameters than form, share and distribution. In addition, the AAI always reproduces mathematical criteria assigned to determine the parameters in the same way, which allows to correctly comparing products manufactured by different technologies. Modern AAI are able to calculate a large number of geometric characteristics of objects, both proposed before the appearance of computers [9] and new, including: the area of the object, the percentage of the area occupied by the object from the area of the image, the perimeter of the object, the maximum and minimum of the Feret and Martin diameters, the coefficient of the region filling, the elongation, the average diameter, the shape parameters, the orientation angle, eccentricity, etc. [4].

However, as shown by the authors industrial experience of AAI application and as repeatedly noted by other researchers [5], the combination and form of structural components on metallographic images can provide a very complex picture, for the objective interpretation of which a computer program currently requires the metallurgist's help in control of available parameters [6]. In order to eliminate the human factor that allows for an unpredictable error in the analysis result, actual metallographic task of the CGI microstructure analysis is to develop a fully automatic mode without the need to control of AAI parameters by the metallurgist. To achieve this objective, it is necessary:

- to establish requirements to sharpness and resolution allowed on quality and quantity of defects of sample preparation, and also the area of micro surface (panorama size) of the analyzed image;
- to develop objective mathematical criteria for the most objective identification and division of graphite inclusions into types, providing the evaluation of morphology and geometric dimensions of each particle with the minimum error in the automatic without interference from the metallurgist.

3. Conclusions The tasks of developing methods for controlling structural components of materials based on modern geometric principles [7-12] in particular methods for estimating graphite phase parameters are still relevant and require urgent solutions. At the same time, the use of program complexes allows in some cases to significantly reduce the error of determining the VG share, which indicates the need for further development of these methods for assess the structure of CGI.

Acknowledgements The authors would like to thank Tatiana Alexandrovna Sivkova, SIAMS LLC specialist, for her valuable comments and recommendations on this work.

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