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FRACTAL DIMENSION OF NON-METALLIC INCLUSIONS IN THE WELD METAL STRUCTURE

Solving the problem of metal structures with specified physical and mechanical properties diagnose is based on the classical triad "composition - structure - property" and requires the objective quantitative indicators introduction for numerically describe the structure geometric and statistical features, as well as reflect the structure formation processes in metal and associate them with quality characteristics. The modern approach to considering the described problem involves using the fractal structures theory from the standpoint of the closely related modern synergy science.

A number of studies have been conducted that confirm the metal fractal nature. First, the metal structure is self-similar - this is the main fractal property. Secondly, the structure parameters, such as the grain size calculation or non-metallic inclusions can be compared with the fractal dimension.

This work presents the study results concerning the relationship between the non-metallic inclusions content in the metal structure and the fractal dimension for the high-strength low-alloy steels welds.

The carrying out this work expediency is justified by the fact that, until now, there is no comprehensive understanding mechanisms for describe the factors that control the microstructures formation during phase transformations, especially in the electric arc

The real welds metals structure complexity is the main obstacle to the adequate models synthesis for structures computer-aided design and their properties prediction. Fractal formalism, in particular, structures fractal and multifractal parameterization, can in principle become the basis for choosing adequate real welds structures numerical models, necessary for structures computer design and their properties prediction.

The non-metallic inclusions influence can have a negative character and even is a serious danger, since the stress concentration can exceed the limit values for the material and the inclusion, therefore, can become a destruction focus. Therefore, we conducted studies to determine the possibility of estimating the non-metallic inclusions content in the welds metal using fractal analysis methods.

Research methodology**.**

Experiments were carried out on the welds metal samples which were obtained during 09G2 steel butt joints welding with Sv-08ГН2МА wire in an M21 shielding gas environment. In order to detect the different composition non-metallic inclusions effect on the welding bath liquid metal during welding, dispersed refractory compounds particles (> 500 μm) were introduced through the additive powder wire according to the method [1].

In order to carry out the work, a methodology was developed and implemented, which in general consists of three consecutively executed parts-stages [2]:

• The first part consists in obtaining two-dimensional microscopic images of the main weld joint zones and fracture zones using a JSM35CF camera-equipped scanning electron microscope (Japan) and preprocessing these images.

• The second part is devoted to the certain fractal characteristics computer calculation of the studied structures using special software.

• At the third, final stage, the obtained characteristics statistically reliable connections with mechanical properties were found.

The studied weld metal samples were prepared according to standard sample preparation procedures for metallographic analysis. The minimum image resolution was 300x300 pixels. The image pre-processing consisted in applying the images binarization procedure.

The selected binary image is then subjected to computer processing according to a specially developed algorithm, which ultimately allows to calculate the generalized Regny fractal dimensions spectrum and, in particular, the usual fractal dimension (Haudorf-Bezikovich) as a multifractal rough characteristic, its informational (D_1) and correlational (D_2) dimensions, as well as; the orderliness degree and homogeneity degree of the weld metal structure.

Conclusions**.** As a result of the conducted research, it is shown that the use of the fractal formalism for the inclusions analysis in weld metals allows:

• to obtain information about the metal structural state in numerical form (quantitatively assess the dispersion and fragmentation degree). The using welds initial characteristics according such computer modeling makes it possible to significantly improve the developed models quality;

• ultimately calculate the fractal dimension for the corresponding samples structures and obtain a complete picture of the structural components influence on the metal mechanical characteristics;

• in the future, the numerical modeling of the welding technology and the welding consumables composition influence on the weld metal mechanical properties, taking into account metal structural features.

At the same time, the actual involvement of fractal and multifractal parameterization acts as an comprehensive approach essential part to solving the problem of creating technological welding processes that provide a guaranteed weld metal properties level. The thermodynamic modeling of phases formation in the weld metal, these phases kinetic growth in welding conditions, shell be basing on fractal approach to the weld metal structure description and adequate methods of numerical assessment of its properties.

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ЗАСТОСУВАННЯ ТЕХНОЛОГІЇ ПЕРЕДРЕКРИСТАЛІЗАЦІЙНОЇ ТЕРМІЧНОЇ ОБРОБКИ ДЛЯ ПОЛІПШЕННЯ РЕЗУЛЬТАТІВ ПЛАЗМОВОГО НАПИЛЕННЯ

Існує цілий ряд методів покращення властивостей покриттів, які виконані розповсюдженим методом плазмового напилення. Треба згадати вибір матеріалів в тому числі нанорозмірних порошків для отримання шару напилення певної структури, застосування оптимальних режимів ведення процесу, вдосконалення існуючих та розробку нових високоефективних вузлів установок для напилення. Все це широко представлено в роботах [1, 2]. Є й інноваційні розробки, які стосуються застосування імпульсних методів впливу на процес плазмового напилення. Можна вказати і на деякі комбіновані, або комплексні техніко – технологічні рішення.

Окремо розглядаються інноваційні розробки, які стосуються передрекристалізаційної термічної обробки напиленого плазмою шару покриття в якості дієвого способу впливу на його деякі фізико-механічні характеристики. Насамперед це стосується твердості покриття