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INTERDISCIPLINARY TOPICS

About Iron Globules Formed at Cooling of Iron-Contained Plasma[1]

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Abstract—This paper is devoted to the investigation of iron globules that are formed during cooling of the iron–carbon–helium plasma and as a result of destruction of a natural ball lightning. Scanning electron microscopy, X-ray fluorescence, X-ray diffraction, and ferromagnetic resonance investigations were carried out. The magnetization values of the samplers were determined.

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1. INTRODUCTION

At present, products that are formed in plasma-chemical reactions attract great attention. Typical examples are papers devoted to substances that are synthesized upon cooling of carbon plasma, i.e., fullerenes and nanotubes [1]. It is known that the temperature and electron concentration are the main parameters that influence the synthesis of these carbon structures [2].

2. METHOD AND RESULTS

In this paper, we present some results of the investigation of globules that were formed

(1) during cooling of a helium plasma containing iron and carbon (G_p); and

(2) upon the destruction of a natural ball lightning (G_f).

The G_p globules were synthesized in a setup described in [3]; the G_f globules were found at the place

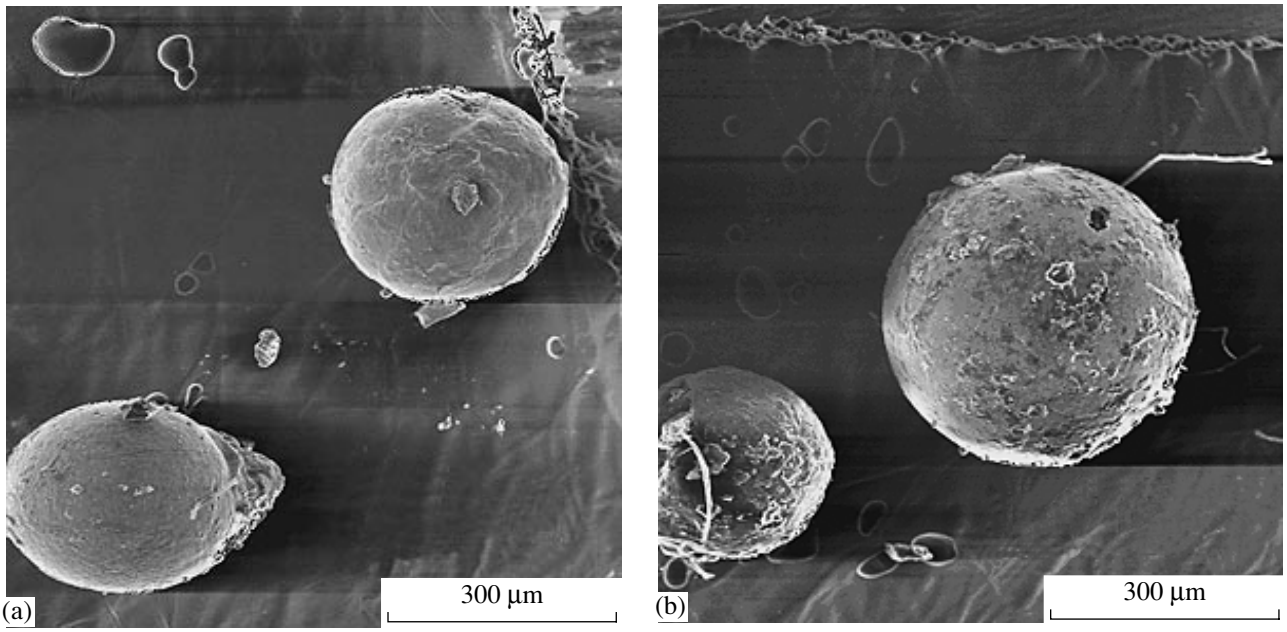

Fig. 1. SEM pictures of (a) G_f and (b) G_p globules.

[1]The text was submitted by the authors in English.

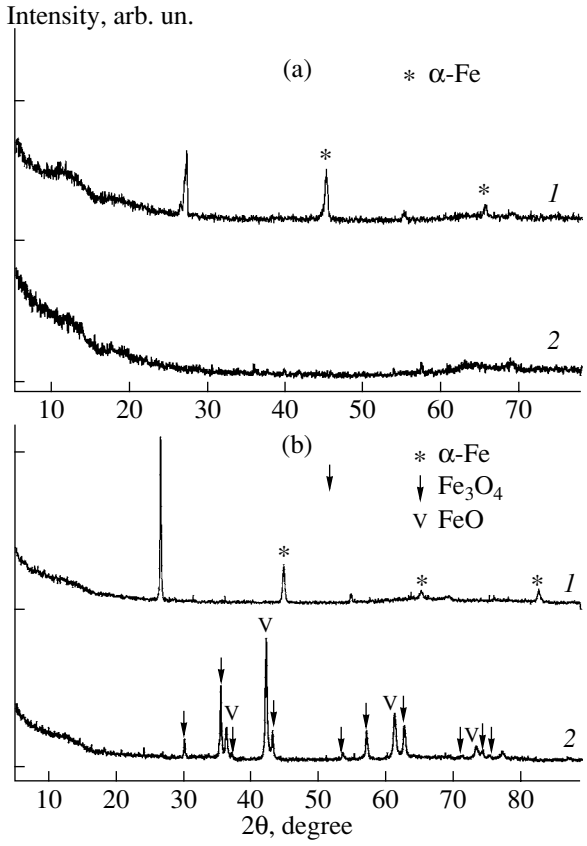

Fig. 2. X-ray diffraction patterns of (a) initial (*1*) G_p and (*2*) G_f globules; and (b) of powders of (*1*) G_p and (*2*) G_f globules. The unmarked peaks belong to graphite.

where a ball lightning was destroyed. The SEM pictures of G_p and G_f globules were obtained with the help of an REMMA-202M scanning electron microscope (Fig. 1). In spite of the similar shape, the objects were different: the G_f globules were hollow and the G_p globules were solid (without hollows).

The presence of iron atoms in both samples was registered by X-ray fluorescence analysis (using a SPARK-1 spectrometer). The initial globules and powder of it were investigated by X-ray diffraction (on a DRON-4 diffractometer) (Fig. 2). It was established that the G_p globules consist of an α-Fe phase with graphite additions. The G_f composition (unlike G_p) was changed after grinding. The powder of 80% Fe_3O_4 and 20% FeO was formed after grinding (Fig. 2). Hence, during grinding the hollow G_f globules were oxidized.

Ferromagnetic resonance showed the presence of α-Fe in the G_f sample. Perhaps this phase was not registered by X-ray powder diffraction method because of the small size of the α-Fe crystallites. The ferromagnetic resonance of the G_p samples showed that iron compounds are present beside the α-Fe phase. The presence of compounds with carbon is most probable.

By the method of vibration-sample magnetometry, the magnetization σ was determined to be σ_{G_p} = 114 emu/g and σ_{G_f} = 72 emu/g.

Taking into account that $\sigma_{\alpha\text{-Fe}}$ = 218 emu/g and $\sigma_{Fe_3O_4}$ = 84 emu/g [4] and that FeO and graphite are nonferromagnetic, and taking into consideration the ratio of these phases in the samples, we see that the measured σ_{G_p} and σ_{G_f} values fit the composition of the magnetic and nonmagnetic phases that was determined by X-ray diffraction. Therefore, it is possible to assume that the G_p globules consist of ~50% α-Fe and ~50% graphite, while the G_f globules consist of ~80% Fe_3O_4 and ~20% FeO.

3. CONCLUSIONS

Primary relative analysis of the products synthesized under conditions of cooling of both laboratory plasma and ball-lightning plasma were carried out. The results of investigations show that the products differ significantly. It was determined that at the destruction of a ball lightning, hollow amorphous globules were formed. A powder consisting of 80% Fe_3O_4 and 20% FeO was formed after grinding. In the laboratory plasma, solid globules consisting of α-Fe and graphite were created. Hence, it is possible to assume that upon the destruction of a ball lightning, the faster cooling of the plasma gas occurs in comparison with the cooling of a laboratory plasma.

ACKNOWLEDGMENTS

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