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STUDY OF RAPID COOLED ALLOY STRUCTURE $Fe_{61}Co_{10}Hf_{2.5}Zr_{2.5}Ti_2W_2B_{20}$

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Abstract

The paper presents the results of the study on the structure of the rapid cooled alloy for which an amorphous structure was obtained. The alloy to be tested is based on iron. Pre-treatment of the sample was carried out by the arcing of melt components in a protective atmosphere of argon. A rapid cooled alloy was produced by a liquid alloy casting method on a copper spinning roller. For this sample, structural studies were performed using a Mössbauer spectroscopy.

Keywords: *rapid cooled; iron based alloy, Mössbauer spectroscopy .*

Introduction

Amorphous alloys have been known for several decades but their structure is still not fully understood and well described as in the case of classical crystalline alloys. Last years brought many new research results on amorphous alloys with increasingly sophisticated properties and chemical composition [1-3]. Interest in materials with an amorphous structure increased significantly as their mass production began using liquid casting on a rotating cylinder. It turns out that slight changes in the chemical composition of the alloy can significantly affect the properties of the alloy produced [4]. Nowadays, new amorphous alloys are characterized with good properties and can economically compete with classic materials.

Fast-cooled iron-based alloys are characterized by good magnetic properties. The unique properties of amorphous alloys are due to their unique structure characterized by a lack of long range order. At the same time, in the structure of amorphous materials there is short-range ordering. The properties of amorphous materials are determined by the defects in their structure. Defects adopt a different form than in the classical crystalline materials, and often are in the form of free volumes and pseudo-dislocational dipoles. [5-6]. The effect on the alloy structure and magnetic properties is primarily because of its chemical composition and the thermal conditions in which it is produced. Amorphous alloys consist of transition metals and elements of different atomic radii. Admixtures of individual elements enhance the ability of the alloy to the glass transition or directly affect the magnetic properties. Thermal conditions determine the possibility of obtaining an amorphous state. n order to obtain an amorphous

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structure it is necessary to cool the molten alloy very quickly. The appropriate cooling speed causes blocking of the crystals formation and results in the formation of a amorphous structure [7-11]. Classic amorphous alloys are obtained at high cooling rates of the order 10^5 K/s, usually in the form of plates or ribbons. High cooling speed is difficult to obtain for large, bulk materials. This limits the maximum dimensions of the amorphous material obtained (thickness of the 100 µm order). Selecting the right chemical composition makes it possible to significantly reduce the speed required for cooling. Production of massive amorphous alloys is possible with a cooling rate of about 10^2 K/s [12].

Materials of amorphous structure are characterized by very good magnetic properties such as low core loss on demagnetization and high magnetizatic saturation. Good magnetic properties make amorphous materials often used in the electronics industry. The well-known use of materials with an amorphous structure is the production of magnetic cores successfully competing with classic materials. [5].

This paper presents studies on samples made of multi-component amorphous alloy $Fe_{61}Co_{10}Hf_{2.5}Zr_{2.5}Ti_2W_2B_{20}$.

Materials and experiment

Elements used for sample preparation are characterized by high purity. Sample composition was weighted on analytical balance. The purity of the elements and their careful weighing guarantee the desired chemical composition of the alloy with a very small margin of error. The ingot was melted using an arc furnace in a protective argon atmosphere. During the ingot melting a titanium ingot was also melted to ensure remove of residual oxygene for increased purity. Melting was repeated several times to obtain homogeneous structure. From the purified and crushed to the smaller pieces ingot, a rapidly cooled alloy was produced. The method of rapid cooling of the melt from a liquid state on a rotating copper wheel was used. The ingot was melted in a protective atmosphere of argon. The alloy was obtained in the form of tapes. The results in the form of Mössbauer spectra and the distribution of induction of superfine fields are presented.

Results

Figure 1 shows Mössbauer transmission spectra and induced hyperfine field distribution. The Mössbauer spectra corresponding to the sample (a, c) in the form of tapes both in solidified state and after thermal treatment consist only of broad unsymmetrical overlapping lines which are typical of materials of amorphous structure. Mössbauer's spectra obtained from the Mössbauer spectra are bimodal. This means that in the volume of the sample there are areas with different concentrations of iron.

Table 1 shows the results of the numerical analysis of Mössbauer's transmission spectra. As indicated in Table 1, after heating of the tape, there was an increase in the induction of the average hyperfine field. This is due to the diffusion of atoms in the volume of the alloy, which increases homogenization of the sample with respect to the environment of the Fe atoms.

Table 1. The numerical analysis of Mössbauer's transmission spectra

	Ribbon in as quenched state	Ribbon after thermal treatment
Bhf	16.56	16.87
D	5.43	5.20

Bhf – average hyperfine induction field, D – distribution dispersion

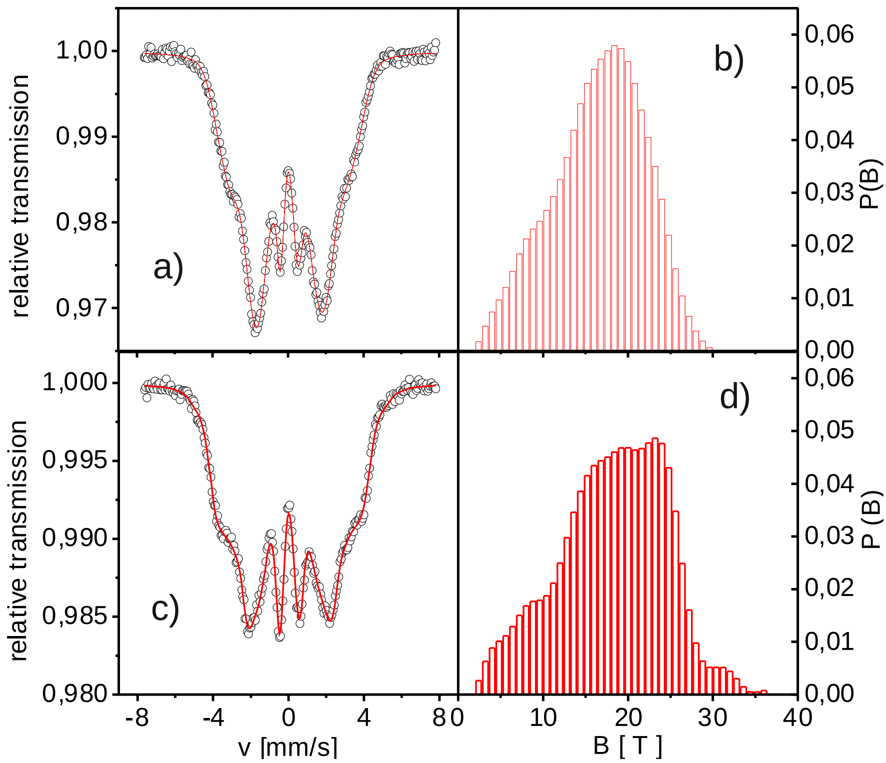

Fig.1. Mössbauer transmission spectrum (a, c) and their hyperfine field distribution (b, d)

Conclusions

Using melt-spinning technology, alloy of composition $Fe_{61}Co_{10}Hf_{2.5}Zr_{2.5}Ti_2W_2B_{20}$ in form of tapes can be produced with amorphous structure. A good technique for studying the structure of amorphous alloys is Mössbauer's spectroscopy. Using this technique it is possible to evaluate indirectly the distribution of iron in the alloy. Based on the analysis of the shape of the distribution of the induction of superfine fields, the probability of Fe^{57} surrounding as a function of the hyperfine induction field can be evaluated. As it was shown in this work, the heating of amorphous samples below the crystallization temperature leads to an increase in the homogeneity of the alloy.

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