MöSSBAUER SPECTROSCOPY OF HITPERM ALLOY QUENCHED AT DIFFERENT CASTING TEMPERATURES

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1. Introduction

Amorphous and nanocrystalline soft magnetic alloys have garnered interests in academia and industry due to their potentials for applications, such as power transformers, electric motors, and sensors [1]. Materials such as FINEMET, NANOPERM and HITPERM are seconded by new intensely investigated systems where special attention is put on materials with high saturation magnetization while preserving low coercivity. Diverse systems based on Fe-B with additions of Co, Cu, C, P and other elements were developed and tested [2]. Investigation of one of these types of materials is presented in this paper: HITPERM with addition of phosphorus. Master alloy $Fe_{72}Co_6Si_4Mo_1B_9P_8$ was prepared at different casting temperatures (1185 °C, 1193°C, 1197°C, 1202 °C) and investigated using Mössbauer spectroscopy in transmission geometry.

2. Experimental details

Master alloy $Fe_{72}Co_6Si_4Mo_1B_9P_8$ was prepared by planar flow casting at different casting temperatures 1185 °C, 1193°C, 1197°C and 1202 °C. Mössbauer spectra were collected at room temperature in transmission geometry using conventional constant-acceleration spectrometer equipped with ^{57}Co γ-ray source in a rhodium matrix. Velocity calibration was performed by an α-Fe foil. Mössbauer spectra were analyzed by least-square fitting procedure using the CONFIT fitting software [3]. The spectra were evaluated by Lorentzian line sextets employing distributions of hyperfine magnetic fields *P(B)*. Magnetic anisotropy of ^{57}Fe resonant atoms was characterized by measuring relative ratios of the 2nd and the 5th lines of the spectral sextets.

3. Results and discussion

Room temperature Mössbauer spectra recorded in transmission geometry accompanied by their corresponding distributions – probabilities *P(B)*, are depicted in Fig. 1. The spectra exhibit well separated six broad absorption lines which are characteristic for amorphous ferromagnetic material. They were evaluated using hyperfine magnetic field distributions *P*(*B*). Spectral line width generally increases from the inside pair (3,4) to the outside pair (1,6) of absorption lines in all samples indicating the importance of field fluctuations which tend to dominate in the outer lines. The spectra are smooth, ie no structures like shoulders are present within the lines themselves. The spectra also exhibit line width and line intensity asymmetries which are also typical for metallic glasses. Relatively large line widths are a consequence of the distribution of hyperfine interactions [4].

In order to monitor spin texture in the specimens, an $A_{2,5}/_{3,4}$ parameter that put into ratio the intensities (areas) of the 3rd and 4th lines to the 2nd and 5th ones was used for quantification. The $A_{2,5}/_{3,4}$ parameter equals to 4 in the absence of any stresses in the specimen since all atomic spins are expected to remain within the ribbon plane (due to shape anisotropy). On the other hand, for completely random spin alignment $A_{2,5}/_{3,4}$. The value of $A_{2,5}/_{3,4}$ = 0 means that the spins are perpendicular to the ribbon plane [5].

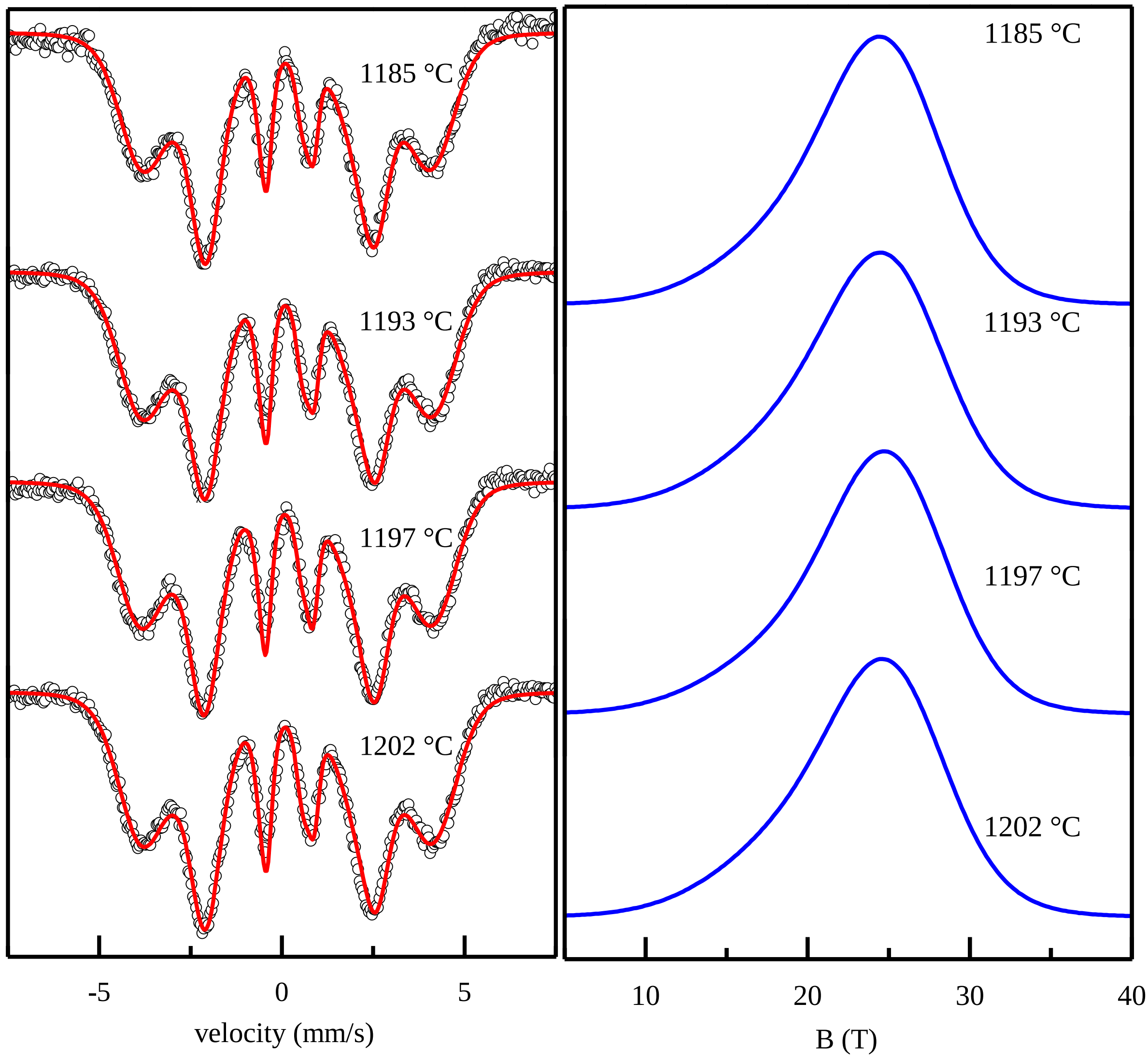

Fig.1: *(a) — room temperature transmission ^{57}Fe Mössbauer spectra and (b) —probability P(B) of the hyperfine magnetic field distributions of the $Fe_{72}Co_6Si_4Mo_1B_9P_8$ produced at indicated casting temperatures.*

Variation of the average values of the hyperfine magnetic fields <B> and $A_{2,5}/_{3,4}$ parameter as a function of the quenching temperature are illustrated in Fig. 2(a). Intensities of the second and fifth lines tend to systematically decrease with increasing casting temperature, but it should be noted that the observed differencies are at the detection limit of the measurement method. On the other hand, the average hyperfine magnetic fields plotted in Fig. 2(b) are stable over the entire range of analysed casting temperatures.

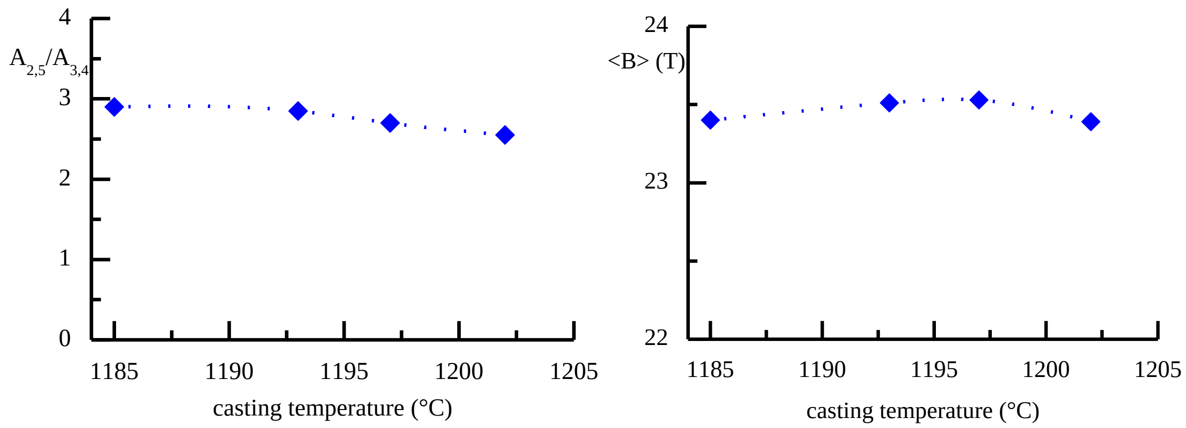

Fig.2: *(a) — $A_{2,5/3,4}$ parameter and (b) — average values of the hyperfine magnetic fields <B> as a function of the casting temperature.*

4. Conclusion

The effect of casting temperature in the planar flow casting method upon specific magnetic properties of $Fe_{72}Co_6Si_4Mo_1B_9P_8$ alloy was investigated by Mössbauer spectrometry. Results confirmed amorphous nature of the produced ribbons.

Average hyperfine magnetic fields do not exhibit substantial deviations with the rising casting temperature and are almost equal within the experimental error range. Intensities of the second and fifth lines tend to systematically decrease with increasing casting temperature, but it should be noted that the observed differencies are at the detection limit of the measurement method.

Acknowledgement

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