Analysis of Thermal and Magnetic Properties by Fe/Co ratio to Fe-based Amorphous Alloys

Seoyeon Kwon* and Haein Choi-Yim
Department of Physics, Sookmyung Women's University, Seoul 04310, Republic of Korea

1. Introduction

Fe-based amorphous alloy systems have attracted interest for the low material cost, and good soft magnetic properties [1-3]. Particularly, improving the soft magnetic properties and glass forming ability of Fe-based amorphous alloy systems has been studied for the several applications [4,5]. These (Co, Fe)-B-Si alloy system was developed in 1974 and used in field of application development for its good soft magnetic properties and high-strength compared with other Fe-B-Si systems [6,7]. Therefore, we have selected this system. Adding Mo in the Fe-B-Si systems enhances glass-forming ability (GFA) and thermal stability. In this study, we researched on effects of replacing Co by Fe and the part of small Mo additions, in Fe-Co-B-Si-Mo alloy system. We examined the thermal and magnetic properties of $(Co_{1-x}Fe_x)_{72}B_{19.2}Si_{4.8}Mo_4$ ($0 \leq x \leq 1$) by amorphous ribbons in detail.

2. Experiment

$(Co_{1-x}Fe_x)_{72}B_{19.2}Si_{4.8}Mo_4$ ($0 \leq x \leq 1$) alloys were prepared by an arc-melting furnace with high purity metals under Ti-gettered Argon atmosphere. In addition, these ingots were re-melted four times respectively, in order to be homogeneous alloys. Then, these samples, ribbons with width of 3mm were prepared by single copper roller melt spinning machine in 39.27m/s. After processing of ribbons, we identified ribbons' thermal and magnetic property by multiple measuring equipment. The structure of amorphous is confirmed by X-ray diffraction (XRD). We conducted an analysis of the results by differential scanning calorimeter (DSC)) to identify the thermal properties such as the crystallization temperature (T_x). The saturation magnetization (M_s) at room temperature was measured by vibrating sample magnetometer(VSM) with a maximum applied field of $800 kAm^{-1}$.

3. Result and discussion

In this research, we performed diverse study on Co-Fe-B-Si-Mo system in order to identify that adding Mo element enhances glass-forming ability and thermal stability. Also we want to study into the thermal and the magnetic properties for Co-Fe based amorphous alloys with Mo in depth. $(Co_{1-x}Fe_x)_{72}B_{19.2}Si_{4.8}Mo_4$ ($0 \leq x \leq 1$) amorphous ribbons showed the crystallization temperature (T_x) were decreased with decreased the ratio of Co. Furthermore, the amorphous ribbons of these composition exhibited good soft magnetic properties. Thus Fe/Co ratio in $(Co_{1-x}Fe_x)_{72}B_{19.2}Si_{4.8}Mo_4$ alloys will be related with the thermal stability and soft magnetic properties and the addition of a small quantity of Mo have beneficial effects on magnetic properties.

4. References

[1] A. Inoue, B. L. Shen, and C. T. Chang, Acta Mate. 52, 4093 (2004).
[2] B. L. Shen, A. Inoue, and C. T. Chang, Appl. phys. Lett. 85, 4911 (2004).

[3] B. L. Shen, C. T. Chang, T. Kubota, and A. Inoue, J. Appl. phys. 100, 013515 (2006).
[4] A. Inoue and A. Makino, Nano. Mater. 9, 403 (1997).
[5] A. Inoue, Mater. Sci. Eng. 304, 1 (2001).
[6] K. Hayashi, M. Hayakawa, Y. Ochiai, H. Matsuda, W. Ishikawa, and K. Aso, J. Appl. Phys. 61, 2983 (1987).
[7] A. Datta and C. H. Smith, Rapidly Quenched Metals, vol. eds. S. Steeb and H. Warlimont, North-Holland, Amster-dam, Oxford, New York, Tokyo (1985), p. 1315.