

Annealing Effect on the Magnetic Properties for Co-based Amorphous Alloys

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1. Introduction

Annealing treatment to the amorphous phase is necessary to optimize their magnetic properties, since amorphous phase caused by rapid quenching is structurally in the metastable state. Annealing effect has been investigated for a number of amorphous alloys [1,2]. It has been found that the heat treatments cause reduction of coercivity and losses [3]. The low coercivity is a primary property of soft materials. Moreover, Annealing below glass transition temperature cause nucleation but not crystallization. In this study, the annealing effect on the magnetic properties of Co-based amorphous ribbon was investigated.

2. Experiment

Alloy ingots with the composition $\text{Co}_{72}\text{B}_{19.2}\text{Si}_{4.8}\text{Cr}_4$ and $\text{Co}_{64.8}\text{Fe}_{7.2}\text{B}_{19.2}\text{Si}_{4.8}\text{Cr}_4$ were prepared by melting high purity constituent elements in arc-melting under a Ti-gettered argon atmosphere. Each ingot was re-melted at least four times to maximize compositional homogeneity. Amorphous ribbons were produced by melt spinning using a wheel speed of 39.27 m/s in an argon atmosphere. The ribbons were typically 2 mm in wide and 20~30 μm in thick. The as-spun ribbons were subjected to annealing treatments at various temperatures below glass transition temperature (T_g) for 15 minutes in vacuum. The composition and structure of ribbons identified by X-ray diffraction (XRD) with Cu-K α radiation. Thermal stability associated with the T_g and crystallization temperature (T_x) were measured using a differential scanning calorimeter (DSC) and thermomechanical analysis (TMA) under a flowing argon atmosphere. The saturation magnetization (M_s) and coercivity (H_c) at room temperature were measured in a maximum applied field of 1500 kA/m with a vibrating sample magnetometer (VSM). The field resolution of VSM is 1 mOe (0.08 A/m).

3. Result and discussion

The annealing effect on the magnetic properties is reported for the $\text{Co}_{72}\text{B}_{19.2}\text{Si}_{4.8}\text{Cr}_4$ and $\text{Co}_{64.8}\text{Fe}_{7.2}\text{B}_{19.2}\text{Si}_{4.8}\text{Cr}_4$ alloy systems. Through the DSC and TMA experiments, we determined the annealing temperature below T_g without crystallization process. All of the ribbon with or without heat treatment was identified as a fully amorphous alloy in XRD patterns. The hysteresis curves indicated the magnetic properties. We confirmed that the annealing contributes to soft magnetic characteristics such as high M_s and low H_c .

4. References

- [1] H.S. Chen, J. Appl. Phys. 52, 1868 (1981).
- [2] H.S. Chen and A. Inoue, J. Non-Cryst. Solids 61&62, 805 (1984).
- [3] F.E. Luborsky, IEEE Trans. Magn. MAG-11, 1644 (1975).