Effect of Boron Additions on Magnetic Properties of Fe-based Amorphous alloys

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1. Introduction

Fe-based ferromagnetic metallic glasses are known as excellent soft magnetic properties including high saturation magnetization (M_s), low coercivity (H_c), and high permeability. Also, Fe-based alloys have low material cost and ultrahigh strength, and high corrosion resistance [1]. In general, it is well known that the metalloid contents improve to glass forming ability (GFA) [2]. In particular, the suitable ratios of B to transition metals leads to the enhancement of its GFA and thermal properties of amorphous alloys. It is important to find optimization component between B and transition metal, because the addition of transition metal component lead to brittle. In this study, we reported the soft magnetic properties of $Fe_{(87-x-y)}Co_yTi_7Zr_6B_x$ (x=2, 4 and y=20, 25, 30, 35, 40) alloys [3,4].

2. Experiment

The ingots of $Fe_{(87-x-y)}Co_yTi_7Zr_6B_x$ (x=2, 4 and y=20, 25, 30, 35, 40) alloys were prepared by vacuum arc melting furnace under argon atmosphere and re-melted four times for homogeneity of alloys. After the arc melting process, ingot re-melted and rapidly cooled by melt spinning at a wheel speed of 56.3m/s. Then, we obtain the ribbons 2 mm in width and 20-30 μm in thickness. Then, we measure the magnetic and thermal properties via various measuring equipment. The structure of amorphous phase was established by X-ray diffraction (XRD). The saturation magnetization (M_s) at room temperature was established by vibrating sample magnetometer (VSM). Thermal properties related of the glass transition temperature (T_g) , crystallization temperature (T_x) and supercooled liquid region ($\Delta T_x = T_x - T_g$) was measured by using differential scanning calorimeter (DSC) and thermo mechanical analysis (TMA).

3. Result and discussion

In this experiment, we studied on the effect of Boron additions on magnetic properties of Fe-based amorphous alloys. The ribbons of $Fe_{(87-x-y)}Co_yTi_7Zr_6B_x$ (x=2, 4 and y=20, 25, 30, 35, 40) showed fully amorphous phase in the XRD patterns except for $Fe_{45}Co_{40}Ti_7Zr_6B_2$ (x=2 and y=40). From the hysteresis loop of these amorphous ribbons, the highest value of Ms was 1.59 T. The DSC and TMA curves notice the GFA of these alloys. The largest values of ΔT_x were obtained as the B content of 4 at.%. This means, the B contents are influence on ΔT_x. In conclusion , the Fe-Co-Ti-Zr-B alloys have excellent soft magnetic properties and it can be expected to improve their properties after annealing process.

4. References

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