Effect of Metalloid Ge Addition on the Magnetic Properties of Fe-based alloys

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1. Introduction

Magnetic materials play an increasingly important role in modern industry as essential components of commercial products. Fe-based amorphous alloys have attracted tremendous attention due to their excellent soft magnetic properties including low coercivity and high saturation magnetization. It is necessary to develop Fe-based amorphous alloys with high saturation magnetization using low cost constituent elements. A series of Fe-P-C alloys, which exhibit good soft magnetic properties and low cost have been developed. It has been demonstrated that the contents of metalloid elements play an important role in the glass-forming ability and properties of the Fe-based amorphous alloys. The purpose of this work is to investigate the effects of Metalloid Ge substitution for P on the magnetic properties of the Fe-P-C alloys.

2. Experiment

Alloy ingots were prepared by induction melting mixtures of high purity Fe (99.95%), Ge (99.999%), C and industry-grade pre-alloys of Fe_3P (99 %) in an argon atmosphere. Ribbons of each composition were fabricated using the melt spinning under argon atmosphere at a roll speed of 56.3 m/s. Phase structures of the specimens were identified by X-ray diffraction with Cu-Kα radiation. Thermal property of melt-spun alloys was evaluated with a differential scanning calorimetry at a heating rate of 0.33 K/s under an argon flow. The saturation magnetization and coercivity were measured by a vibrating sample magnetometer and a dc B-H loop tracer. respectively. Additionally, the density of the specimens was determined using a helium pycnometer.

3. Result and discussion

For the Fe-metalloid type amorphous alloys, the valence electrons (sp electrons) of the metalloid elements greatly influence the saturation magnetization of them. Generally decreasing sp electrons results in higher saturation magnetization. The numbers of sp electrons in P, C and Ge are 5, 4 and 4, respectively. Thus the substitution of metalloid element Ge for P is expected to increase the saturation magnetization of the alloys.

4. References

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