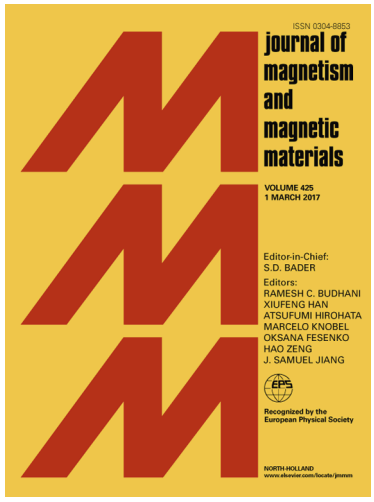

Effect of Y addition on crystallization behavior and soft-magnetic properties of $Fe_{78}Si_9B_{13}$ ribbons

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Abstract A series of amorphous Fe-Si-B ribbons with various Y addition were prepared by melt-spinning. The effect of Y addition on crystallization behavior, thermal and magnetic properties was systematically investigated. With the increase of Y content, the initial crystallization temperature shifted to a higher temperature, indicating that the thermal stability of amorphous state in Fe-Si-B-Y ribbon is enhanced compared to that of Fe-Si-B alloy. Meanwhile, compared to the two exothermic peaks in the samples with lower Y content, a new exothermic peak was found in the ribbons with Y content higher than 1at%, which corresponded to the decomposition of metastable Fe_3B phase. Among all the alloys, $Fe_{76.5}Si_9B_{13}Y_{1.5}$ alloy exhibits optimized magnetic properties, with high saturation magnetization M_s of 187 emu/g and low coercivity H_{cJ} of 7.6 A/m.

Keywords Amorphous; Thermal analysis; Soft magnetic material

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1 Introduction

Amorphous soft magnetic alloys have attracted much attention due to the excellent properties, such as magnetic properties, corrosion resistance, mechanical properties [1]. Thus, they have been widely applied in the field of soft magnetic materials [2].

Amorphous Fe-Si-B alloys are the representative with several practical applications in transformers and inductors because of their excellent soft magnetic properties such as high permeability, low coercivity and low core losses [3-7]. However, compared with the silicon steel, the saturation magnetic moment of Fe-Si-B amorphous alloys is still lower. Thus, it is of great importance to enhance the saturation magnetic moment to improve the soft magnetic properties of Fe-Si-B alloys.

Generally, to increase the iron content is a valid method to increase the magnetic moment [8-10]. But with the increasing of the iron content, it will become difficult to produce the amorphous alloy. If there is no great breakthrough in rapid quench technology, industrialization would be difficult. The soft magnetic properties depended on the microstructure of the as-quenched alloys, which is greatly affected by big diameter elements, such as Zr, Nb, Mo and the rare-earth elements [11-17]. Many rare-earth functional materials have been developed due to the unique physical and chemical properties of rare-earth elements. For example, La can significantly enhance the performance of the amorphous soft magnetic alloy during used at high frequency and Y can improve the glass forming ability.

In this paper, a typical amorphous alloy $Fe_{78}Si_9B_{13}$ with rare earth Y element doping is systematically studied. The results suggest that a trance amount of Y addition can improve the soft magnetic properties of Fe-Si-B amorphous alloy, by enhancing the saturation magnetic moment and decreasing the coercivity. Also, the thermal property was discussed with the Y addition.

2 Experimental

Alloys with nominal composition $Fe_{78-x}Si_9B_{13}Y_x$ (x=0, 0.5, 1.0, 1.5, 2.0, 3.0) were melted for three times to obtain the homogenous ingots, and metallic ribbons were prepared by a melt-spinning technique under a high-purity argon atmosphere with a speed of 40 m/s. The ribbon was about 30 μm in thickness and about 2 mm in the width. The