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Effect of the substitution of C for Si on microstructure, magnetic properties and bending ductility in high Fe content FeSiBCuPC alloy ribbons*

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ABSTRACT: The microstructure, magnetic properties and bending ductility of the $Fe_{85}Si_{1.5-x}B_9Cu_{0.5}P_4C_x$ (x=0, 0.1 0.2, 0.3, 0.4, 0.5) alloy ribbons with high Fe content were investigated. The partial substitution of C for Si increases the amorphous forming ability and enlarges the maximum thickness of glassy from 19 μm to 25 μm of the alloys. It is clearly seen that the addition of C increases the first crystallization temperature (T_{x1}), while the reduction of Si slightly decreases the second crystallization temperature (T_{x2}). The amorphous alloys exhibit the low Curie temperature (T_c), and large T_{x1} - T_c allows the alloys to obtain better soft magnetic properties. In amorphous state, with the increase of C, the saturation magnetization (Ms) and the coercivity (Hc) of the amorphous alloys descend slightly, which decrease from 168.0 emu/g to 166.8 emu/g and 10.0 A/m to 9.3 A/m, respectively. Through the optimum annealing treatments, the $Fe_{85}Si_{1.4}B_9Cu_{0.5}P_4C_{0.1}$ nanocrystalline alloy exhibits highest Ms of 205 emu/g (Bs ≈ 1.93 T) and lowest Hc of 5.8 A/m. Both of the amorphous alloys exhibit good bending ductility before and after annealing.

Keywords: Fe-based amorphous alloy; Thermal ability; Saturation magnetization, bending ductility.

1. Introduction

Fe-based amorphous/nanocrystalline alloys as a new type of soft magnetic materials have attracted great attention due to their excellent soft magnetic properties[1-2]. After decades of development, various Fe-based amorphous/nanocrystalline alloys have been developed, some of which are used widely in electronics and power industries[3-5]. However, these alloys contain expensive metal elements (such as Nb, Zr, Co, etc.) which increase the cost of the alloy. The low Fe concentration (73 at. %) of the alloy results in a low saturation magnetic flux density (Bs) of about 1.25T[6-8]. Recently, it has been reported that a new system of Fe-based nanocrystalline alloys exhibits excellent soft magnetic properties. Nanocrystalline FeSiBPCu alloys, known as “NANOMET”, are characterized by the high permeability (μ) and saturation magnetic flux density (Bs). The Bs of the alloys can reach up to 1.8 ~ 1.9 T, which is approximate to the silicon steel, and the permeability of the alloys is higher than that of silicon steel[9-11]. In this alloy system, due to the

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