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Magnetic Properties of Bilayer Co/Fe-based Amorphous Ribbons Prepared by Single Melt-Spun Method

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Introduction

Ever since the discovery of exchange coupling in nanocrystalline phase, it has been renewed interest in the investigation of homogeneous amorphous and nanocrystalline phases. Single melt spun as a method for preparing amorphous ribbon was used in industry productions and experiments extensively. But the ribbon just has one layer after the process. It is difficult to prepare bilayer structure of amorphous ribbons.

In this work, we produced the $Co_{74.1}Fe_{4.5}Si_{5.7}B_{15.7}$(up)/$Fe_{73.7}Cu_{0.8}Nb_3Si_{13.5}B_9$ (bottom) bilayer amorphous ribbon and investigated its magnetic properties.

Experiments

The ingot with the composition $Co_{74.1}Fe_{4.5}Si_{5.7}B_{15.7}$(at%) and $Fe_{73.7}Cu_{0.8}Nb_3Si_{13.5}B_9$ (at%) was prepared by high frequency furnace under Ar_2 atmosphere. And then it was crashed it to small size to suit the next step. Single roll melt spun method, which have twin nozzle(diameter is 0.5 mm), was used to prepare the bilayer ribbon. The wheel speed was controlled at 4000 m/min and the argon atmosphere pressure is 1.5 atm. The distance between wheel surface and nozzle is about 1 mm.

The microstructure of the bilayer ribbon was observed by scanning electron microscope (SEM). The magnetic properties were measured by vibration sample magnetometer (VSM) and AC magnetic response was measured by B-H analyzer.

Result and discussion

A comparison of hysteresis loops of amorphous Fe, Co-based single layer and Co/Fe bilayer ribbon was shown in Fig.1, which were measured by VSM. The coercivity of bilayer ribbons lower than the Fe, Co-based single ones. The squareness of the bilayer ribbon is lower than the single ones. Fig.2 shows hysteresis loop of Co/Fe bilayer ribbon under the different annealing temperatures. At 500 ℃, the exchange coupling between the nanocrystalline come into being, and with the annealing temperature increase the effect of exchange coupling became larger and larger for the volume ratio of nanograin increasing. The increase of coercivity to 450 ℃ due to the beginning of crystallization. It has been report that for some nanocrystalline system, where the weak magnetic matrix shows reduced capability to transmit the exchange coupling between nanocrystalline grains [1, 2]. With the temperature increase, the coercivity decrease for the exchange coupling between nanocrystalline grains[3]. Because there have two phase in the bilayer ribbon, the exchange coupling nanocrystalline gains including Fe-Fe, Co-Co, and Fe-Co(near the interface of the two layers). Fig. 3 shows transverse cross section of the bilayer ribbon measured by SEM. Obviously, it illustrate that the bilayer is observed, a layer is bottom layer and b is up layer. A layer stock with b layer sensitively. The thickness of the bilayer ribbon is about 0.03 mm. Fig. 4

shows the AC response ability of bilayer ribbon. The maximum permeability of bilayer Co/Fe amorphous ribbons is higher than the single Fe, Co-based ones under a frequency range of 10 to 100 KHz. It is maybe due to the appearance of exchange coupling near the interface of the two layers.

Conclusion

1. Fe/Co bilayer amorphous ribbon can be produced by single melt spun method
2. The coercivity of bilayer ribbons is lower than the Fe, Co-based single ones.
3. Fe/Co bilayer amorphous ribbon shows a higher maximum permeability from 10KHz to 80KHz.

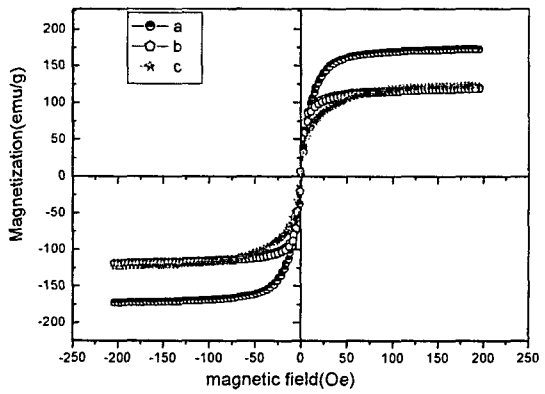

Fig.1 Hysteresis loop of as quenched ribbon, which denote Fe-based single layer, b denote Co-based single layer and c denote Fe/Co two layer ribbon.

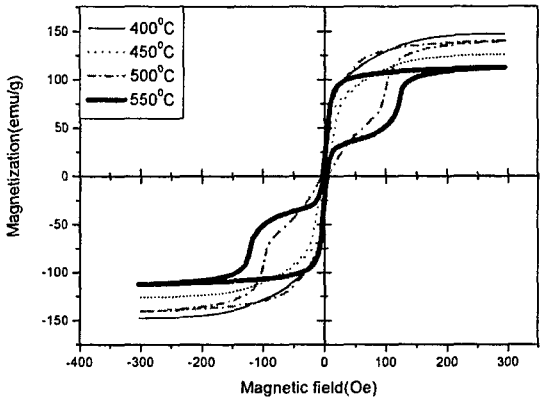

Fig.2 Hysteresis loop under the different annealing a temperature of Fe/Co bilayer ribbon.

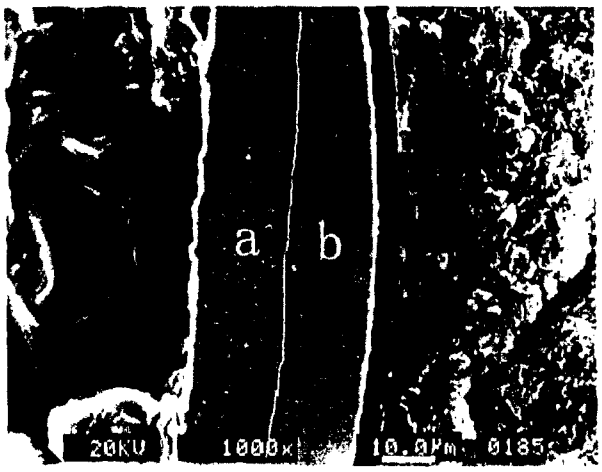

Fig.3 The observation of the Fe/Co bilayer ribbon measured by SEM, a(Fe-based), b(Co-based).

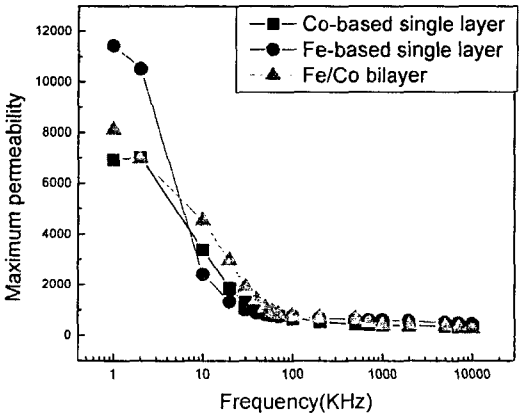

Fig.4 Maximum permeability of Fe-based, Co-based single layer and Fe/Co bilayer ribbon as a function of frequency.

Reference

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