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Magnetic Properties of CoFe Films with in-plane Uniaxial Anisotropy Prepared by Electrodeposition

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Soft magnetic materials have a wide application in electromagnetic devices such as step motors, magnetic sensors and magnetic recording heads [1]. Recently, CoFe alloys have attracted more attention due to its high saturation magnetization. Up to now, magnetic films have been successfully fabricated by means of molecular beam epitaxy, sputtering, electroless plating, electrodeposition and so on. Electrochemical methods are preferred, because of its low capital cost.

In this study, CoFe alloy thin films have been successfully electrodeposited on the ITO conductive glass by constant voltage modes. The effects of deposition time, current density were studied, and it was found that the additives can improve the soft magnetic properties. The results show that coercivity Hc decreased with increasing the film thickness, and films with low Hc can be obtained using large current density. Magnetic measurements obtained by VSM show that in-plane uniaxial anisotropy can be induced by a magnetic field applied parallel to the film during electrodepositing and the magnetic anisotropy is very sensitive to different preparation conditions. In-plane hysteresis loops along the induced easy and hard axes for that alloy film are reported in Fig. 1 The anisotropy field H_k = 103 Oe of the film could be extracted from the hysteresis loops in the hard and easy axes. Fig. 2 shows frequency-dependent permeability spectra [2] and the resonance frequency is 3.9 GHz. Furthermore,considering the microwave application, the high frequency magnetic properties are worthy of a further research.

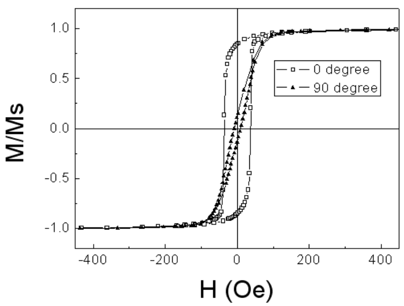

Fig. 1. In-plane hysteresis loops measured at 0° and 90° of a $Co_{52.1}Fe_{47.9}$ alloy film.

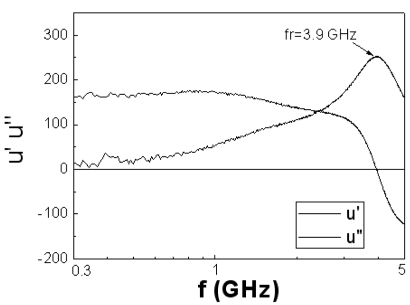

Fig. 2. Permeability spectra of a $Co_{52.1}Fe_{47.9}$ alloy film with in-plane uniaxial anisotropy.

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Thermodynamic Properties of Ferromagnetic/Antiferromagnetic Bilayers

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Magnetic bilayer with its distinctive properties has become one of the most exciting fields of Condensed Matter Physics [1-2], and it has been widely used. Magnetic bilayer usually consists of ferromagnetic/antiferromagnetic films which are magnetically coupled with each other, while the interlayer interaction may be ferromagnetic or antiferromagnetic. This kind of material is an element of many spintronic devices [3], as well as a single component of the magnetic superlattice [4]. However, theoretical works [5, 6] of magnetic bilayers still need to be improved. In this paper, double-time Green's function method is utilized to investigate the thermodynamic properties of ferromagnetic/antiferromagnetic coupled Heisenberg bilayers, in which the quantum number of the spin is equal to 1 and single-ion easy-axis anisotropy is introduced.

We use the decoupling scheme proposed by Anderson and Callen to treat the terms including single-ion anisotropy, and random phase approximation to decouple the terms concerning exchange interactions. After formulating the expressions to calculate the magnetization of the system, temperature-dependent magnetizations are studied for different interlayer exchange interactions, single-ion anisotropies in the antiferromagnetic monolayer and external magnetic fields. The results show that compared with a ferromagnetic interlayer exchange interaction, an antiferromagntic one can cause stronger quantum fluctuations. In addition, when the interlayer exchange interaction is strong enough, there is a slight increase of the magnetization of a frustrated sublattice in the lower temperature region before the magnetization decreases with the temperature increasing, which results from the competition between thermal fluctuations and the frustration effect-a mechanism to restrain thermal fluctuations of spins. It is also found that a weak external field can cause more influence on the magnetization of the ferromagnetic monolayer than that of the antiferromagnetic monolayer.

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