ES07

BUni- and Bi-Axial Anisotropies of Ultra Thin Fe Layers on GaAs(100) Substratesrillouin Light Scattering Study of Magnetic Anisotropy in GaAs/Fe/Au System

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The ferromagnetic-semiconductor hetero-structure proposes interesting fundamental magnetism of ultrathin films and also has potential to develop new devices. Since Fe/GaAs system has reasonably low lattice mismatch, which provides good epitaxial growth, we fabricated an expitaxial Fe(001) wedge layer in the thickness range of 0~3.4 nm on to the GaAs(100) surface, and coved it with a Au capping layer of 5 nm. The magnetic anisotropy in this ultrathin Fe film was investigated by employing Brillouin light scattering (BLS) in the back scattering geometry [1, 2]. Spin wave frequencies of magnons, which were thermally excited in the Fe film, were obtained as functions of external magnetic field, Fe layer thickness and azimuth angle of the scattering vector. In fig. 1, azimuth angle dependences of the spin wave frequencies are shown for several Fe film thicknesses. As shown in the figure, the dependences were well fitted with analytic expression of spin wave modes in the ultrathin film by adjusting in-plane magnetic anisotropy parameters. The GaAs/Fe/Au system has both biaxial and uniaxial magnetic anisotropy. From the fitting it is concluded that the uniaxial anisotropy increases with decreasing the Fe layer thickness. While biaxial anisotropy, which originates from bulk cubic anisotropy in the bcc-Fe, is reduced with increasing decreasing Fe film thickness. This result suggests that the uniaxial anisotropy is originated in the interface between GaAs surface and Fe layer.

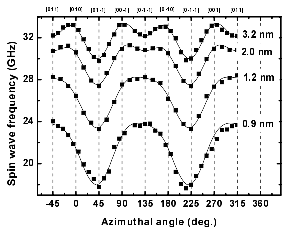

Fig. 1. Experimental (points) and calculated (curves) spin-wave frequencies for Fe films of different thicknesses as a function of the in-plane direction of the applied magnetic field relative to the [001] reference direction. The field intensity is 5.1 kOe while the incident angle of light is 45°.

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ES08

Exchange Bias in the Exchange Spring-like Ising Bilayer

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Exchange bias is a shift in the magnetization curve away from the zero applied field axis. The phenomenon was discovered fifty years ago [1], since then it is observed in many different film systems, such as antiferromagnetic/ferromagnetic bilayer film [2] and antiferromagnetic coupled ferromagnetic/ferromagnetic bilayer [3,4] Recently, ferromagnetic coupled exchange spring has attracted many attentions due to the application in the magnetic recording. Many details of experiments and theories exhibit the reversal mode of the exchange spring [5, 6], however, the exchange bias is not mentioned in their works.

In this paper, an Ising model is utilized to describe the exchange spring-like bilayer. The spins are equal to 1 in both ferromagnetic layers, in which a hard ferromagnetic layer (HL) with big anisotropy couples with a soft ferromagnetic layer (SL) with small anisotropy ferromagnetically. In this system, the switching field of the hard magnetic layer is larger than that of the soft layer due to the big anisotropy, resulting in a bias field. Using the linear cluster approach, we study the magnetic behavior of the system in applied field and demonstrate the exchange bias existing in certain parameters zone.

For the small easy-plane anisotropy of the soft layer, it is found that the exchange bias does not occur in the small range of the intralayer interaction, but appears with the intralayer interaction increasing, then vanishes as the intralayer interaction increases to a certain value, as shown in Fig.1. Moreover, the absolute value of exchange bias 0(h_{EB}) increases and coercivity (h_C) decreases as the interlayer interaction increases in certain parameter zone (Fig.2).

In the presence of the easy-axis anisotropy in the soft magnetic layer, the exchange bias only occurs for several special parameters in applied field (Fig.3).

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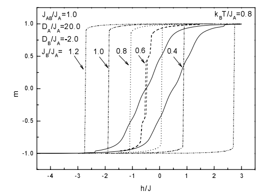

Fig. 1. The hysteresis loops of the soft layer with easy-plane anisotropy in applied field for various intralayer interactions.

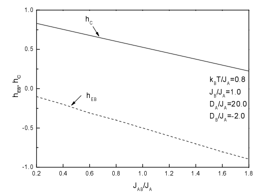

Fig. 2. The coercivity and exchange bias as a function of the interlayer interaction.

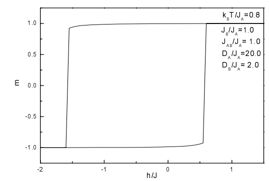

Fig. 3. The hysteresis loop of the soft layer with easy-axis anisotropy in applied field.

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