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Effect of Interfacial Roughness Configuration on Exchange Bias in NiO-based Spin Valves

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Exchange-bias (EB) effect between ferromagnetic (FM) and antiferromagnetic (AF) thin films has attracted increasing attention for its important role in pinning the FM layer in giant magnetoresistance heads or spin valves. The properties at the interface of FM/AF play a key role in affecting the EB effect. In order to systematically study the interface dependence of the EB effect, in the present paper, two batches of NiO-Co-Cu based spin valves with different deposition conditions were fabricated. The nominal structure for the two batches is the same. Each batch of samples includes a TSV, with a NiO layer at the top of the Co/Cu/Co, and a BSV, with a NiO layer at the bottom of Co /Cu/Co. For batch 1 (SV1), the base pressure was 1.95×10^{-5} Pa and the sputtering Ar pressure remained 0.1Pa during the sample growing. The deposition rate for NiO was 0.034nm/s. For batch 2 (SV2), the base pressure was 3×10^{-5} Pa, the sputtering Ar pressure raised to be 0.3Pa, and the deposition rate for NiO was 0.020nm/s. Phases and textures for each film were identified by X-ray diffraction (XRD). The thickness, surface & interface microstructures were characterized by the grazing incident X-ray reflectivity (XRR) and transverse X-ray scattering measurement (TXS). For TSV2, the Co, Cu and NiO sub-layers are all in the texture of (111), but for others, there are no textures observed. EB effect is only observed in batch 2. We believe that textured structure is not a prerequisite factor for EB effect in NiO/Co/Cu/Co spin valves. For all samples, the averaged roughness of NiO/Co interface are almost the same (0.3nm for BSV, 1.2nm for TSV), which indicates that there is no obvious relationship between the EB effect and interface average roughness. However, TXS fitting clearly showed that the correlation length of the interface roughness for SV2 is about 100nm, which is much larger than that for SV1. The dimension of the roughness for SV2 is also a little different from that for SV1 (about 10nm). We, therefore, conclude that the correlation length and dimension of the interface roughness may be the key factors of affecting the EB effect in NiO based Co/Cu/Co spin valves.

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Effect of Unidirectional Deposition Field of Exchange Bias Coupling of NiFe/FeMn/NiFe Trilayer

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Recent studies for microscopic origin of exchange bias coupling field (H_{ex}) is processing in several models, which are the existence of interfacial uncompensated spin, dilution of antiferromagnetic layer, and orange coupling field [1,2].

In this study, the exchange coupling depending on the unidirectional depostion field of FeMn layer in a NiFe/FeMn/NiFe trilayer film has been measured. NiFe/FeMn/NiFe multilayers with Ta seed and capping layers were prepared through ion beam deposition. The H_{ex} of the multilayer with the crystalline (1 1 1) texture dominant increased as the thickness of FeMn increased. The value of H_{ex} is due to unidirectional components of the magnetic anisotropy energy. To make sense the exchange biasing mechanism, NiFe/FeMn/NiFe trilayer is prepared under several unidirectional magnetization axes of external field during deposition for only antiferromagnetic FeMn film, as in Fig. 1(a). Different angular dependence and symmetry have been observed for the exchange fields top and bottom H_{ex}, which was defined in Fig. 1 (b).

Inspecting the experimental data there is the existence of clear evidence. The bottom H_{ex} at unidirectional angle of $\pi/2$ during growth of FeMn film was almost disappeared, as shown in Fig. (2). We have shown the effect of unidirectional deposition field of FeMn layer in NiFe/FeMn/NiFe trilayer. A switching of unidirectional anisotropy in plan of the multilayer to a direction perpendicular to the direction of growth field has been observed clearly at peculiar angle point, which could be attributed to the angle dependence of antiferromagnetic layer [3]. Future study is reported to develop a full model of the exchange bias coupling effect in the new observation.

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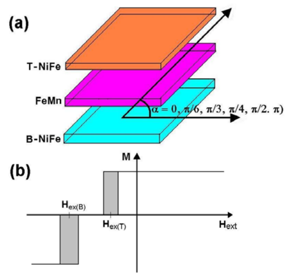

Fig. 1. (a). Schematic of NiFe/FeMn.NiFe trilayer with uniaxial deposition field of FeMn. (b) definitions of exchange bias fields to the bottom and top NiFe layers.

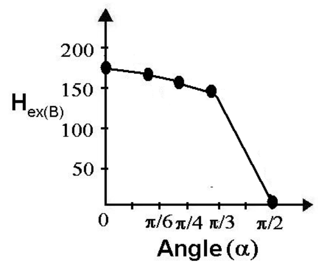

Fig. 2. Unidirectional deposition field of FeMn layer versus bottom exchange biasing coupling field in NiFe(50 nm)/FeMn(12 nm)/NiFe(7 nm) trilayer.

[1] T. Ambrose, R. L. Sommer, and C. L. Chien, Phys. Rev. B 56, 83 (1997).
[2] B. K. Kim, J. H. Kim, D. G. Hwang, and S. S. Lee, J. Kor. Mag. 12, 132 (2002).
[3] S. Riedling, M. Bauer, C. Mathieu, and B. Hillebrands., J. Appl. Phys. 85, 6648 (1999).