Angular-dependent exchange bias with competing anisotropies in epitaxial Co_3FeN/MnN bilayers

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Exchange coupling between ferromagnets (FMs) and antiferromagnets (AFMs) is one of the important phenomena in spintronic devices. Therefore, the main properties of exchange coupling are well understood for, in particular, polycrystalline bilayers [1]. In the case of full epitaxial FM/AFM bilayers, the situation is more difficult because of unusual magnetization switching processes resulting from competing anisotropies between a fourfold magnetocrystalline anisotropy and a unidirectional exchange coupling [2]. Up to now, we have clarified the unusual magnetization switching processes and angular-dependent exchange bias (H_{ex}) effects in fully epitaxial Co_3FeN/MnN bilayers, where the unidirectional exchange coupling has been applied along the easy axis of magnetocrystalline anisotropy of Co_3FeN [3]. In this presentation, we present further studies of the relationship between magnetocrystalline anisotropy and unidirectional exchange coupling in fully epitaxial Co_3FeN/MnN bilayers [4].

Figure 1 presents the angular-dependent H_{ex} of Co_3FeN/MnN bilayers obtained by longitudinal magneto-optic Kerr effect magnetometry, where the unidirectional exchange coupling is applied along easy (a) and hard axes (b) of Co_3FeN fourfold magnetocrystalline anisotropy. The angular-dependent H_{ex} exhibits 180° period for the sign switching of the exchange-bias field when the exchange coupling is parallel to the easy axis [Fig. 1(a)], while the angular-dependent H_{ex} exhibits an approximately 45° period when the exchange coupling is parallel to the hard axis [Fig. 1(b)]. Taking into account the experimentally obtained values of the fourfold magnetocrystalline anisotropy, the unidirectional anisotropy field, the exchange-coupling constant, and the uniaxial anisotropy including its direction, the calculated angular-dependent H_{ex} reproduces the experimental results. At the presentation, we will show the change of angular-dependent H_{ex} as a function of the ratio between exchange-coupling constant and magnetocrystalline anisotropy constant.

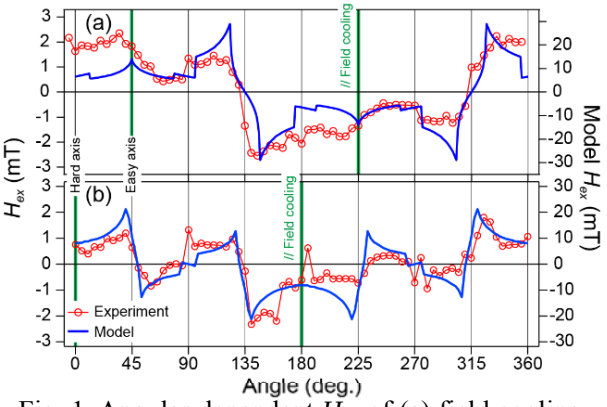

Fig. 1. Angular-dependent H_{ex} of (a) field cooling // easy and (b) // hard axes, respectively.

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