ONSET OF POSITIVE EXCHANGE BIAS IN NANOSTRUCTURED THIN FILMS

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Exchange bias (EB) phenomenon appears in ferromagnetic/antiferromagnetic (FM/AF) materials in intimate contact and below the Néel temperature of the AF (T_N) [1,2]. The exchange interaction between FM and AF spins at the interface leads to a shift of the hysteresis loop along the magnetic field axis known as exchange bias field (H_{EB}).

The sign of H_{EB} depends on the magnetic history of the cooling process across T_N. Most of the EB systems exhibit only negative H_{EB} at positive cooling fields (H_{FC}), independently of the magnitude of H_{FC}. However, there are few magnetic systems, like FeF_2/FM bilayers, that show positive H_{EB} at high H_{FC}. These systems also show negative H_{EB} at low H_{FC}, as regular EB films. The transition between negative and positive EB regimes depends on the crystalline quality of the AF. In epitaxial FeF_2 it has been observed that it occurs through a *bidomain* state [3], where AF domains with opposite pinned uncompensated moments coexist below T_N. This lateral structure yields double hysteresis loops (DHL), i.e. two subloops with the same absolute value of H_{EB} and opposite sign [4]. The ratio between both positive and negative subloops depends on the magnitude of H_{FC} [3].

In this work we report about the minimum H_{FC} necessary for fully positive EB in both patterned and unpatterned FeF_2/Ni bilayers. The onset of DHL and positive EB was investigated in FM dotted magnetic nanostructures as function of the dot size and compared to the value of continuous films. Fig. 1 shows a cross section sketch of patterned AF/FM bilayers (a) and an atomic force microscopy (AFM) image of the array (b). Magneto-optical measurements of hysteresis loops demonstrate that the smaller the dot size the lower the magnitude of H_{FC} necessary for positive H_{EB}. This effect has been related to the correlation of FM and AF domain sizes, which can qualitatively explains the results.

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References:

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Figures:

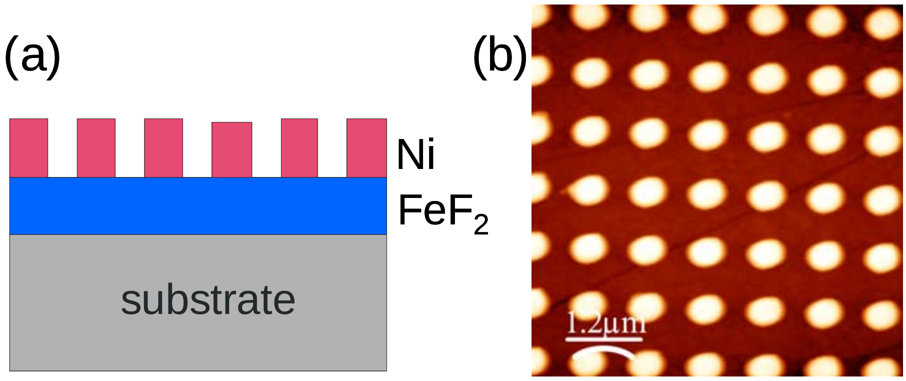

Fig. 1. (a) Cross section sketch of FM dotted FeF_2/Ni bilayers. (b) AFM image of FeF_2/Ni nanostructures.