SPATIALLY DEPENDENT EXCHANGE BIAS IN FeF_2/Ni BILAYERS: INFLUENCE OF COOLING PROCESS

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Upon cooling a ferromagnet (FM)-Antiferromagnet (AFM) in close contact below the Néel temperature T_N of the antiferromagnetic material, an unidirectional anisotropy is induced in the ferromagnet that results in a horizontal shift of the hysteresis loop of the ferromagnet (exchange bias). This effect has attracted much interest in recent years [1] because of its applications in the design of magnetic devices. In particular, it can be of fundamental relevance to overcome the superparamagnetic limit of small magnetic structures, helping to stabilize their magnetization against thermal fluctuations.

The exchange bias field H_E in AFM-FM bilayers is strongly affected by the sample microstructure and the cooling process. It has been found that H_E can be either positive or negative as a function of the field applied during the cooling process [2]. In some cases, double hysteresis loops (i.e. coexistence of positive and negative H_E) can be observed in certain range of cooling fields or by zero field cooling a sample in a partially demagnetized state [3].

In this work we have studied the spatial dependence of the exchange bias field using focused Transverse Magneto-Optical Kerr Effect (T-MOKE) as a function of the cooling process used to induce the low temperature double hysteresis loops.

Figures 1(a) and (b) show the T-MOKE hysteresis loops of a FeF_2(100nm)/Ni(21nm) bilayer at 20 K illuminating the whole sample area after two different cooling processes: In Fig. 1(a) the sample has been zero field cooled (ZFC) after demagnetizing it at room temperature to a state of zero remanence. In Fig. 1(b) the sample has been field cooled (FC) in a saturated state with an applied field of 1 kOe. In both cases, the low temperature hysteresis loops are very similar, with almost zero remanence and two steps at $H_E = \pm 1$ kOe. However, the T-MOKE measurements using a laser beam focused on a 500 μm diameter spot give completely different results. In the case of cooling at remanence, the sample presents a single hysteresis loop with opposite signs of H_E depending on the spatial location of the laser beam (Figs. 1 (c)-(d)). On the contrary, after the field cooling process, very similar double hysteresis loops are obtained in all of the different points of the sample (Figs. 1 (e)-(f)). These differences will be discussed in terms of the domain sizes resulting from the cooling process and the non-averaging regime of EB.

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References:

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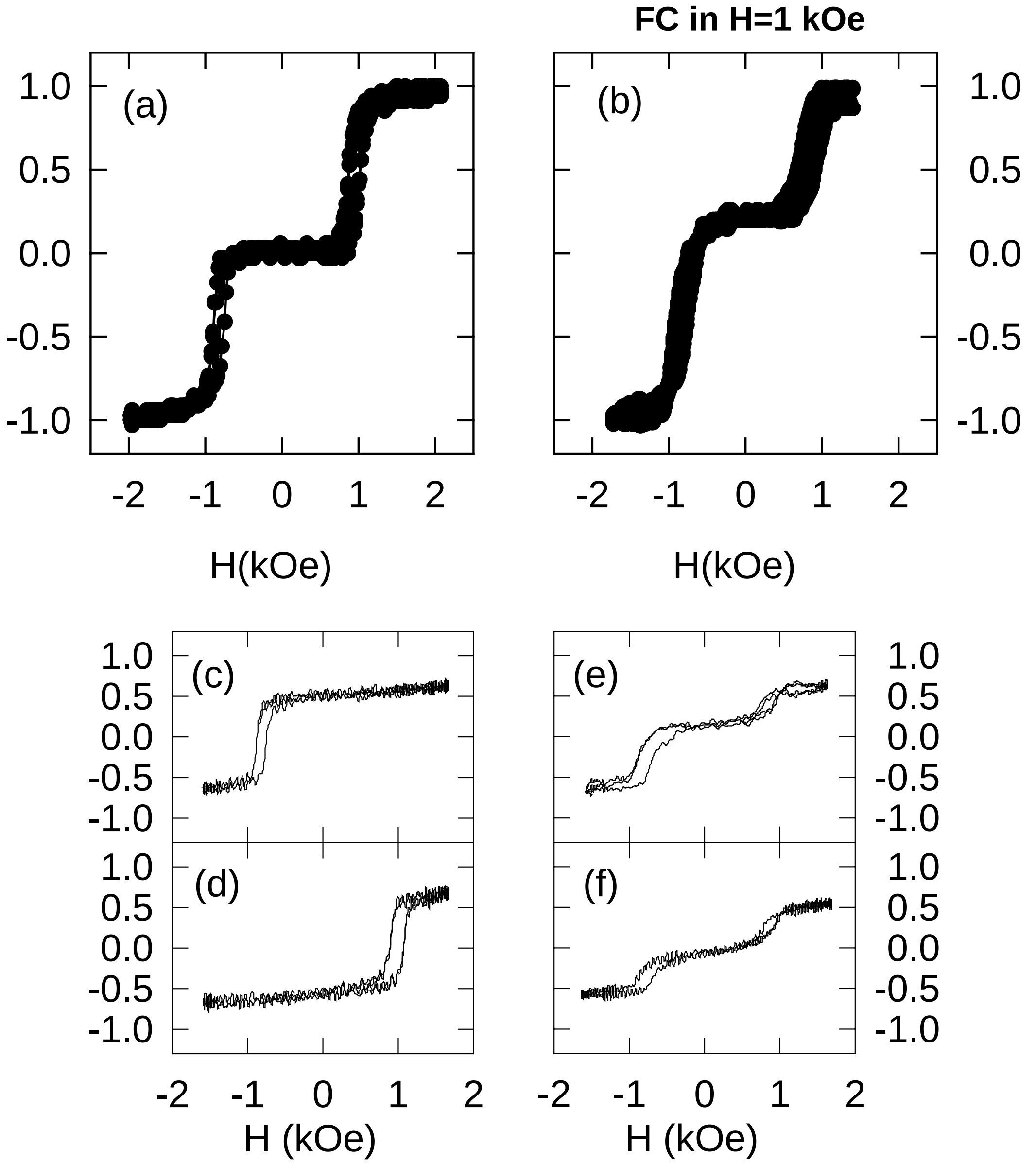

Figures:
Figure 1: T-MOKE hysteresis loop measured from the whole surface area of a FeF_2(100nm)/Ni(21nm) bilayer at 20 K (a) after cooling in a demagnetized state and (b) after cooling in an applied field of 1 kOe. (c) and (d) Focused T-MOKE loops at 20 K from the right and left sample regions after cooling in a demagnetized state. (e) and (f) Focused T-MOKE loops at 20 K from right and left sample regions after field cooling with H=1 kOe.