INTERLAYER EXCHANGE COUPLING TEMPERATURE DEPENDENCE IN ANTIFERROMAGNETICALLY COUPLED MULTILAYERS

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The study of Interlayer Exchange Coupling (IEC) through non-metallic spacers has stimulated intense research, both from the experimental and the theoretical point of view. Most of the available results correspond to the Fe/Si system, where several mechanisms based on tunneling, RKKY-like exchange, interface bands and spin fluctuations have been suggested to be in the origin of the coupling. In addition, the presence of impurities in the spacer or in the interfaces has been recently suggested as a mechanism leading to the coupling observed in the Fe/Si system [1,2]. Interestingly, the temperature dependence of this type of coupling shows a decrease in strength with increasing temperature which is contrary to the predictions made by the model based on quantum interference [3]. These differences in the predicted behaviour of the temperature dependence of the coupling constant can be very useful to identify the mechanisms underlying the experimentally reported IEC through non-metallic spacers.

Although the case of Co/Si has been less studied, recently, weak antiferromagnetic exchange coupling has been reported at room temperature for amorphous Co_xSi_{1-x} / Si multilayers [4]. The presence of antiferromagnetic (AF) coupling has been confirmed by Magneto-Optical Transverse Kerr Effect (MOTKE) for compositions in the amorphous range, below 76 % atomic Co. Figure 1 shows MOTKE hysteresis loops for the case of a 2 period multilayer having the following structure (3 nm Si / 5 nm $Co_{74}Si_{26}$ $)_{x\,2}$ / 3 nm Si / Substrate. Panel (a) corresponds to the loop obtained by applying the magnetic field along the easy axis direction. The plateau observed around zero magnetic field corresponds to the formation and stabilization of the AF state. Interestingly, the switching field needed to break this state and reverse the magnetization is very low, of the order of only 2 Oe for passing from positive to negative saturation. A detailed characterization by MOTKE of the AF plateau and switching field has been done as a function of T. Interestingly, for this simple case of a 2 period multilayer, the coupling strength, J, can be easily written in terms of the H_1-H_4 fields indicated in Figure 1. This has been used to characterize the temperature dependence of J [5]. The results indicate that J decreases when increasing the temperature, in agreement with the predictions of some of the theoretical models [1,2].

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Figures:

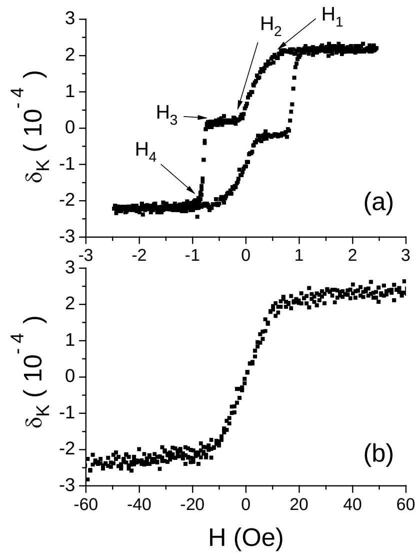

Figure 1. MOTKE hysteresis loops for a two period multilayer measured applying the magnetic field along the easy (a) or hard (b) axis direction. The plateau observed in panel (a) is characteristic of the AF coupling. Panel (b) confirms the in-plane uniaxial magnetic anisotropy of the films.