Magnetic properties of Fe-NiO bilayers grown on MgO(100)

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Exchange bias (EB) phenomenon occurring in the systems composed of ferromagnetic and antiferromagnetic substances finds wide technological applications in read heads of recording devices and magnetoresistive random access memories (MRAM). Since the discovery in 1956 by Meiklejohn and Bean a lot of theoretical models explaining EB have been created but a satisfactory quantitative explanation of this phenomenon is still lacking.

In order to shed more light on the complex phenomenology of EB, a thorough analysis of the magnetic properties of a model NiO- Fe epitaxial system was performed.

The bilayer structures were prepared in UHV using molecular beam epitaxy (MBE) in both Fe/NiO and NiO/Fe configurations. A fourfold magnetic anisotropy of Fe films was modified using different in plane orientations of Fe flux (along Fe [100] easy or Fe [110] hard magnetocrystalline axis) and two thicknesses of Fe (15ML and 50 ML thick).

Magnetooptic Kerr effect (MOKE) magnetometry was used to study magnetization reversal under the applied field, revealing the role of magnetic anisotropies. Magnetic domain structure was studied in remanence using magnetic force microscopy (MFM). The chemical composition of the interfaces between Fe and NiO was described using ^{57}Fe conversion electron Mössbauer spectroscopy (CEMS). A field cooling procedure together with the MOKE measurements were applied in order to determine exchange bias fields (H_{EB}).

Deposition order (NiO deposited onto Fe vs Fe deposited onto NiO) showed a great influence not only on the chemical composition of the interface but also on the structural and magnetic properties of the resulting films due to different growth modes and lattice strains. The interplay between magnetocrystalline and growth induced anisotropies was found to strongly depend on the film thickness and deposition order. The complex magnetic structure of the investigated system will be discussed and linked to the occurrence of the exchange bias.

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