Magnetic domains studies in strongly and weakly exchange coupled Co/NiO bilayers

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Co/NiO bilayers were prepared at 293 K onto glass and SiO_2(101)/Si(111) substrates using UHV (5×10^{-10} mbar) RF/DC magnetron sputtering. The Co layers were deposited using a DC source in an Ar atmosphere. The NiO-layer was prepared using a RF source in Ar + O_2 atmosphere. The chemical composition and the cleanness of all layers was checked *in-situ*, immediately after deposition, transferring the samples to an UHV (4×10^{-11} mbar) analysis chamber equipped with X-ray photoelectron spectroscopy (XPS). Finally, 5 nm - Cu cap layer was deposited to prevent the oxidation of the Co layer. Selected samples were also analysed by Auger electron spectroscopy (AES) with depth-profile analysis in order to confirm with a chemical method the actual composition of the NiO-Co interfaces.

The structure of the samples was examined *ex-situ* by standard θ-2θ X-ray diffraction with Co-K_α radiation. The magnetic characterisation of the bilayers was carried out at RT using the magnetooptical Kerr effect and a vibrating sample magnetometer (VSM). For the Co/NiO bilayers with $d_{Co} > 20$ nm the high-angle X-ray diffraction patterns show an appreciable (111) texture of fcc-Co and NiO. The average cobalt grain size in direction perpendicular to the substrates, as determined from the Scherrer equation, are comparable to their respective sublayer thicknesses. From the exponential variation of the XPS Co-2p and Ni-2p integral intensities with increasing layer thickness we conclude that the Co and NiO layers grow homogeneously. Results on AES with depth profiling showed that at the Co-NiO interface itself only oxygen is present, making it very likely that only NiO is formed and no other nickel or cobalt compounds, which grow apparently with smaller probability. Furthermore, the XPS peaks positions and shape of the spectrum revealed formation of the single phase NiO layer during the reactive RF sputtering. The above result is very important in interpretation of magnetic properties of the bilayers, because the exchange coupling at the interface depends on the stoichiometry of the AFM layer.

Results on magnetic measurements showed that the exchange-biasing and coercivity fields are inversely proportional to the Co layer thickness down to 2nm. On the other hand, an average exchange coupling energy for the NiO-Co interface strongly depends on the preparation conditions. Therefore, the samples with strong (0.04 mJ/m^2) and weak (0.005 mJ/m^2) coupling energy were studied by Kerr microscopy to determine domains and walls structure during the magnetisation reversal process of the top Co layers. For the Co layers with the strong interface exchange coupling we have observed large uniform domains and 180^o walls. On the other hand, the Co layers with the weak interface coupling showed large domains with a strong ripple structure and nonuniform 180^o walls.

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