Exchange bias effects in Co/CoO coupled with molecular layers

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In systems where a ferromagnetic and an antiferromagnetic layers are put in contact, exchange bias (EB) effects can arise. In presence of EB, visible modifications of the magnetic properties of the ferromagnetic layer are registered, such as the shift of the FM hysteresis loop and the modification of its coercivity. The ratio between the coupling energy at the interface between the layers and the anisotropy energy of the AFM determines the coupling regime and the reversal mechanism in these systems. In this work we were able to tune the EB effect acting on the spin configuration of the AFM layer by the insertion of a molecular layer on top of the FM/AFM interface.

We deposited polycrystalline thin films of Co, ranging from 5 to 10 nm thick and we formed a bilayer with a single interface between Co and CoO by exposing the sample to a controlled oxygen atmosphere (10^2L), generating an oxide thickness of 2 nm. On the top of CoO a thick molecular layer (25nm) was deposited. We focus on Gaq3(Gallium-quinoline) and C60 (buckminsterfullerene) as molecular layers because they have been proved to hybridize with magnetic layers modifying their magnetic properties. Temperature dependent of Co hysteresis loops of the samples were acquired after cooling down to 50 K after appropriate training. The presence of the molecular layer determines an hardening of the Co layer: C60 shows the largest increase of coercive field of Co with respect to reference Co/CoO samples produced without additional coatings.

We interpret our data considering the hybridization with molecular layer as source of AFM magnetic defects. These defects decrease the anisotropy locally and lead to an overall reduction of the AF energy. This reduction of the AF energy gives rise to a local energy minimum for certain defect positions relative to the interface. The domain walls can be pinned at such positions and contribute to the increase of coercivity.