Influence of NiO layers on Exchange Bias Coupling and Perpendicular Magnetic Anisotropy of Co layers

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Nowadays, magnetic multilayers consisting of oxide layers have been intensively investigated due to their crucial role in modification of magnetic properties of ferromagnetic (F) films. For example, it was recently shown that metal oxide (MO) layers may induce strong Perpendicular Magnetic Anisotropy (PMA) [1] and/or Dzyaloshinskii-Moriya interaction at the F/MO interface [2]. Both effects can also be controlled with antiferromagnetic oxides (AFOs) [3, 4], which also gives an additional degree of freedom to tune magnetic properties through exchange bias (EB) coupling.

Here, we focused on NiO^b/Co/Au and NiO^b/Co/NiO^t polycrystalline systems (the superscript b and t denote the bottom and top NiO layer, respectively) where PMA of Co layer and EB coupling between NiO and Co layers were investigated. For both systems, we found strong PMA of Co layers and strong EB coupling between Co and NiO [5]. The results for the NiO^b/Co/NiO^t system are particularly interesting because the Co layer is only in contact with the oxide material. This shows that it is possible to achieve a strong PMA of the F layer replacing the heavy metals by AFOs. Moreover, the coercivity and the exchange bias (H_{EB}) field almost doubled in comparison to those observed for the NiO^b/Co/Au and Au/Co/NiO^t systems. This can be explained assuming an additive contribution of the NiO^b/Co and the Co/NiO^t interfaces to the effective EB coupling. Additionally, for NiO^b/Co/Au and NiO^b/Co/NiO^t systems, we demonstrated that after field cooling in moderate temperatures (∼450 K) the PMA is enhanced due to an increase of surface contributions to the effective anisotropy. However, further field colling procedure up to 450 K enables to tune H_{EB} in a wide range without perturbing other magnetic properties of importance.

References:

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