Interlayer Exchange Coupling in Magnetic Layered Systems Containing Mn Component

R. Anwar,[1] A. Pietruczik,[1] P. Aleszkiewicz,[1] W. Dobrogowski,[2] A. Maziewski,[2] and A. Wawro[1]

[1] *Institute of Physics, Polish Academy of Sciences, Warsaw, Poland*

[2] *Faculty of Physics, University of Bialystok, Bialystok, Poland*

Magnetic ultrathin layered systems exhibit numerous tunable properties governed by the composition, thickness, and stacking sequence of the constituent layers. These properties include (PMA), (IEC), (iDMI), and magnetic domain structure. In particular, systems combining ferromagnetic (FM) layers with heavy metals (HM) possessing strong spin–orbit coupling are predicted to host enhanced iDMI and chiral magnetic textures. Recent theoretical studies suggest that Mn-containing multilayers, such as Au/Mn/W-based systems [1] may exhibit especially strong iDMI. Motivated by these predictions and previous studies of stacks with Mo-based spacers [2, 3], we investigate static magnetic configurations in Co/Mn-based multilayers of increasing complexity. The systems include a single Co layer, two Co layers separated by a Mn spacer, and two Co layers separated by composite double-layer spacers (Mn/Pt, Mn/W, Mn/Re). All samples were fabricated by molecular beam epitaxy. Magnetic states and reversal processes of the investigated systems are deduced from hystersis loops recorded in steup exploiting visual (VMOKE) and polar (PMOKE) magnetooptical Kerr effects. For single Co layers, the magnetic anisotropy strongly depends on Co thickness (d_{Co}) and stacking sequence, with PMA stabilized over a limited (d_{Co}) range that is further reduced by the presence of a bottom Mn layer. In bilayer Co systems, interlayer coupling modifies the magnetic anisotropy of each layer. Simple Mn spacers predominantly mediate FM IEC, while double-layer spacers lead to more complex states, includes AFM and FM coupling with perpendicular or in-plane orientations. The resulting magnetic configuration is governed by the interplay between the magnetic anisotropy of individual Co layers (depending on (d_{Co}) and the nature of adjacent layers) and the type and strength of the interlayer exchange coupling (depending on the spacer composition, thickness and sequence). By tuning the thicknesses of the component layers and their stacking order, desired magnetic proper- ties can be achieved. Moreover, due to the asymmetric environment of the Co layers, the presence of iDMI is expected, which may significantly influence the domain structure in systems with PMA. These results demonstrate that Mn-based spacers act as magnetically active layers that provide an efficient route for tuning IEC, magnetic anisotropy, and non-collinear spin configurations in magnetic multilayers.

References:

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