Magnetic Anisotropy of Ultrathin Co-Layers Deposited by Electron Beam Evaporation in Moderate Vacuum Conditions

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Perpendicular magnetic anisotropy (PMA) in Co/Pt multilayers has been broadly studied for decades due to their potential for technological applications, particularly in the field of high-density magnetic storage and spintronics.[1] The main approach to fabricate these materials is magnetron sputtering,[2] offering high quality thin films and good control on critical growing parameters. However, its deposition geometry makes difficult to integrate with nanopatterning, often giving rise to problems with the quality of the edges of the nanostructures. Electron beam evaporation (EBE) is an accessible and a non-conformal physical vapor deposition technique to easily create ultra-thin film nanopatterns with a high degree of PMA for spintronic applications. There are not many studies using this technique, and those existing are based on very low vacuum pressures ($<10^{-8}$ mbar).[3] Pressure control is a crucial parameter for roughness and epitaxiality control of deposited layers and, therefore, for a good thin film quality and a high degree of PMA. In this work, we explore the magnetic and structural properties of ultra-thin Co/Pt multilayers (below 1nm thick) evaporated in lower vacuum conditions compared to previous literature (up to $\sim10^{-5}$ mbar). Results show that a Cu buffer layer between the Si substrate and the Co/Pt heterostructure is key to promote a high degree of PMA in the aforementioned vacuum conditions. The proper engineering of the Cu layer thickness dramatically changes the magnetic properties of the multilayer, such as the coercivity or the loop squareness. This work provides with an easy path to develop magnetic heterostructures compatible with nanolithography, tunable magnetic properties and high degree of PMA even on rough pressure environments.

References

[1] Yang, et al. Nature 606 (2022) 663-673
[2] N. Soriano, et al. AIP Advances 10 (2020) 065321
[3] Bromley, et al. Scientific Reports, 12 (2022) 7786

Figures

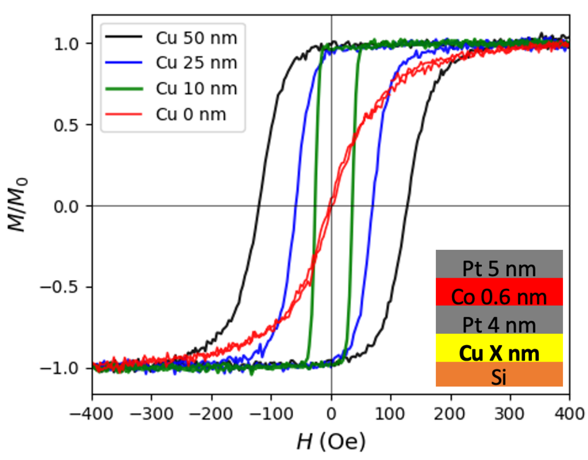

Figure 1: Normalized polar Kerr hysteresis loops of e-beam evaporated Si/Cu(x)/Pt(4)/Co(0.6)/Pt(5) ultra-thin films (units given in nm). All samples were fabricated in the same run.