

Observation of domain walls without magnetic domains in ferrimagnetic Tb/Co multilayers using NV centre microscopy

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The presence of two magnetic sublattices in ferrimagnetic Tb/Co multilayers (MLs) opens the possibility to pattern regions with opposite sublattice dominance by selective modifying one sublattice. This has been achieved by reducing the contribution of the Tb sublattice using either ion bombardment [1] or plasma oxidation [2] or enhancing the contribution of the TM sublattice by deposition on a Co underlayer [3]. In all these cases, this leads to a shift of the room temperature compensation point to higher concentrations of Tb. It has been suggested that a unique magnetic texture can form at the interface between two locally modified regions of opposite sublattice dominations: magnetic domains without domain walls (DWs) or DWs without domains [4]. However, the presence or absence of the DW in these states has only been inferred from previous experimental results by micromagnetic simulations and minor loop shifts between the two states.

In this study, we investigate these unique magnetic configurations using NV centre magnetometry, magnetic force microscopy and PEEM-XMCD. To achieve this, we used a 30 keV Ga⁺ focused ion beam to fabricate a series of periodic lattices of bombarded squares (with size 1×1 μm²) embedded in a Tb dominant (Tb⁺) matrix in (Tb/Co)₆ MLs that were Tb⁺ prior to bombardment. Each lattice was uniformly irradiated with ion doses in the range 1×10¹³–17×10¹³ ions/cm². The stray field from the patterned structures was measured using NV centre microscopy in both states to directly observe the DW in monodomain state for the first time. This allowed us to study the magnetic configurations for lattices of above and below the ion dose at which the two sublattices are magnetically compensated as well as how the change in saturation magnetization affects such configurations.

References:

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