Exchange Bias

An obstacle for understanding the exchange bias (EB) effect is that only a subset of the pinned uncompensated spins (pinUCS), those pinned and coupled to the ferromagnet (F) are responsible for the EB effect. Experimental methods that measure the pinUCS density distribution with spatial resolution comparable to the materials grain size are needed. Here we use quantitative, high-resolution magnetic force microscopy (MFM) to measure the local areal density of pinned uncompensated spins (pinUCS) and to correlate the F-domain structure in a perpendicular anisotropy Co/Pt multilayer with the pinUCS density in the CoO antiferromagnet [1]. Larger applied fields drive the receding domains to areas of proportionally higher pinUCS aligned antiparallel to F-moments. This confirms our prior results [2-4] that these antiparallel pinUCS are responsible for the EB effect, while parallel pinUCS coexist. The experimentally observed domain evolution with field could be matched well with a 2D phase-field model that incorporates the 10 nm-resolution measured local biasing characteristics of the antiferromagnet [5]. Frustration limits the exchange bias field in typical ferromagnet/antiferromagnet EB systems, and it can be avoided if the antiferromagnet is replaced by a rare-earth ferromagnetic layer; exchange bias fields larger than 1T were observed in this case [6,7] (see work on rare-earth transition metal ferrimagnets).

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