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The role of vortex-antivortex pairs in the magnetization reversal of Permalloy thin films

S. Singh, H. Gao, U. Hartmann
Saarland University, Institute of Experimental Physics, Saarbrücken, Germany

Text

Substructures of magnetic domain walls such as vortex-antivortex pairs have a strong influence on the wall's static and dynamic properties within applied magnetic fields or under the influence of current pulses [1, 2]. By applying an in-plane magnetic field during Magnetic Force Microscope measurements, we analyzed the details of magnetization reversals along the long and short axes of micro-patterned Permalloy thin film samples, respectively. The evolution of domain wall clusters and the transfer of the magnetic flux across the domain walls were investigated by observing the nucleation and annihilation of substructures inside the walls. The transfer of magnetic flux across the domain walls was observed to be governed by cumulative transport of a resulting single vortex along the axis of the wall. Furthermore, the experimental findings were evaluated by micromagnetic calculations. Based on the resulting magnetic energies within the whole sweep range of the applied field, it can be concluded that the demagnetization and exchange energies dominate the Zeeman energy at small applied fields. This restricts the nucleation and annihilation of substructures inside the walls near the remanent state of the sample.

[1] A. Hubert and R. Schäfer, Magnetic domains: the analysis of magnetic microstructures (Springer, Berlin, 1998).

[2] C. Zinoni, A. Vanhaverbeke, P. Eib, G. Salis, and R. Allenspach, Phys. Rev. Lett. 107, 207204 (2011).

Authors

First author: Sukhvinder Singh
Presented by: Sukhvinder Singh
Submitted by: Sukhvinder Singh

