Evolution of stripe domains in ferromagnetic thin films

Sukhvinder Singh, Haibin Gao, Uwe Hartmann

Institute of Experimental Physics, Saarland University, Saarbrücken, Germany

Since the first observation of stripe domains in ferromagnetic films, i.e., since more than 50 years [1], the formation of these domains from an in-plane domain structure was considered as an abrupt nucleation process. Domains separated either by Néel or cross-tie domain walls (as shown in Fig. 1(a)), were supposed to be abruptly superimposed by stripe domains with an out-of-plane magnetization component (as shown in Fig. 1(b)). On the basis of our work, the widely used domain phase diagram [2] can now be refined. We found that the formation of stripe domains is a continuous transition and that they evolve from the domain walls at a thickness well below the critical thickness [2,3]. The latter was so far considered as a threshold for the formation of stripe domains. Local modifications induced by a perpendicular anisotropy inside the domain walls and wall junctions were observed in detail. A periodically oscillating out-of-plane magnetization is formed inside the walls. This expands throughout the in-plane domains to form stripe domains all over the film. A threshold limit for the perpendicular anisotropy inducing the evolution of stripe domains could be defined.

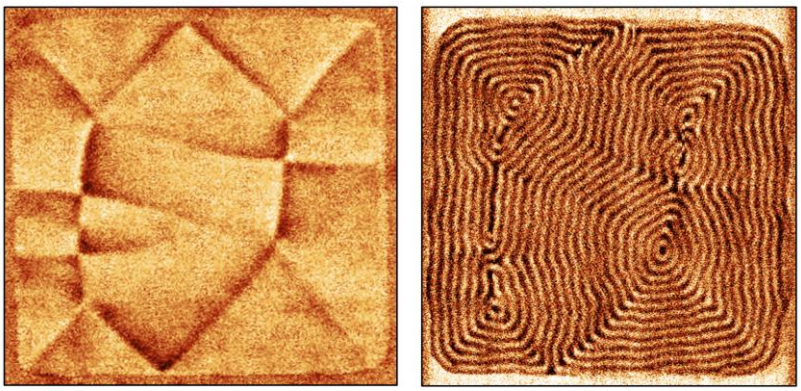

Figure 1: The magnetization configuration of a 5 x 5 μm^2 Permalloy film at (a) 45 nm thickness with in-plane domains separated by Néel and cross-tie walls, and (b) at 85 nm thickness with superimposed stripe domains.

[1] N. Saito, H. Fujiwara, and Y. Sugita, J. Phys. Soc. Jpn. 19, 1116 (1964).

[2] A. Holz and H. Kronmüller, Phys. Stat. Sol. (b) 31, 787 (1969).

[3] F. Virot, L. Favre, R. Hayn, and M. D. Kuz'min, J. Phys. D: Appl. Phys. 45, 405003 (2012).