Magnetization reversal asymmetry in structured ferromagnetic nanoparticles with hard/soft areas

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Asymmetric hysteresis loops can be found in exchange-bias systems in which a ferromagnet is exchange-coupled with an antiferromagnet [1]. In purely ferromagnetic samples, such effects can occur due to undetected minor loops or thermal effects. While the exchange bias is long established in hard-disk read/write heads and diverse spintronics applications, minor loops are sometimes used for the calculation of first order reversal curves (FORCs). Reports about their technological relevance, however, are scarce. Here we report on micromagnetic simulations of sputtered nanoparticles with different structures and varying height, consisting of tessellations of a defined area. After saturating these nanostructures by a strong magnetic field pulse, several tessellations show distinctly asymmetric, horizontally shifted hysteresis loops, especially in the transverse magnetization component. We show the dependence of this asymmetry on the external magnetic field orientation and investigate the reliability of this effect for randomly oriented magneto-crystalline anisotropy axes per grain.

References:

[1] Blachowicz, T.; Ehrmann, A. Exchange bias in thin films – an update. Coatings 2021, 11, 122