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Surface and Bulk Magnetization Behavior of Isolated Ferromagnetic NiFe Nanowires

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Abstract : The surface and bulk magnetization behavior of template released isolated ferromagnetic Ni₆₀Fe₄₀nanowires of relatively thick diameters (~200 nm), deposited from a dilute suspension onto pre-patterned insulating chips have been investigated experimentally, using a highly sensitive Magneto-Optical Ker Effect (MOKE) magnetometry and Magneto-Resistance (MR) measurements, respectively. The MR data were consistent with the theoretical predictions of the anisotropic magneto-resistance (AMR) effect. The MR measurements, in all the angles of investigations, showed large features and a series of nonmonotonic "continuous small features" in the resistance profiles. The extracted switching fields from these features and from MOKE loops were compared with each other and with the switching fields reported in the literature that adopted the same analytical techniques on the similar compositions and dimensions of nanowires. A large difference between MOKE and MR measurments was noticed. The disparate between MOKE and MR results is attributed to the variance in the micro-magnetic structure of the surface and the bulk of such ferromagnetic nanowires. This result was ascertained using micro-magnetic simulations on an individual: cylindrical and rectangular cross sections NiFe nanowires, with the same diameter/thickness of the experimental wires, using the Object Oriented Micro-magnetic Framework (OOMMF) package where the simulated loops showed different switching events, indicating that such wires have different magnetic states in the reversal process and the micro-magnetic spin structures during switching behavior was complicated. These results further supported the difference between surface and bulk magnetization behavior in these nanowires. This work suggests that a combination of MOKE and MR measurements is required to fully understand the magnetization behavior of such relatively thick isolated cylindrical ferromagnetic nanowires.

Keywords : MOKE magnetometry, MR measurements, OOMMF package, micromagnetic simulations, ferromagnetic nanowires, surface magnetic properties
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