Magnetic properties of nanowires and nanotubes

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With the growing need for the miniaturization of sensors, storage devices and biomedical chips, magnetic nanomaterials have gained much importance in the last years. Nanowires (NWs) and nanotubes (NTs) have thus received increased attention, as they exhibit anisotropic (shape-dependent) collective properties. Most applications use arrays of nanostructures, adding new degrees of freedom as the importance of inter-element coupling increases. The ability to control the NW/NT dimensions, the array configuration and interwire distance, allow obtaining novel phenomena induced by nanoscopic confinement or proximity effects. Therefore, a thorough understanding of the magnetic properties of NW and NT arrays with tailored geometries is of extreme importance for their implementation in future applications.

The ability to tune the magnetization reversal modes of nanoelement arrays by external parameters, such as the applied magnetic field, has also become attractive as it improves the implementation and control of novel devices. Depending on the geometrical specifications of the system under study, three main modes of magnetization reversal have been previously identified: coherent mode (C), transverse mode (T), and vortex mode (V). In recent reports a simple analytical model has been proposed to understand the magnetization reversal processes by predicting the variation of the coercivity with the angle of applied external magnetic field and allowing the understanding of the magnetization reversal processes for NW and NT arrays with different geometrical parameters.

Finally, the magnetization in the NW arrays is found to reverse by the nucleation and propagation of a transverse-like domain wall; on the other hand, for the NT arrays a non-monotonic behavior occurs above a diameter of 50 nm, revealing a transition between the vortex and transverse reversal modes.

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