MAGNETIC REVERSAL MODES IN MAGNETITE NANOTUBE ARRAYS SYNTHESIZED BY ATOMIC LAYER DEPOSITION

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Magnetic properties are related to the geometrical parameters for magnetic nanotubes, where the magnetization reversal strongly depend on the relation between the external radius and the internal radius of the nanotube [1-2], so if it is possible to get control over the geometry, implies that is possible to control the reversal of the magnetization in nanotubes. Technological applications of nanotube systems require a deep understanding and experimental characterization of their magnetic behavior. Changes in the internal and external radii are expected to strongly affect the magnetization reversal mechanism and thereby the overall magnetic response [3]. In this study, three samples of magnetic nanotubes with different external radius and same wall thickness were investigated. Arrays of highly-ordered Fe$_3$O$_4$ magnetic nanotube arrays were obtained by combining atomic layer deposition of Fe$_2$O$_3$ in porous alumina membranes with a subsequent thermal reduction process. In order to obtain Fe$_2$O$_3$ tubes, one ALD Fe(C$_5$H$_5$)$_2$/O$_3$ cycle was repeated 1150 times. After the ALD process, the sample is reduced from Fe$_2$O$_3$ to magnetic oxide Fe$_3$O$_4$ under hydrogen atmosphere. The morphology of nanotubes was investigated by scanning electron microscopy and energy dispersive spectroscopy analysis was carried in order to obtain a compositional analysis of the magnetic iron oxide. Magnetic properties, such as coercivity and squareness, have been determined in a vibrating sample magnetometer at room temperature depending on the applied field direction; from parallel to the nanotube axis to perpendicular to the nanotube axis. Different magnetic behaviours of the hysteresis loops were found in nanotubes with different external diameter, keeping constant the wall thickness, and a theoretical model was used in order to explain these effects.

Keywords: Nanotubes, Magnetic reversal, Atomic Layer deposition

References:


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