Study of Dynamic Magnetization Reversal Process in Ni Nanowires

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This paper reports on the investigation of dynamic magnetization reversal process in Nickel nanowires by employing nanosecond magnetic pulse. Magnetization reversal process is characterized in terms of switching fields and time (ns to ps). If an external magnetic field of sufficient strength is applied parallel to a magnetic sample, the magnetization direction reverses in a characteristic way. The time required for a complete magnetization reversal of a magnetic material under the magnetic field called dynamic relaxation or switching time. The experimental techniques to measure magnetization reversal are described in this paper.

Nickel nanowires are grown by electrodeposition technique through the pores of nanochannel alumina (NCA). A detail description of the fabrication process of nickel nanowires inside porous alumina template has been reported in ref. [1]. The nanowires are examined by X-ray diffraction (XRD) for crystallographic analysis and surface analysis is carried out with atomic force microscopy (AFM), scanning electron microscopy (SEM) and Focused Ion Beam (FIB) technique. Magnetic properties of the nanowires grown inside the NCA templates are investigated using the Vibrating Sample Magnetometer (VSM). Figure 1 shows structural analysis of the nanowires grown inside the NCA templates by FIB technique.

Two different techniques are used to determine the nanosecond magnetization reversal in the nanowires: Magneto-Optic Kerr Effect (MOKE) described in Figure 2 and nanosecond pulsed field magnetometer. In both techniques, a co-planar waveguide, shown in Figure 2(b), is used as a source of nanosecond magnetic field and is generated using 0-200 V, 2-200 nanosecond pulse generator and a Helmholtz pair has provided the saturating and bias fields required for both techniques. Results of dynamical behavior as a function of several variables such as applied magnetic bias field, magnetic pulsed field amplitude and width are described in detail using both techniques. A computer simulation package called Object Oriented Micro-Magnetic Framework (OOMMF) has been used to simulate the magnetic domain patterns of the samples. These simulated domain patterns are compared with the experimental results based on MOKE images of magnetic domain patterns. In this paper a discussion of the dependence of magnetization reversal on the nanostructure that has evolved from the electrodeposition conditions will be presented.

References:

1) I. Z. Rahman, K. M. Razeeb and M. A. Rahman, Fabrication and characterization of nickel nanowires deposited on metal substrate, J. Magn. Magn. Mater. 262(1) (2003) 166.

Figures:

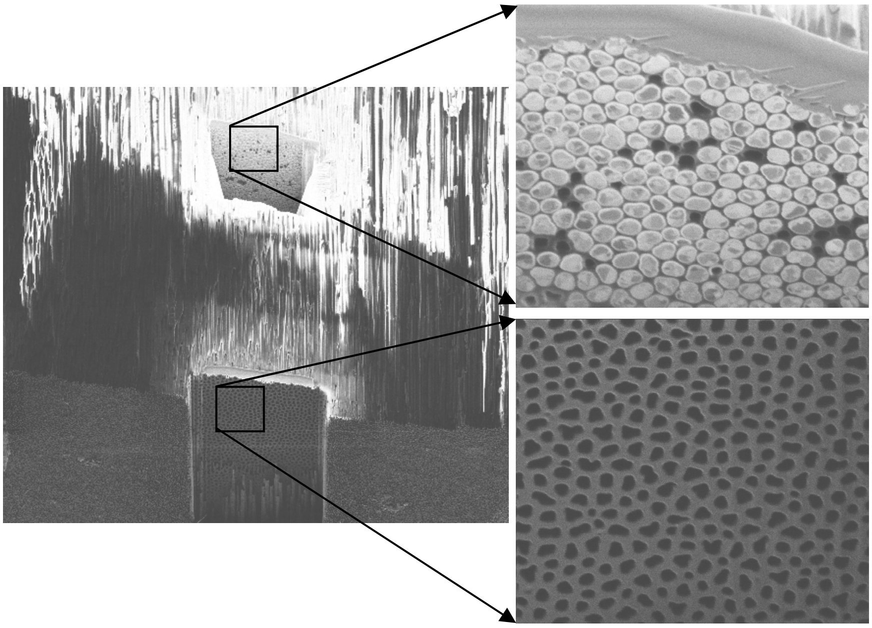

Figure 1: Focused Ion beam images of nano wire array grown inside NCA template. Top part shows the NCA pore filled with nickel nanowires and bottom part shows NCA nano pore without any fillings.

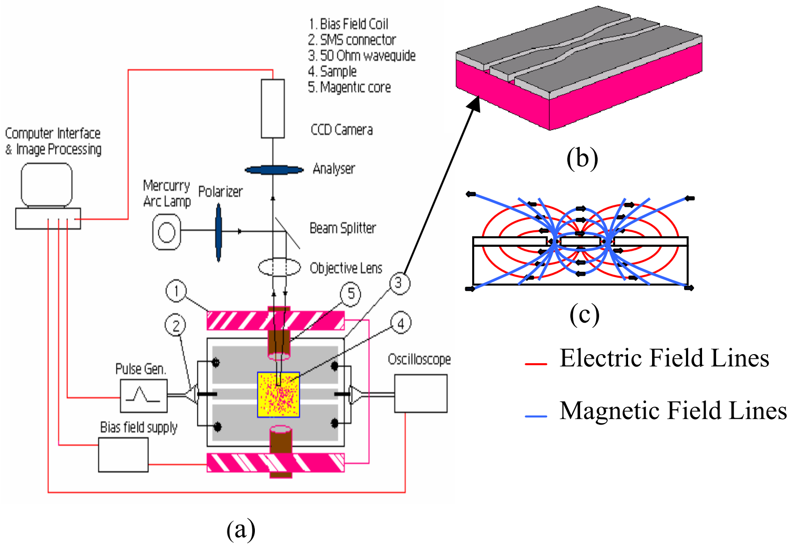

Figure 2: (a) Experimental set-up of longitudinal MOKE **(b)** Fabricated Co-Planar Waveguide (CPW) 3D view **(c)** Electric and magnetic field distribution in CPW