Electrochemical Synthesis of Ni Magnetic Wire Arrays

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Introduction

Patterned magnetic fine structures are an important class of materials for various technological applications including data storage devices. The areal density of the conventional types of magnetic recording media is anticipated to reach their upper limit, which demands a new type of recording media to further increase the storage capacity. Patterned arrays of magnetic wires are one of the promising candidates as they can provide opportunities to develop three-dimensional magnetic recording media, however, it is necessary to establish their fabrication method and to better understand their magnetic behavior in correlation to the microstructure. The objective of this study is to investigate the electrochemical synthesis of magnetic Ni wire arrays and to clarify their magnetic properties in correlation to the microstructure.

Experimental

Ni magnetic wires were fabricated inside a porous alumina template that has pores with their length of 50 ± 1 μm, diameter of 80 ± 8 nm, and porosity of 10%. One of the template surfaces was sputter-coated with Pt that acts as a conductive layer for electrodeposition. The wires were indeed made into a Cu-Ni-Cu trilayer structure with various layer thicknesses. The wires were grown by pulsed electrodeposition from an aqueous solution with 0.2 M $NiCl_2$, 0.5 M H_3BO_3 and 0.2 M $CuSO_4$, 0.5 M H_3BO_3[1]. The magnetic properties of the samples were characterized by Vibrating Sample Magnetometer (VSM), their magnetoresistance (MR) effects were measured at room temperature and their microstructure was identified by Scanning Electron Microscope (SEM).

Results and Discussion

Figure 1 shows the image of the fabricated Ni magnetic wires taken by SEM where the actual length of the wires are around 4.4 μm. However, the length of the wires were longer than expected due to the possibility of the solution did not enter the pores. Therefore, the wires can be said successfully deposited inside the alumina template.

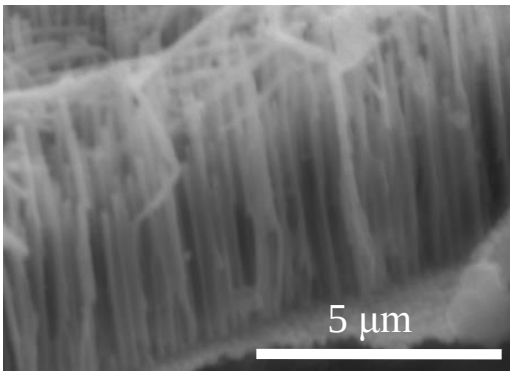

Fig. 1 Ni nanowire arrays.

As shown in the magnetic hysteresis curves measured for Ni wire sample with the length of 4.4 μm (see Fig. 2), the coercive force is larger when magnetic field was applied parallel to the wire compared to when applied perpendicularly. Also, the magnetic susceptibility is steeper when magnetic field was applied perpendicular to the wire. Based from these two reasons, the Ni wires are easily magnetized when the magnetic field is applied in the direction parallel to the wires.

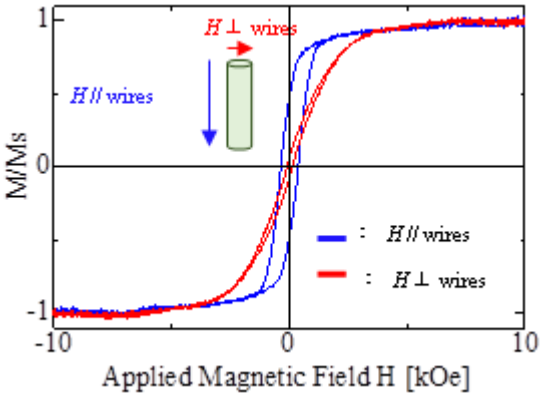

Fig. 2 Magnetic hysteresis curves of Ni wires

References

[1] M.S. Chandrasekar, Malathy Pushpavanam, *Electrochimica Acta* 53 (2008) 3313–3322