SB04

Microstructure of Nanopores in AAO Templates Favoring the Growth of Nickel Nanowires by Electrodeposition

Jong-Hyeon Jeong[1], Sun-Hong Kim[1], Ki-Ho Kim[1], Yong Choi[2], Sung-Soo Kim[1]*
[1]Department of Materials Engineering, Chungbuk National University, Cheongju 361-763, Korea
[2]Department of Electronic Materials Engineering, Sunmoon University, Asan 336-840, Korea
*Corresponding author: sskim@chungbuk.ac.kr, Phone: +82 43 261 2418, Fax: +82 43 271 3222

The fabrication of nanoscale structures has attracted much interest recently owing to their potential use in many applications. Creation of well-ordered metallic or semiconducting nanowire arrays has become important aspects to realize their promise in nanomagnetics or nanoelectronics [1]. Among the various methods, electrodepostion of nanowires into porous anodic aluminum oxide (AAO) template is the simple, low-cost and high throughput technique [2]. Morphology of periodical pores in AAO templates has been studied in relation with anodizing process, focusing on the growth of nickel nanowires by electrochemical deposition. The AAO templates were prepared by a two-step anodization process. The high purity aluminum plates were anodized in oxalic acid aqueous solution with variation of cell voltage. The pore size and inter-pore distance both increase with the applied potential. For AC electrodeposition of nickel nanowire arrays, barrier layer of alumina at pore tips was thinned by current-limited anodization process. During the post treatment of barrier thinning, small-size pores with split-up structure at the tips are observed due to current-limited anodizing process (decreasing cell potential) as shown in Fig. 1. The rectifying properties of the barrier layer allow the pores to be filled by nickel by AC electrodeposition. The nickel nanowires array shows the ferromagnetic properties with a preferred magnetic orientation along the wire axis due to shape anisotropy of nanowires with high aspect ratio as shown in Fig. 2.

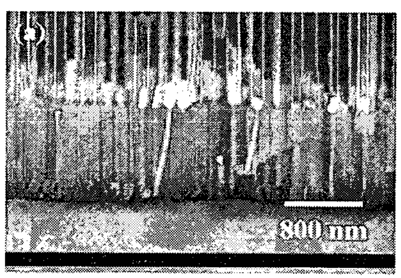

Fig. 1. Pore structure after barrier thinning.

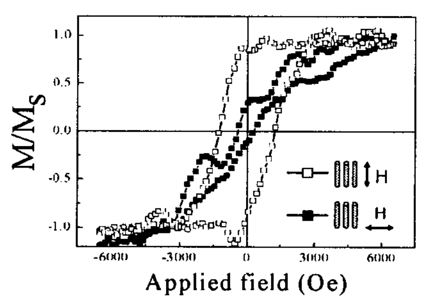

Fig. 2. Magnetization curve of Ni nanowire.

REFERENCES
[1] S. Kato, H. Shinagwa, H. Okada, G. Kido, K. Mitsuhashi, Sci. & Tech. Adv. Mat. 6, 341 (2005).
[2] D. J. Sellmyer, M. Zheng, R. Skomski, J. Phys.: Condens. Mater. 13, R433 (2001).

SB05

High-frequency Noise Absorbing Properties of Nickel Nanowire Arrays Prepared by DC Electrodeposition

Jong-Hyun Jeong[1], Sun-Hong Kim[1], Young Keun Kim[2], and Sung-Soo Kim[1]*
[1]Department of Materials Engineering, Chungbuk National University, Cheongju 361-763, Korea
[2]Department of Materials Science and Engineering, Korea University, Seoul 136-713, Korea
*Corresponding author: sskim@chungbuk.ac.kr, Phone: +82 43 261 2418, Fax: +82 43 2713222

Creation of well-ordered metallic nanowire arrays has become important aspects to realize their promise in nanomagnetics or nanoelectronics. Noise absorber in micro-EMC (electromagnetic compatibility) is one of the potential applications of the magnetic nanowire arrays due to their distinguished electrical and magnetic properties [1]. Almost infinite in-plane electrical resistance and high magnetic permeability can beobtained from the periodic array structure of individual nanomagnets with high aspect ratio and nanometer-scaled diameter which is much smaller than skin depth in microwave frequency range. The purpose of this study is to investigate the potential application of the magnetic nanowire arrays in high-frequency noise absorbers. Nickel nanowire arrays are fabricated by electrochemical deposition in highly ordered nanosized pores in AAO (anodized aluminum oxide) templates, and their static and high-frequency electromagnetic properties have been investigated.

The AAO templates were prepared by a two-step anodization process. The pre-treated aluminum plates were anodized in 0.3 M oxalic acid solution under constant voltage 50 V at 5 ℃. After anodization for 3 h, the alumina layer was removed by a mixture solution of 0.2 M phosphoric acidand 0.4 M chromic acid. Then the aluminum plate was anodized again for 30 min under the same anodization conditions as the first step. Subsequent pore widening was conducted by chemical etching in 0.1 M phosphoric acid at 20 ℃ for 1 min. For DC (direct current) deposition of Ni nanowire arrays, the remaining aluminum was removed in saturated $HgCl_2$ solution. A transparent and through-hole (channelled) AAO template was obtained by a subsequent etching of barrier layer in 0.2 M H_3PO_4. Silver thin film was deposited on one side of the through-hole AAO template by sputtering. Nickel was electrodeposited into the channelled pores using a Watts bath solution. The electrolyte temperature was 57 ℃ and pH was 3.8.

Using the channelled AAO templates, a long nickel nanowire array (as high as 12 μm with diameter of 200 nm, and wire density of about 1.6×10^9 wires/cm^2) was fabricated by DC electrodeposition. Magnetic hysteresis was observed with a coercive force of 250~300 Oe depending on the field orientation with respect to wire axis. Noise absorbing properties of the nickel nanowire was measured using the microstrip line [2]. S_{11} parameter increases with frequency and reaches a saturated value of about -10 dB. The reflected power (about 10%) is much less than that of nickelfilm (about -3 dB), which is due to higher in-plane electrical resistance of the nanowire array structure. S_{21} decreases with frequency and has a value of -3 dB at 2 GHz. The attenuation of conduction noise through microstrip line is due to the magnetic loss of individual nickelnanowires. Power absorption of the Ni nanowire array was determined to be 50% in the frequency range above 2 GHz.

REFERENCES
[1] K. H. Kim, H. Orikasa, T. Kyotani, and M. Ymaguchi, IEEE Trans. Magn. **41**, 4075 (2005).
[2] S. T. Kim, G. B. Ryu, and S. S. Kim, J. Appl. Phys. **99**, 08M919 (2006.04).