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금속 나노와이어의 제조와 특성

보보무로드 함라쿠로프[1] · 김인수[1#]

Metal nano-wire fabrication and properties

B. Hamrakulov[1], Insoo Kim[1#]

Abstract

Metal nano-wire arrays on Cu-coated seed layers were fabricated by aqueous solution method using sulfate bath at room temperature. The seed layers were coated on Anodic aluminum oxide (AAO) bottom substrates by electrochemical deposition technique, length and diameter of metal nano-wires were dominated by controlling the deposition parameters, such as deposition potential and time, electrolyte temperature.

Anodic aluminum oxide (AAO) was used as a template to prepare highly ordered Ni, Fe, Co and Cu multilayer magnetic nano-wire arrays. This template was fabricated with two-step anodizing method, using dissimilar solutions for Al anodizing. The pore of anodic aluminum oxide templates were perfectly hexagonal arranged pore domains. The ordered Ni, Fe, Co and Cu systems nano-wire arrays were characterized by Field Emission Scanning Electron Microscopy (FE-SEM) and Vibrating Sample Magnetometer (VSM). The ordered Ni, Fe, Co and Cu systems nano-wires had different preferred orientation. In addition, these nano-wires showed different magnetization properties under the electrodepositing conditions.

Key Words: anodic aluminum oxide (AAO), metal nano-wires, nano-template, electrodeposition

1. 서 론

Fabrication and characterization of metal nano-wires has attracted extensive attention as one of the important fields in modern science [1-3]. Because of their potential applications in high density magnetic memory [4], magneto-electronic devices [5,6]. Fabrication of nano-structures with nano-meter dimension is the starting point of nano-technology research.

The Anodic aluminum oxide (AAO) templates have many desirable characteristics, easy to change the pore diameter and length, good mechanical properties, thermal stability, and corrosion resistance.

Anodic aluminum oxide (AAO) nano-template has been widely used to prepare nano-wire arrays because of their self-organized, honeycomb-shaped, cylindrical and uniform holes can be controlled by changing anodizing conditions and and subsequent procedure. This character is favorable for perpendicular magnetic recording and patterned media.

Recent research, we present successful results for fabrication of metal nano-wires and AAO via anodization process using dissimilar solutions in two step anodizing method. Electrodeposition is employed to fabricate nano-rods in the AAO template.

2. 실험 방법

Commercial AA 1050 Al sheet (low purity 99.8 % Al alloy) with a thickness of 0.4 mm was cut into 60 mm x 60 mm size. AAO nano-template was fabricated with

1. 금오공과대학교 신소재시스템공학부
교신저자: 금오공과대학교 신소재시스템공학부,
E-mail: iskim@kumoh.ac.kr

two-step anodizing method, using dissimilar solutions for Al anodizing. The pore of anodic aluminum oxide templates were perfectly hexagonal arranged pore domains. The holes interval of anodic alumina porous, in other words the cell size, is determined by the applied voltage used for anodization. Pretreated aluminum sheets was anodized in 0.3 M Oxalic acid for 1 h at 5° and a voltage 50V for 1st step and 10wt% Phosphoric acid for 15min at 5°C to to prepare an AAO template.

The average diameter of the pores is about 80 nm. Ni and Ni/Fe/Cu multi-metal layer nano-wires were electrodeposited into the template with method showed in Fig.1.

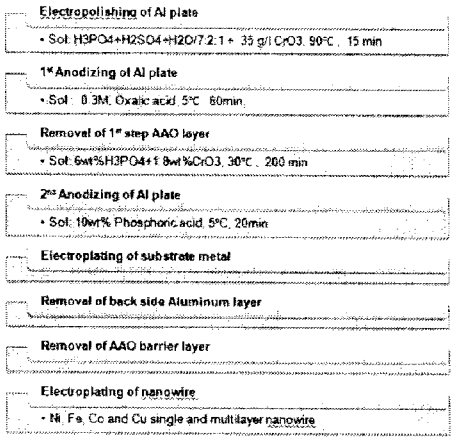

Fig.1 Basic method for fabrication of metal nano-wires

The following compositions had the electrolyte that used to deposit metal nano-wires: Ni ($NiSO_4 \cdot 6H_2O$, 300g/l; $NiCl_2 \cdot 6H_2O$, 45g/l; H_3BO_3, 45g/l), Fe ($FeSO_4 \cdot 7H_2O$, 120g/l; H_3BO_3, 45g/l), Cu ($CuSO_4 \cdot 5H_2O$, 125g/l; H_2SO_4, 100g/l) and saccharin as an additive. Deposition was carried out at room temperature with an AC voltage 0.5A using similar metal rods for each nano-rods and AAO template with aluminum plate as working electrode. After the fabrication of nano-wires, these nano-wires arrays were investigated with FE-SEM and were analyzed with EDS, after chemical removing of AAO template. Prior to FE-SEM imaging, the alumina template was mechanically broken and investigated the cross sectional view of samples.

3. 결과 및 토의

Fig. 2 shows FE-SEM photographs of AAO anodized with different solutions in two step anodizing method using 1st-Oxalic acid and 2nd-Phosphoric acid with similar conditions for anodizing step. It can be found that these AAO nano-pores photographs show highly ordered and uniform holes in Fig. 2 (b). It makes possible to make anodizing of Al with two kinds of solutions to prepare AAO template.

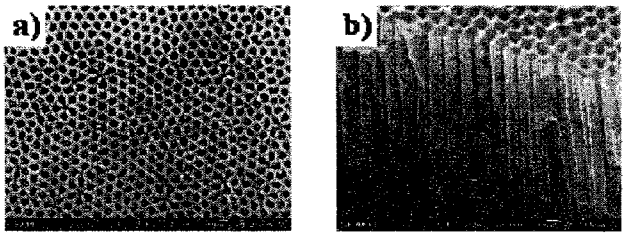

Fig.2 FE-SEM photographs of AAO anodized with dissimilar solutions in two step anodizing method, a) top view b) cross section view

Fig. 3 shows FE-SEM photographs of electroplated, free standing nickel nano-rods and Ni/Fe/Cu multi-metal layer nano-rods after removing AAO nano-template.

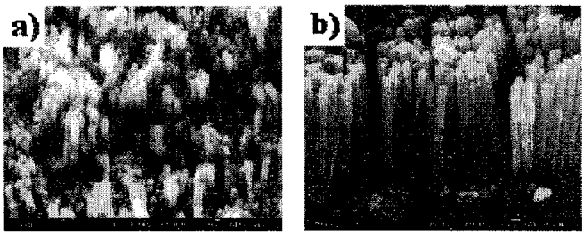

Fig. 3 FE-SEM photographs of a) Copper nano-rod and b) Ni/Fe/Cu multi-metal layer nano-rod

4. 결 론

Fabricated AAO nano-template using dissimilar solutions in two step anodizing method have highly ordered and uniformed holes and attract walls and ordered Ni/Fe/Cu multi-metal layer nano-wires with an average diameter of nano-wires 80nm fabricated successfully by DC electrodeposition in AAO nano-template.

참 고 문 헌

[1] A.R. Deshpande, J.M.K. Wiezorek, J. Magn. Magn. Mater. 270 (2004) 157.

[2] T. Mohri, T. Horiuchi, H. Uzawa, M. Ibaragi, M. Igarashi, F. Abe, J. Alloys Compounds 317–318 (2001) 13.

[3] H. Kato, Y.C. Liang, M. Taya, Scripta Mater. 46 (2002) 471.

[4] A.Blondel, J.P. Meier, B. Doudin, J.P. Ansermet, Appl.Phys.Lett. 65(1994) 3019

[5] A. Bai, C.-C. Hu, Electrochemistry Communications 5 (2003) 78-82

[6] A.Saedi, M. Ghorbani, Materials Chemistry and Physics 91 (2005) 417-423