Accepted Manuscript

Controlling structural and magnetic properties in CoNi and CoNiFe nanowire arrays by fine-tuning of Fe content

Farzaneh Noori, Abdolali Ramazani, Mohammad Almasi Kashi

PII: S0925-8388(18)31584-6

DOI: 10.1016/j.jallcom.2018.04.261

Reference: JALCOM 45899

To appear in: *Journal of Alloys and Compounds*

Received Date: 20 December 2017

Revised Date: 13 April 2018

Accepted Date: 23 April 2018

Controlling structural and magnetic properties in CoNi and CoNiFe nanowire arrays by fine-tuning of Fe content

Farzaneh Noori[1], Abdolali Ramazani[1,2]*, Mohammad Almasi Kashi[1,2]

[1] Institute of Nanoscience and Nanotechnology, University of Kashan, Kashan 87317–51167, Iran

[2] Department of Physics, University of Kashan, Kashan 87317–51167, Iran

*****E-mail: rmzn@kashanu.ac.ir; Phone/Fax: +98 31 5591 2578

Abstract

Herein, $Co_{70}Ni_{30}$ and $Co_xNi_yFe_z$ ($45 \le x \le 70$; $22 \le y \le 33$; $5 \le z \le 30$) nanowire (NW) arrays with a length of approximately 15 μm and diameter of 30 nm have been fabricated using a pulse electrochemical deposition technique in anodic aluminum oxide templates. Increasing the Fe additive concentration (ranging between 0.0035 and 0.05 M) in electrolyte solution has a considerable effect on the composition and crystalline characteristics of the resulting NW arrays, changing the *hcp*-Co and *fcc*-Ni phases into the *bcc*-Fe phase in $Co_{45}Ni_{25}Fe_{30}$ NWs. On the other hand, hysteresis curves obtained from $Co_{70}Ni_{30}$ NWs show that, while the average coercivity (H_c^{Hyst}) of parallel and perpendicular applied fields is nearly the same (H_c^{Hyst}~ 400 Oe), the corresponding squareness ratio is greater in the latter case, indicating a perpendicular anisotropy of NWs. Changing the Fe content in the range of 8-11% causes shape anisotropy to dominate the CoNiFe NW system with the *bcc*-Fe crystalline phase, allowing for controllable magnetic properties. The advanced analysis of angular first-order reversal curves (AFORCs; $0° \le \theta \le 90°$) revealed that the FORC coercivity (H_c^{FORC}) in $Co_{62}Ni_{29}Fe_9$ NWs increases from 700 Oe at θ= 0° to 950 Oe at θ= 90°, thereby evidencing a vortex domain wall mode (VDW). However, for $Co_{55}Ni_{22}Fe_{23}$ NWs with a dominant *bcc*-Fe phase, H_c^{FORC} reaches 2700 Oe at θ= 77°, starting from 1400 Oe at θ= 0°. In addition to occurring the VDW mode, a single vortex appeared in the $Co_{55}Ni_{22}Fe_{23}$ NWs when $68° \le \theta \le 77°$, followed by its annihilation for θ> 77°.

Keywords: CoNi nanowires, CoNiFe nanowires, anodic aluminum oxide template, Fe additive, magnetic properties, angular first-order reversal curves.

Keywords: A. nanostructured materials; B. chemical synthesis; C. microstructure; D. magnetic measurements.

Abbreviations: Nanowire (NW); anodic aluminum oxide (AAO); angular first-order reversal curves (AFORCs); average coercivity (H_c^{Hyst}); FORC coercivity (H_c^{FORC}); vortex domain wall (VDW); single vortex (SV).