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Fabrication of Composition Modulated Multi-segments NiFe Nanowire

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One-dimensional nanostructures such as nanowire, nanotube and nanobelts are attracting building blocks for future nanoelectronics, nanooptoelectronics and magnetoelectronics because of their unique size dependent physical properties. Among other fabrication methods, template-directed electrodeposition method has been the most widely used method to synthesize nanostructures because of its simplicity and ability to tailor composition and microstructure.

There are great interests to understand magnetization process of a single ferromagnetic nanowire (e.g. nickel, cobalt and permalloy) because of its potential application in high density magnetic recording and magnetoelectronics devices, which use the spin of an electron to enable data storage or data processing, and provide the advantage of non-volatile operation, low power consumption, high-speed operation and low cost. Recently, the magnetic race-track memory was disclosed by IBM. The concept with this memory technology is moving domain walls of magnetic strip materials using current pulses. There are two domain structures in magnetic strip; transverse and vortex domain wall in the magnetic strip. Therefore, understanding about the magnetization process of ferromagnetic nanowire which is one candidate of magnetic race-track memory materials is important to control the magnetic domain wall.

In this study, we demonstrate the fabrication the composition modulated nanowires (Ni-rich NiFe / Fe-rich NiFe) with 200 nm diameter using electrodeposition method for studying to understand the structural and magnetic interactions at the interface between two magnetic materials segments. We also made the artificial defects on these nanowires with chemical etching method; artificial defects are expected to pin the magnetic domain wall at specific location along the nanowire when the domain wall pushed by spin polarized current.

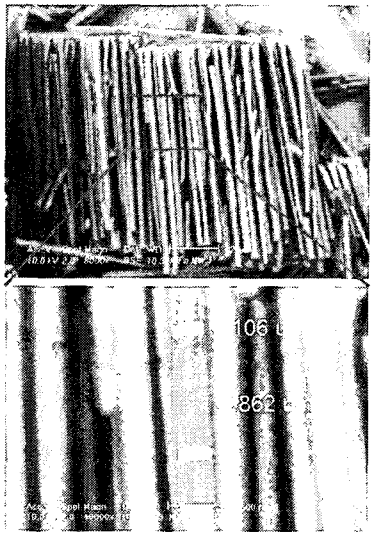

Fig. 1. Ni-rich NiFe / Fe-rich NiFe composition modulated nanowires

SB03

Synthesis of NiFe Nanowires Using Self Assembled Diblock Copolymers

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Electrodeposited NiFe nanowires were grown on self assembled diblock copolymer nanoporous templates. While keeping the pore size constant at 40nm with the electrolyte pH value of 3.82. The dc current density is 50 mA/cm^2 and the time of deposition is varied from 30 sec. to 50sec. as an attempt to obtain nanowires of various aspect ratios and morphologies. For the fabrication of nanoporous template we used the commercially available PS-b-PMMA with molecular weight 55000 g/mole and 22000 g/mole as diblock copolymer. As shown in Fig.1&2. NiFe nanowires forms in the spherical PS shells,such formation can be called as core-shell morphology. In order to remove PS from the electrodeposited template it is heated at 400°C for one hour and NiFe nanowire appears after removing Polystyrene as shown in Fig.3. SEM images shows NiFe forms as wires and they are interconnected.

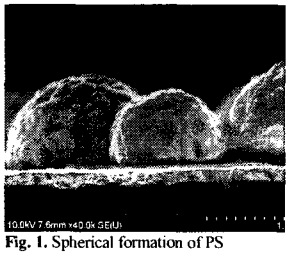

Fig. 1. Spherical formation of PS

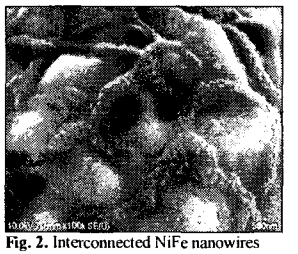

Fig. 2. Interconnected NiFe nanowires

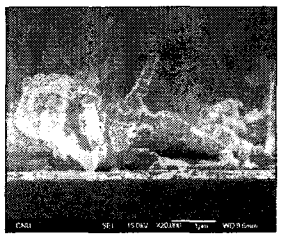

Fig.3. NiFe nanowires after removing PS

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