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Ni/Mn 초격자-NiFe/Cu/NiFe 스핀밸브 박막에서 자기저항 특성

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MAGNETORESISTANCE ON Ni/Mn SUPERLATTICE-NiFe/Cu/NiFe SPIN-VALVE FILMS

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1. INTRODUCTION

At room temperature, bulk NiMn is antiferromagnetic with a CuAu-I ($L1_0$) ordered tetragonal crystal structure which consists of alternating planes of Ni and Mn atoms. The Neel temperature of ordered NiMn is around 800℃. Exchange coupling field (H_{ex}) in the NiMn/NiFe system is obtained through post-deposition annealing which promotes atomic ordering in the NiMn layer [1]. There has been a considerable amount of interest in NiMn alloy-pinning layer/NiFe/Co/Cu/Co/NiFe spin-valve films, since it has a very high H_{ex} (~650 Oe), a high blocking temperature (380℃), and a high thermal stability [2]. To enhance the H_{ex} and the annealing effect, we fabricated Ni/Mn superlattice instead of NiMn alloy films. The magnetoresistive properties in the Ni/Mn superlattice-NiFe/Cu/NiFe spin-valve films depending on the thickness of the pinned NiFe layer were investigated.

2. EXPERIMENTAL

The [Ni(2 Å)/Mn(3 Å)]×40 superlattice multilayers was grown on Corning glass(7059) substrate by means of a 3-inch multi-target dc sputtering at a working pressure of 5 mTorr, and its measured composition is 60 at. % Mn. Also, the various Ni/Mn superlattice films were performed by thickness control and different deposition rate. The spin-valve sandwich films of NiFe(t = 50, 70, 100 Å)/Cu(30 Å)/NiFe(60 Å) was sequentially deposited at the rates of 1.5 Å/s ~ 2.0 Å/s without uniaxial deposition field. In order to induce the H_{ex} between Ni/Mn superlattice and NiFe pinned layer, a thermal annealing cycle of 3 hours interval at 300℃ was treated under static magnetic field of 250 Oe. The structure phase and the H_{ex}, magnetoresistance (MR) ratio (%) were measured by the θ-2θ x-ray diffraction (XRD) and the magnetoresistance curve, respectively.

3. RESULTS AND DISCUSSION

The as made Ni/Mn superlattice spin-valve films do not show a siginificant exchange coupling. Due to annealing treatment Ni/Mn superlattice, the conversion of phase structure from fcc to fct was observed by the XRD. By measuring MR curves of Ni/Mn superlattice spin-valve films, the H_{ex} with the pinned NiFe layer thickness of 70 Å is larger than that of 50 Å and 100 Å. Fig. 1(a), (b), and (c) show the MR major and minor curves for the glass/$[Ni/Mn]_{40}$/NiFe(70Å)/Cu(30 Å)/NiFe(60 Å) after thermal annealing cycles varying from 3 hrs to 9 hrs at 300℃. The H_{ex} and coercive field (H_c) increased upto 220 Oe and 100 Oe, respectively. These results indicates that the spin-valves with Ni/Mn superlattice pinning layer exhibit better stabilities than the those with NiMn alloy-pinning layer, in case of the insertion to between NiFe layer and Cu layer.

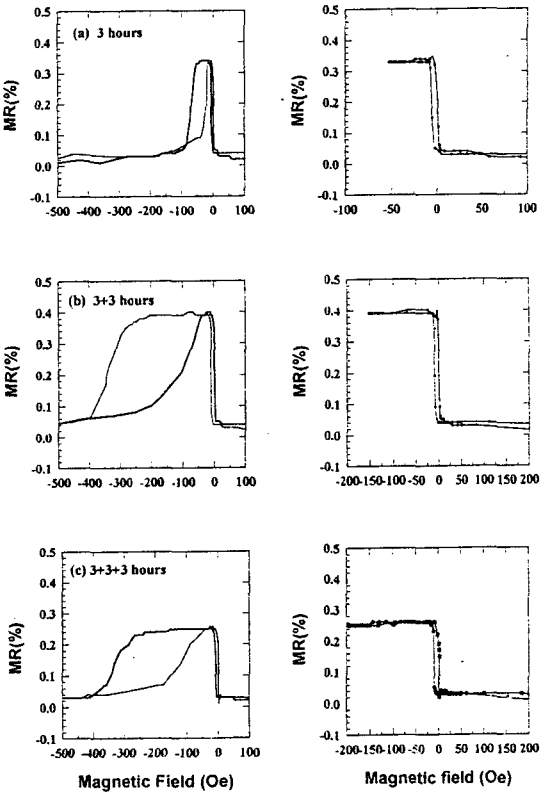

Figure 1. Magnetoresistance curves for [Ni(2 A)/Mn(3 A)]$_{40}$ superlattice/ NiFe(70 A)/Cu(30 A)/NiFe(60 A) spin-valve films after annealing cycles of (a) 3 hrs, (b) 6 hrs, and (c) 9 hrs at 300 °C.

4. REFERENCE

[1] B. Y. Wong, C. Mitsumata, S. Prakash, D. E. Laughin, and T. Kobayashi, IEEE Trans. Mag. **32**, 3425 (1996). c

[2] S. Mao, S. Gangopadhyay, N. Amin, and E. Murdock, Appl. Phys. Lett. **69**, 3593 (1996).