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Uniaxial Magnetic Anistotropy of NiO-Spin Valve Device

Sang-Suk Lee[1]*, Young-Seok Park[2], Do-Guwn Hwang[1], and Jang-Rho Rhee[3]

[1]Dept. of Oriental Biomedical Engineering, Sangji University, Wonju, Gangwondo, South Korea

[2]Dept. of Oriental-Western Biomedical Engineering, Sangji University, Wonju, Gangwondo, South Korea

[3]Physics Department, Sookmyung Women's University, Seoul, South Korea

*Corresponding author: Author1 Sang-Suk Lee, e-mail: sslee@sangji.ac.kr

Changing to the transversal direction, which is the width direction of the biosensor with the longitudinal direction property of the easy axis for the NiO-SV (spin valve) multilayer biosensor [1], we performed vacuum thermal annealing at 200 ℃ for 1 hr under the permanent magnet of 300 Oe. The schematic of the micro-patterning size of 2×15 μm^2 and the direction of the easy and hard axes, and the sensing current are shown in inset of Fig. 1. After the thermal annealing process, the major and minor loops of MR (magnetoresistance) curves measured by the two-probe method applied to the easy axis are shown in Fig. 1(a) and 1(b), respectively. Moreover, the major loop for the hard axis is shown in Fig. 1(c).

From the vacuum thermal annealing under the magnetic field of uniaxial anisotropy, the easy axis of the magnetic pinned layer of the NiO-SV biosensor should be induced to the width direction or the so-called transversal one, and that of the magnetic free layer to the length direction or the so-called longitudinal one, which was performed using shape magnetic anisotropy. It shows that the developed NiO-SV biosensor is sufficient for its purposes. That is, the easy axis formed by the applied magnetic field of uniaxial anisotropy during the deposition of NiO-SV multilayer was very important to pattern the micro device perpendicular to the length direction of the sample. In this study, although the magnetic sensitivity was decreased, the reason to perform the shape anisotropy through the thermal annealing process was to obtain the optimum condition to minimize and respond to the coercivity of the NiO-SV biosensor in the surrounding region of 0 Oe by variation of a subtle external magnetic field. When the NiO-SV device is used as a biosensor with the ultra-micro-magnetic field, the prepared important characteristics include sufficient magnetic sensitivity and large output amplitudes [2]. Therefore, uniaxial magnetic anisotropy of the magnetic pinned layer and the very soft magnetic free layer occurred to be orthogonal to each other. The MR property of the micro-patterned device should be maintained the linear sensitivity and large amplitude. In addition, in the case of the as-grown IrMn-, FeMn-, and NiMn-based GMR-SV devices, when introduced to the post-annealing treatment in the final process, the considered ideal method is the establishment of the easy axis and shape magnetic anisotropy on the ground of the suggested experimental results.

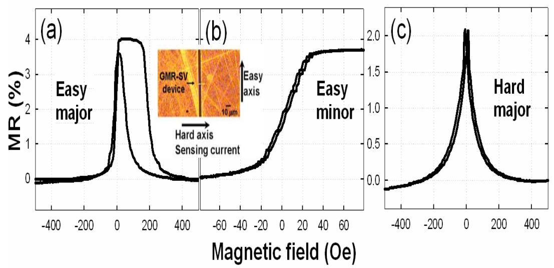

Fig. 1. MR curves measured by the two-probe method for the micro-patterned and post-annealed NiO(300 Å)/NiFe(20 Å)/ CoFe(10 Å)/Cu(26 Å)/CoFe(10 Å)/NiFe(40 Å) NiO-SV multilayer structure: (a) the major MR loop according to the easy axis, (b) the minor MR loop according to the easy axis, and (c) the major MR loop according to the hard axis.

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Development of Differential Method for Real Application of Planar Hall Resistance Sensor

Sunjong Oh, Tran Quang Hung, S. Ananda Kumar, Jong-Ryul Jeong, and CheolGi Kim*

Department of Materials Science and Engineering, Chungnam National University, Daejeon, Korea

*Corresponding Author: C. G. Kim, E-mail address: cgkim@cnu.ac.kr

Planar Hall effect (PHE) sensor using spin-valve structure has been well developed [1]. It has many prominent advantages for biochip applications due to the easy rotation of magnetization under low range of external magnetic field. From the literature, the magnetic bio-sensor reveals that the sensor junction can not be reiterated because of the immobilization of the antibody and/or DNA on the active surface of sensor junction.

In this approach, we have developed the differential method using two PHR sensor elements for bio application. One of them is the active sensor which is used to immobilize the DNA and/or antibody on its surface. Another one as the dummy sensor is used as reference sensor element.

The PHR profiles of dummy and active sensors were characterized by using four probes method with and applied current of 1 mA and an in plane field of -30 ~ +30 Oe. The current lines of the dummy and active sensor elements are serially connected to the single current source. The induced output voltages of these two sensor elements are comparably same as shown in fig.1. In this contest we have successfully detected the presence of the magnetic beads using differential method. It is the prominent result for real bio-application of PHR sensor.

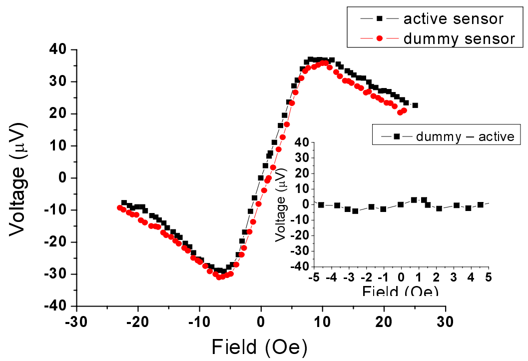

Fig.1. PHR differential sensors signal

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