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Influence of the Nano Oxide Layer Position on Magnetoresistance Ratio and Magnetic Properties in Spin Valves

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Recently, nano oxide layer (NOL) insertion into spin valves was found to an effective method for the increment of giant magnetoresistance (GMR) ratio of spin valve sensors [1]. To date, the effect of the NOL insertion into free and/or pinned layer interfaces, different types of NOL materials, and different NOL insertion position have been reported [2-4]. However, the influence of the NOL insertion effect at the inner positions of each layer in spin valves has not been yet studied. In this study, we have investigated the influence of different NOL positions on the properties of NiFe/Cu/Co spin valves.

All of the spin valves with NOL were deposited onto thermally oxidized Si (100) substrate. Films with structure of the NiFe(9nm)/Cu(4nm)/Co(5nm)/Cu(2nm) were deposited by using rf magnetron sputtering system at a power of 100 W and an argon pressure of 2 mTorr. NOL was formed by natural oxidation method. In order to investigate the NOL position effect, we varied the NOL position within the multilayer with increment of 1 nm. The GMR ratio of the spin valves was measured by four point probe method in the field range of -300 Oe ~ +300 Oe.

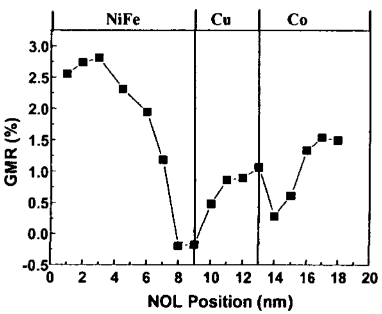

Fig. 1. GMR ratios at different NOL positions in NiFe/Cu/Co spin valves.

The variation of GMR ratio with different NOL position is presented in Figure 1. For the samples with the NOL within the soft NiFe layer, the GMR increases as the NOL moves away from the NiFe/Cu interface and toward the Silica substrate. Similarly, for the NOL inserted into the Co hard layer, the GMR increases as the NOL is moved away from the Cu/Co interface. Finally, for the NOL within the Cu spacer layer, as the NOL position moves from the NiFe/Cu interface to the Cu/Co interface, the GMR increases. Variation of the GMR ratio with NOL position can be explained by the spin electron transport confinement due to the specular reflection of the NOL. Also, the GMR behaviour quite well be interpreted by considering the scattering and shunting analysis model [5]. These significant variations of GMR ratio was correlated with a variation of surface roughness and coercivity.

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EC08

Properties of Sputtered $Ni_{0.8}Fe_{0.2}$-O Films

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Antiferromagnetic NiO films have been studied for the use of giantmagnetoresistance (GMR) elements. Furthermore, permalloy ($Ni_{0.8}Fe_{0.2}$) films are used as ferromagnetic elements. We tried to obtain the two kinds layers from one sputtering target of permalloy. NiFe-O films were obtained by sputtering with various O_2 partial pressure PO [O_2/ (O_2+Ar)] ranging from 0% to 20 %. The film thickness was typically 5000 A. We will presentcrystallographic, electric, and magnetic properties of the ferromagnetic fcc $Ni_{0.8}Fe_{0.2}$ and antiferromagnetic rohmbohedral $Ni_{0.8}Fe_{0.2}O$ films.

Figure 1 shows P_O dependence of electric resistivity (ρ). Below O_2=2%, fcc ferromagnetic $Ni_{0.8}Fe_{0.2}$ films were obtained. The resistivity increases with P_O partial pressure. They contain interstitially-sited oxygen, because the saturation magnetization (M_s) decreases and coercive force (H_c) increases with P_O. Compared to previous Ni-O system, P_O region for fcc $Ni_{0.8}Fe_{0.2}$becomes narrow from 10% because the metal contains active Fe. Between 2 and 5%, mixed phases of fcc $Ni_{0.8}Fe_{0.2}$ and rohmbohedral $Ni_{0.8}Fe_{0.2}O$ were observed. Above 5%, a single phase of rohmbohedral $Ni_{0.8}Fe_{0.2}O$ having antiferromagnetism was obtained. Previously we reported that as-deposited antiferromagnetic $Ni_{1-\gamma}O$ films are not stoichiometric and they are Ni defective (γ~0.2) and their electric resistivityis not large compared with typical oxides [1]. In these $Ni_{0.8}Fe_{0.2}O$ oxide films, nearly the same properties are obtained (~1 Ωcm).

Figure 2 shows P_O dependence of lattice constants of fcc $Ni_{0.8}Fe_{0.2}$ and rohmbohedral $Ni_{0.8}Fe_{0.2}O$.

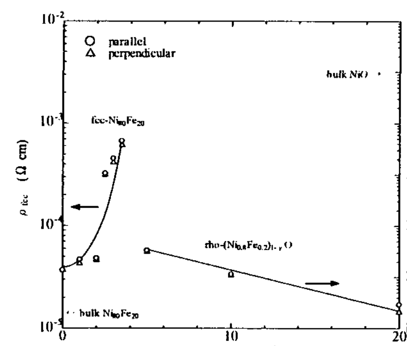

Fig. 1. Electric resistivity (ρ) vs P_O.

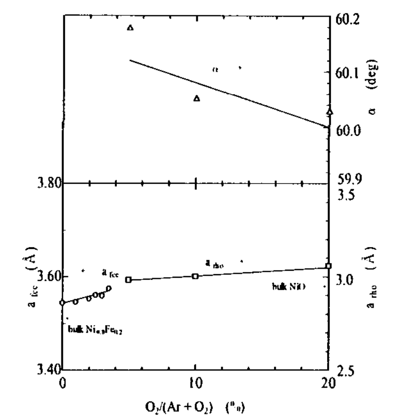

Fig. 2. Lattice constants (a_{fcc}, a_{rho}) and axis angle α vs P_O.

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