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Magnetoresistance and Magnetic Anisotropy Properties of Strain-induced Co/Ag, Cu Multilayer Films

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The studies on the physical properties of the metallic multilayer films have attracted much attention not only in the fundamental physics, but also in electronic engineering [1-2]. Pulse electrochemical deposition is a convenient method of growing multilayer and alloys [3-5]. By choosing appropriate material composition, regulating the thicknesses of the individual layers, and inducing strain, it seems to be possible to tailor the magnetic anisotropy in multilayer and alloy films.

We report on the results of series of electro-deposited Co/Ag, Cu multilayer films grown by systematically varying the layer thickness of ferromagnetic cobalt and non-magnetic silver and copper. It was possible to induce uniaxial magnetic anisotropy in all the multilayer films. Fig. 1 shows the magnetization curves for $[Co15\ Å\ /15Ag\ Å]_{20}$ multilayer films at induced-strain, ε equal to1.5%. Inset in the diagram shown are the direction of the applied strain and magnetic fields, respectively. These mutlialeyrs were grown on 15 nm conducting buffer layer of copper. The buffer layers were grown on polyamide substrates ($1cm^2$) and strain was induced mechanically. The multilayers were studied with vibrating sample magnetometer, Torque-meter, X-ray diffractometer, and four-probe magneto-resistance (MR) measurements. The results of $[Co1.5\ nm\ /\ Ag\ 1.5\ nm]_{20}$ are compared with the results of $[Co1.5\ nm\ /\ Cu\ 10\ nm]_{20}$ that showed a minimum hysteresis loss at 1 kOe. A remarkable difference of magnetic field dependence of the magnetoresistance ratio was observed, corresponding to the orientation of magnetization curves. These multilayer structures with remarkable anisotropy properties are of practical use in the application as a magnetic sensor.

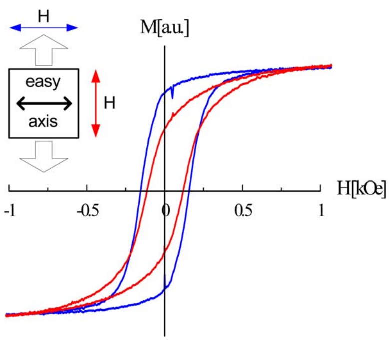

Fig. 1. M-H hysteresis loops for $[Co15\ Å\ /15Ag\ Å]_{20}$ multilayerd at strain-induced, ε = 1.5%.

[1] S. S. P. Parkin, Annu. Rev. Mater. Sci. vol 25, 357(1995).
[2] C. S. Rizal, J. Mag. Magn. Mater. vol. 310, 646 (2007).
[3] C. S. Rizal et.al. Physica Status Solidi C: Conferences, vol. 1, 1756 (2004).
[4] A. Yamada et.al., J. Japan Inst. Metals, 66, 869 (2002).
[5] Y. Ueda et.al., J. Solid State Chem.. 147,274 (1999).

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Negative Magnetoresistance in GMR Spin Valve Structures

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The GMR effect, in spin valves, is due to spin-dependent scattering occurring in the bulk ferromagnetic and/or at the ferromagnetic/nonmagnetic (F/N) interface. When the spin-dependent scattering coefficient ratios ($\alpha = \frac{\rho\downarrow}{\rho\uparrow}$) of the two ferromagnetic layers in the spin valve structure (F1/N/F2) are the same and are both larger than 1, the GMR is expected to be positive. When α is larger than 1 in F1 and smaller than 1 in F2, however, the GMR is expected to be negative [1]. In this study, we show that Ta/CoFe/Cu/CoFe (F1)/Ru t/CoFe (F2)/Cu/CoFe/IrMn/Ta dual spin valve structures exhibit negative GMR due to opposite electron spin scattering asymmetries between the CoFe (F1)/Ru t/CoFe (F2) synthetic antiferromagnetic layer and CoFe layers. Figure 1 shows the Ru thickness ($0 \leq t \leq 0.8$ nm) dependence of the GMR ratio in these structures. Although a GMR of 6% is observed in the structure without the Ru spacer layer, insertion of a 0.2 nm thick Ru layer between the CoFe layers results in a negative GMR. With increasing t, the GMR ratio increased to -3% and disappeared at the Ru thickness of 0.8 nm. The GMR oscillation as a function of the Ru thickness can be described in terms of the oscillation of interlayer exchange coupling between F1 and F2 across a Ru layer [2]. Using SQUID magnetometry, antiferromagnetic exchange coupling is observed for the sample with $0.2 \leq t \leq 0.6$ nm Ru layer and this result agrees well with results shown in fig. 1.

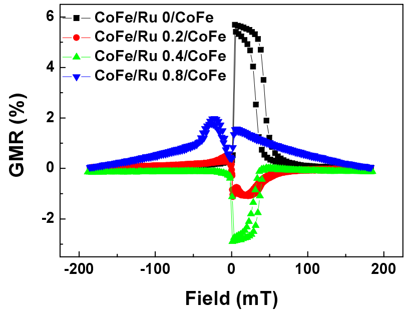

Fig. 1. Ru thickness dependence of the GMR ratio in the Ta/CoFe/Cu/CoFe/Ru t/CoFe/Cu/CoFe/IrMn/Ta structures.

[1] J. M. George et al, Phys. Rev. Lett., 72, 408 (1994).
[2] S.S.P. Parkin et al, Phys. Rev. Lett., 72, 3718 (1994).