17p-E7-6

Co 薄膜における電界による保磁力変化の符号反転

Sign reversal of electric field modulation of coercivity in Co ultra-thin films

東大物工 [1]，JST さきがけ [2]　°小山知弘 [1]，大日方絢 [1]，日比野有岐 [1]，千葉大地 [1,2]

The Univ. of Tokyo[1], JST PRESTO[2], Tomohiro Koyama[1], Aya Obinata[1], Yuki Hibino[1], and Daichi Chiba[1,2].

E-mail: tkoyama@ap.t.u-tokyo.ac.jp

Control of magnetic properties by an electric field has been intensively studied using a field-effect capacitor structure. Recently, electric field control of the coercivity (H_c) and the Curie temperature (T_C) has been achieved at room temperature in Co ultra-thin films sandwiched by MgO and Pt layers[*1]. In this system, it has been reported that T_C and H_C increased with electron density. Here, we report a systematic study of the effect of the electric field on H_C using the same system and show that the sign of the effect depends on the sputtering power during the deposition of the MgO capping layer[*2].

A multilayer consisting of MgO (2.2 nm)/Co (0.25 nm)/Pt (0.79 nm)/Ta (2.2 nm) from the surface side was deposited on an intrinsic Si substrate by rf sputtering. The rf power for depositing the MgO layer was changed (with powers of 65 W, 100 W, and 150 W used for samples labeled #1, #2, and #3, respectively).

The curves in Fig. 1(a) show the results of the Hall measurement obtained in sample #1 for the gate voltage (V_G) = +10 V (red line), 0 V (black line) and -10 V (blue line). H_c measured at V_G = +10 V (-10 V) was larger (smaller) than that at V_G = 0 V. The direction of the change in H_C by V_G was the same as that found in previous reports in this sample. However, as shown in Fig. 1(b), H_c at V_G = +10 V was smaller than that at V_G = -10 V in #3. The same direction of the change in H_c was observed in sample #2. This means that the direction of the H_C change became opposite in the samples deposited by high rf power. On the other hand, we observed that electric field effect on the perpendicular magnetic anisotropy was independent of the sputtering power for MgO deposition. The possible reasons of the sign reversal will be discussed.

This work was partly supported by the PRESTO program of JST, Grants-in-aid for Scientific Research (S), Challenging Exploratory Research, and Research Activity Start-up from JSPS.

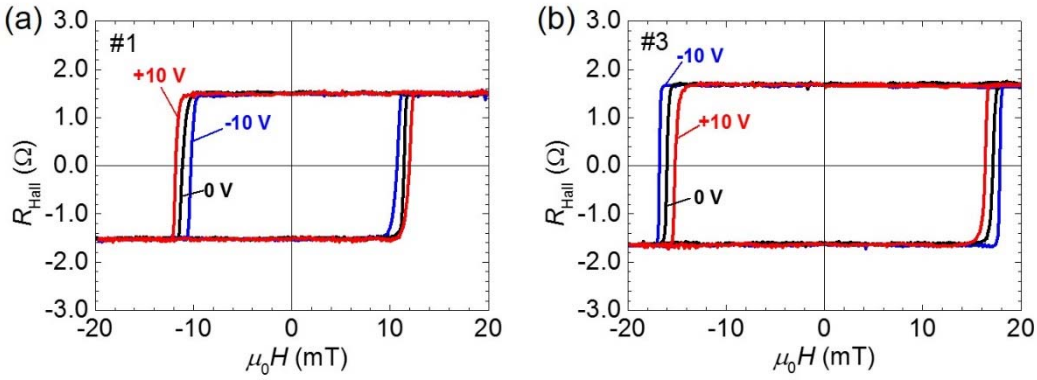

Fig. 1 Anomalous Hall resistance (R_{Hall}) as a function of external perpendicular magnetic field ($\mu_0 H$) for samples (a) #1, (b) #3 when applying a gate voltage of 0, +10 and -10 V.

*1 D. Chiba, et al., *Nature Materials* **10**, 853 (2011). *2 T. Koyama, *et al.*, *Applied Physics Express* **6**, 123001 (2013).