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
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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\textsuperscript{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\textsuperscript{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.

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![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.](image)