

Observation of spin splitting in a two-dimensional electron gas layer

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Spin splitting without external magnetic field is induced by spin-orbit coupling field. In order to detect spin-orbit coupling, two kinds of experiments are executed. Firstly, Shubnikov de Hass(SdH) Oscillation was performed using 16 μm wide 2DEG strip. External field is applied in the perpendicular direction to the 2DEG plane and the resistance is measured. The other method is so-called potentiometric method where the ferromagnet is deposited on 2DEG strip. The potential between the ferromagnet and the 2DEG is measured with varying external field which decides magnetization status of FM.

Fig. 1(a) shows the results of SdH oscillation. Major and minor spins have different amount of carrier concentration. Oscillation frequency depends on the carrier concentration, so that two different kinds of wave are detected in the resistance measurement. When two oscillation signals with slightly different frequency are combined, the beat pattern is usually detected as shown in Fig 1. Using the locations of two nodes indicated by arrows, spin splitting energy(E_s) of 5.93 meV is obtained. Rashba constant is described as $a = E/2k_F$ where k_F is waver vector at Fermi level. From experimental results and calculation $a = 1.15 \times 10^{-11}$ eV-s. Considering spin FET, spin precession angle depends on Rashba constant, a .

Fig. 1(b) presents the results of potentiometric measurements. In the potentiometric geometry, the spin subband difference of chemical potential in the 2DEG is measured by changing the magnetization direction of FM. This

measurement gives a hysteresis loop-like potential curve. The measured R values in the potentiometric geometry at 5K are presented in Fig.2. The size of $\text{Co}_{0.9}\text{Fe}_{0.1}$ pattern is $2.4 \mu\text{m}$ wide and $17 \mu\text{m}$ long. The potential difference ΔV (ΔE_s) at 5 K is about 0.17 mV (0.17 meV) ($I \times \Delta R = 50 \mu\text{A} \times 34 \Omega$) and this value is nearly unchanged at 77 K.

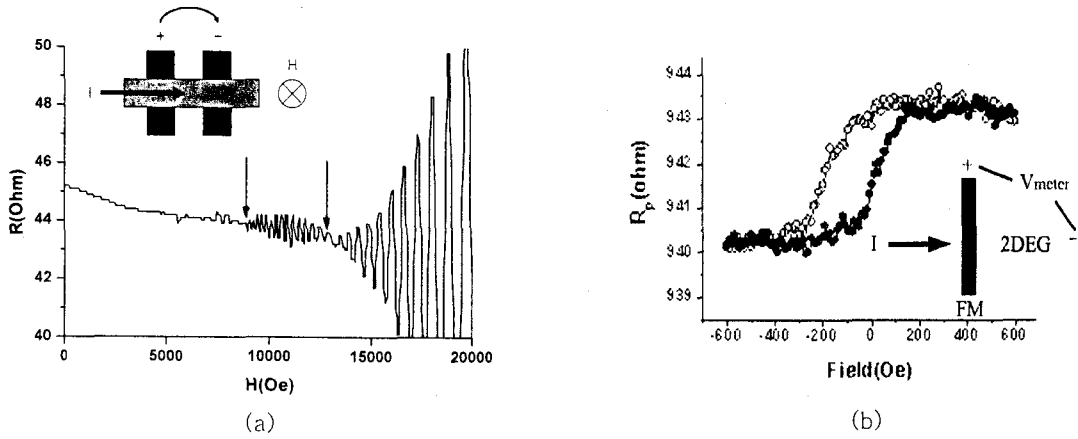


Fig. 1 (a) Shubnikov de Hass(SdH) Oscillation (b) Potentiometric measurement