SO03

Rashba effective field induced anisotropic magnetoresistance in InAs quantum well channel

Won Young Choi[1,2*], Hyung-jun Kim[1], Joonyeon Chang[1], Suk Hee Han[1] and Hyun Cheol Koo[1,2]
[1]Center for Spintronics, Korea Institute of Science and Technology, Seoul 136-791, Korea
[2]KU-KIST Graduate School of Converging Science and Technology, Korea University, Seoul, 136-701, Korea

The Rashba spin-orbit interaction (SOI) has been to the forefront as a core of spin-FET introduced by S. Datta and B. Das. And recently, Rashba SOI at interface between heavy metal and ferromagnetis being actively researched as a source of spin-orbit torque due to its applicability. On the other hand, Rashba SOI in 2DEG channel is also able to act as an origin of spin polarization which affects transport property via SOI, so-called anisotropic magnetoresistance (AMR). In our research, estimation of Rashba SOI in quantum well channel using AMR will be discussed.

We used InAs quantum well structure with carrier density, $n_s = 2 \times 10^{16} \mathrm{m}^{-2}$, and Rashba SOI field, B_R = 7.9T, was evaluated by Shubnikov-de Haas (SdH) oscillation at 1.8 K. To observe AMR we applied in-plane magnetic field because Rashba SOI induced spin polarization istransversal. Then sample was rotated to make total effective field tilt from current direction and angle dependence of resistance was observed.

Measured AMR data is shown in Fig. 1. At angle 0°or 180°, total effective fieldisnormal to current direction, so resistance is low. However external magnetic field is parallel (0°) or antiparallel (180°)to Rashba effective field, so Rashba parallel state, 0°, has much lower resistance due to greater total effective field.

Taking cubic symmetry and Rashba field into account, AMR is described by [1]

$$R_{XX} = a_0 + a_1 B_{tot} cos^2(\alpha + \varphi) + a_2 B_{tot} cos^4(\alpha + \varphi),$$

where α is angle between Rashba and total effective field, φ is arbitrary phase shift. Solid line in Fig. 1 is fitting result using this equation and Rashba field was 7.7T which is comparable to the value from SdHoscillation.

Finally, spin polarization of 2DEG with Rashba SOI was confirmed by measuring AMR and we could estimate the Rashba effective magnetic field.

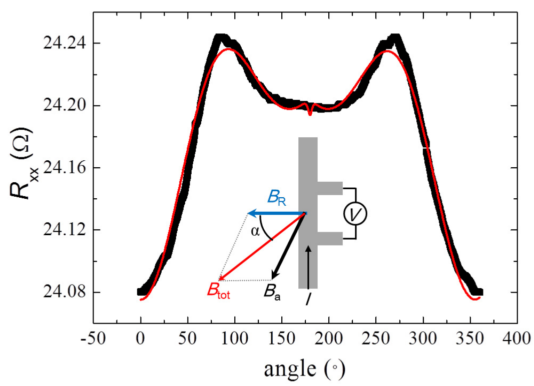

Fig. 1. AMR data of InAs channel

Reference

[1] K. Narayanapillai*et al. Appl. Phys. Lett.*105, 162405 (2014).