Magneto-conductance change induced by the Rashba effect at an oxide interface

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The control of spin generation, manipulation and detection is an important issue for the development of spin-based electronics. The Rashba spin–orbit interaction is useful tool. Because the spin information can be modulated by gate electric field in a strong Rashba system. [1] This phenomenon has been observed very well in a two-dimensional electron gas (2DEG).

Recent studies have shown the successful formation of 2DEG using the $LaAlO_3/SrTiO_3$ (LAO/STO) layers. The interface of LAO/STO showed various physical behavior including superconductivity, magnetism, and quantum transport. [2, 3] The oxide based 2DEG is of great interest in the field of spin electronics because it shows interesting electronic and magnetic properties.

$LaAlO_3/SrTiO_3$ (LAO/STO) has an inherent space inversion asymmetry causing an internal electric field near the interface. The Rashba spin-orbit coupling arising from this structural characteristics has a considerable influence on spin transport. Here we adopt an effective method to characterize the Rashba coupling in the LAO/STO conduction channel. With application of an external magnetic field, we observed conductance change in the LAO/STO channel which is dependent on the sign and magnitude of the field. We found that the magnetic field generates spin filtering effect which induces spin dependent electron mobility. From the conductance difference for vector alignments of Rashba and applied fields, the Rashba parameters are also extracted for various temperatures. This Rashba strength is highly dependent on temperature: it varies from 2.6×10^{-12} eVm to negligible value in the temperature range of 1.8 ~ 12 K. Our characterization method has several advantages over the conventional ones such as the measurements of Shubnikov–de Haas oscillation or weak antilocalization.

References

[1] H. C. Koo, J. H. Kwon, J. Eom, J. Chang, S. H. Han, and M. Johnson, Science **325,** 1515 (2009)

[2] A. Ohtomo and H. Y. Hwang, Nature **427,** 423 (2004)

[3] J. A. Bert, B. Kalisky, C. Bell, M. Kim, Y. Hikita, H. Y. Hwang, and K. A. Moler, Nat. Phys. **7,** 767 (2011).