반도체 운반자 증가현상에 의한 자기저항

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Current switching of resistive state has received considerable attention because of their interesting physical phenomenon and potential applications such as nonvolatile memories, sensors and magneto-logic electronics[1]. In manganite system showing colossal magneto-resistance effect, the dramatic switching of resistive states can be achieved not only by a magnetic field, but also by an electric field[2]. Recently, large magnetoresistance effect has been reported in the Si based system[3,4].

In the report, we have studied an semiconductor system exhibiting switching of conductive states by a magnetic field. The device shape is defined by photolithography and electronbeam lithography technique, and the n-doped region formed by plasma ion doping method. The device is measured at low temperature (10K).

We have observed space-charge effect and carrier multiplication process. We have focused on the carrier multiplication process under magnetic field. Our device exhibited more than three orders of magneto-conductance change. This phenomenon can be controlled by the applied magnetic field, and the magnitude of the on-set magnetic field is turnable by variation of the applied bias voltage. The Magneto-conductance can be increased if the current limit is released.

The carrier multiplication process induced by the impact ionization is responsible for the transport mechanism of the present device. The magnetic field affects the impact ionization through Lorentz force. This switching device can be good candidate for a future reprogrammable electronic device.

[1] J. S. Moodera and P. Leclair, Nature Materials 2, 707 (2003).
[2] A. Asamitsu, Y. Tomioka, H. Kuwahara and Y. Tokura, Nature 388 , 50 (1997).
[3] M. P. Delmo, S. Yamamoto, S. Kasai, T. Ono and K. Kobayashi, Nature 457, 1112 (2009).
[4] J. J. H. M. Schoonus, F. L. Bloom, W.Wagemans, H. J. M. Swagten, and B. Koopmans, Phys. Rev. Lett. 100, 127202 (2008).