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# Gate effect on Hall voltage in a Hybrid InSb/Ferromagnet device

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A novel spintronic device based on hybrid ferromagnet/semiconductor microstructures has recently attracted considerable interest due to the possibility of device applications such as magnetic field sensors, integrated non-volatile memory cells, and logic gate. In a Hybrid Hall device, magnetic fringe fields from the edge of a single, patterned ferromagnetic film generate a Hall voltage in a micron-scaled InSb semiconductor Hall cross junction. 1 ㎛ thick InSb films were thermally evaporated onto insulating Si substrates and 5 ㎛-wide cross junction was fabricated by standard microfabrication techniques using the InSb thin film. After the junction patterning steps, a 50 nm thick $SiO_2$ insulating layer was deposited in order to electrically isolate InSb layer from a gate electrode. A 150 nm thick Py film (FM) was deposited on gate electrode in a dc magnetron sputtering system and then patterned by standard optical lithography and lift-off process. Fig. 1 shows a schematic diagram of gate effect Hall device structure.

We found a hysteric behavior in the $R_H$-$H$ curve as shown in Fig. 2. This is believed to originate from the strong local magnetic field emanating from the edge of the Py film, when an applied magnetic field was parallel to the substrate.

The Hall effect is amplified by a factor of ~ 40% when gate voltage of -25V is applied. The increase is largely attributed to the reduction of carrier density affected by the gate confinement effect. The InSb Hall device controlled by gate voltage demonstrates a possible application for an active nonvolatile memory cells and logic gate.

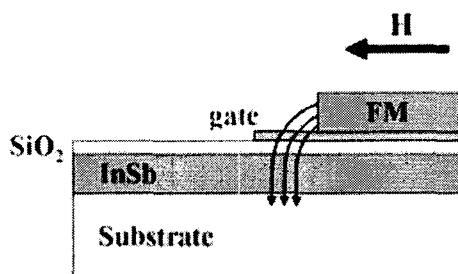


Fig. 1. A schematic diagram of cross-section view of a gate controlled InSb Hall device.

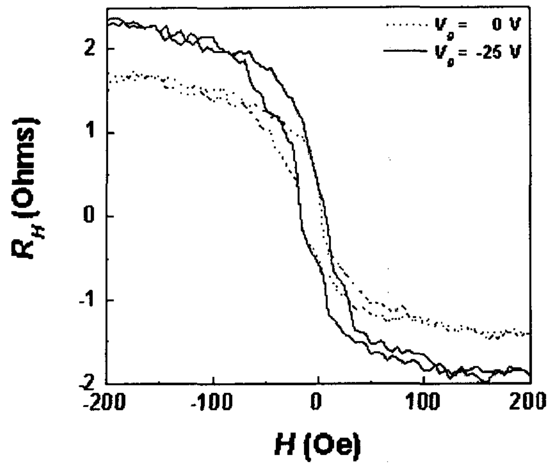


Fig. 2. The variations of Hall resistance ($R_H$) against in-plane magnetic fields.

## Reference

[1] F. G. Monzon, Mark Johnson, M. L. Roukes, Appl. Phys. Lett. **71**, 3087 (1997)
[2] Mark Johnson, Brian R. Bennett, M. J. Yang, M. M. Miller, B. V. Shanabrook, Appl. Phys. Lett. **71**, 974 (1997)
[3] W. Y. Kim, J. Y. Chang, S. H. Han, S. G. Chang, W. Y. Lee, Phys. Stat. Sol. (a) **201**, No.8, 1980 (2004)
[4] S. Zelakiexicz, Mark Johnson, Appl. Phys. Lett. **80**, 3204 (2002)