Non-local spin valve measurements in MnAs/GaAs/InAs/GaAs(111)B heterostructures

Md. Earul Islam, Kazuki Hayashida, Masashi Akabori

Japan Advanced Institute of Science and Technology, Japan

E-mail: s1540002@jaist.ac.jp, akabori@jaist.ac.jp

In semiconductor spintronics, ferromagnetic-semiconductor hybrid structures have already attained attention as potential candidate for spintronic applications, such as spin-field effect transistors (spin-FETs) [1]. To realize spin-FETs, it is necessary to understand spin polarized carrier injection and detection in the hybrid structures. We studied molecular beam epitaxial (MBE) grown MnAs/GaAs/InAs/GaAs(111)B heterostructures [2] to enhance the spin polarization efficiency at the interface by impedance matching for electrical spin injection [3]. In this report, we fabricated and measured lateral spin-valve devices from the heterostructures.

We used 50-nm-thick MnAs with 1-nm-thick GaAs barrier on 200-nm-thick InAs channel grown by MBE on GaAs(111)B substrate. For lateral spin-valve device fabrication, we used electron-beam lithography (EBL), Ar^+ etching, evaporation, and lift-off processes. For the device measurements, we performed non-local measurements with AC lock-in technique. Figure 1 shows non-local signal curves with MnAs electrode spacing of 2.5 μm at 1.5 K. We can see spin-valve dips with hysteresis around -130 and +120 mT. We also studied 3-terminal signals of 0.5-μm and 3.0-μm-size electrodes which expected to show different hysteresis. Figure 2 shows difference of 3-terminal and non-local signals between up and down sweeps. The non-local peak and dip seem inside of the 3-terminal peaks and dips with different sizes. This indicates spin injection and detection in the device.

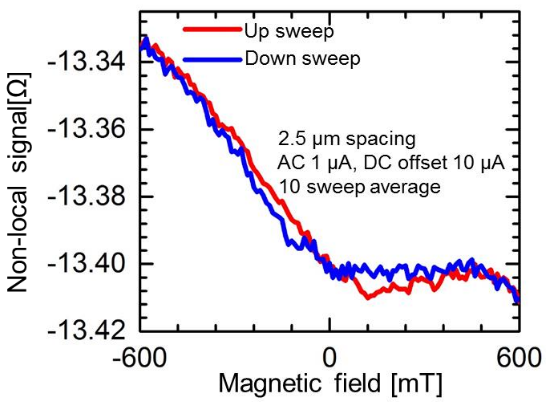

Figure.1. Non-local spin valve signal.

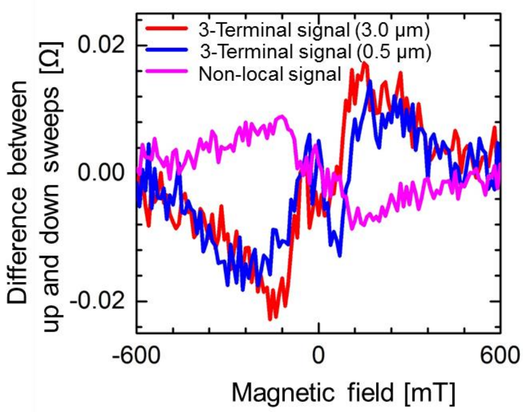

Figure.2. Difference between up and down sweeps signal.

References: [1] S. Datta and B. Das, Appl. Phys. Lett. 56 (1990) 665. [2] E. Islam and M. Akabori , 77th JSAP spring meeting (2016) 13p-P8-41. [3] E.I Rashba, Phys. Rev. B 62 (2000) R16267.