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