Detection of chemical potentials in a strong Rasbha channel

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1. Introduction

We report the detection of a chemical potential change induced by the Rashba effect in an InAs-based high electron mobility transistor(HEMT) structure. In this potentiometric measurement, we deposit a ferromagnetic junction ($Ni_{81}Fe_{19}$) as a spin detector on an InAs HEMT channel. We observe hysteretic voltage signals which is determined by the vector alignment between the magnetization of $Ni_{81}Fe_{19}$ electrode and the Rashba field. We investigated the temperature dependence of the spin signal and observed clear signal up to room temparatrue.

2. Experiment and Result

The potentiometric measurement is performed in a three-terminal configuration involving one ferromagnetic contact (Py/NiFe) and two non-magnetic contact(Au). The bias current is applied between the two Au electrodes and a voltage is measured between the $Ni_{81}Fe_{19}$ electrode and Au contacts. The magnetization direction of $Ni_{81}Fe_{19}$ can be switched to be either parallel or antiparallel to the current induced Rashba field in the InAs HEMT channel. The voltage measured by the detector shows a clear hysteretic step change during the magnetic field sweep. This potentiometric measurements are performed for various temperatures from 1.8 K to 300 K. The amplitude of the voltage decrease with increasing temperature due to the smearing of the Rashba spin splitting at a higher temperature.

3. Discussion and conclusion

We have carried out electrical measurements of the chemical potential change induced by the Rasbha spin splitting. The spin-dependent potentiometric voltage were detected up to room temperature and the temperature dependence of the potentiometric signal was also observed. Utilizing this method, we can extract the strength of the Rashba effect in semiconductor channels.