Spin transport in a two-dimensional electron gas in an AlGaAs/GaAs structure at room temperature

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A two-dimensional electron gas (2DEG) system in a GaAs-based heterostructure is an attractive platform for spintronics, since it exhibits high mobility and its spin-orbit interaction can be modulated by a gate voltage [1]. Thus, the 2DEG is a possible candidate of an electric-gate-controlled spin transistor [2]. However, room temperature (RT) spin transport through the 2DEG has not been realized. The purpose of this study is to achieve the first spin transport through the 2DEG in an GaAs/AlGaAs interface at RT.

In order to confirm the quality of 2DEG of our sample, we observed the Shubnikov-de Haas oscillation at 1.8 K and the Hall resistance at RT. The sheet carrier density of the 2DEG was estimated to be 2.3×10^{11} cm^{-2} at 1.8 K and 1.95×10^{11} cm^{-2} at RT, which indicates the 2DEG is successfully formed. In the spin transport experiment, we used spin pumping from $Ni_{80}Fe_{20}$ to the 2DEG. The generated spin current propagated through the 2DEG spin channel of 1 μm in length, and was detected by the inverse spin Hall effect (ISHE) in a Pt electrode (Fig. 1). Polarity of the electromotive force due to the ISHE was reversed together with magnetization of the $Ni_{80}Fe_{20}$ (Fig. 2), which is in agreement with the symmetry of the ISHE. This corroborates the successful spin transport in the 2DEG in an GaAs/AlGaAs interface at RT.

[1] J. Nitta, T. Akazaki, H. Takayanagi, and T. Enoki, Phys. Rev. Lett. **78**, 1335 (1997).

[2] S. Datta and B. Das, Appl. Phys. Lett. **56**, 665 (1990)

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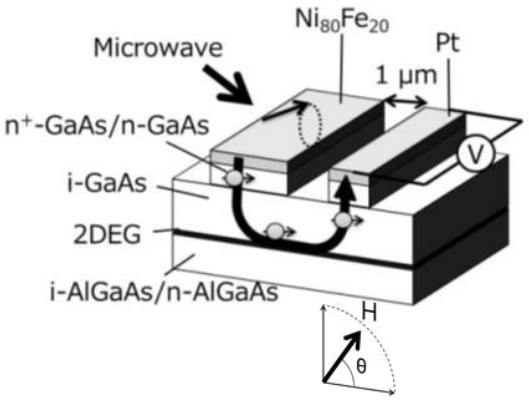

Fig. 1. An experimental setup of spin transport measurement.

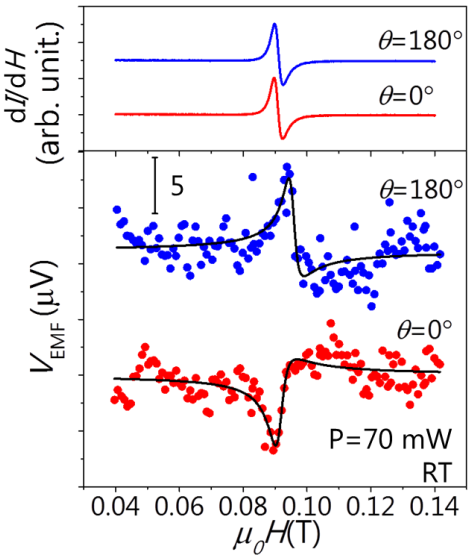

Fig. 2. Experimental results on spin transport measurement.