All-electric spin transistor using perpendicular spins

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The spin field effect transistor proposed by Datta and Das involves the spin injection, detection, and gate modulation using a two-dimensional electron gas system[1]. On disadvantage in previous work [2, 3] was that external magnetic fields should be applied to align the magnetization of ferromagnets transverse to the Rashba field for spin precession.

In order to realize fully electrical spin transistor, we employ a perpendicular magnetization system which enables us to operate the spin transistor without an external magnetic field. For the injection and detection of perpendicular spins in the quantum well channel, we use $Tb_{20}Fe_{62}Co_{18}/Co_{40}Fe_{40}B_{20}$electrodes, where the $Tb_{20}Fe_{62}Co_{18}$ layer produces perpendicular magnetization and the $Co_{40}Fe_{40}B_{20}$ layer enhances the spin polarization of the ferromagnetic source. In this spin transistor device, a gate-controlled spin signalas large as80mΩ is observed at 10K without an external magnetic field. In order to confirm the spin injection and relaxation independently, we measure the three-terminal Hanle effect with an in-plane magnetic field, and obtain a spin signal of 1.7mΩ at 10 K. These results clearly present that the electric field is an efficient way to modulate spin orientation in a strong spin-orbit interaction system.

Reference

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