

Spin Hall Transistor using In As 2DEG Channel and Logic Devices

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In InAs 2DEG channel, spin Hall and Rashba effects are utilized to provide spin transistor. A ferromagnetic electrode and Hall bar type probe are used for injection and detection of spin current, respectively. In the channel, polarization direction of spin current precesses due to Rashba effective field and the rate of precession is controlled by gate electric field which determines a strength of the Rashba effect. By observing channel length dependence of spin Hall voltage, spin current and coherent spin precession are electrically monitored. From the original Datta-Das technique, we measured the oscillation of channel conductance as the gate voltage varies. When the polarization direction of injected spin is reversed by 180° , the phase of the Datta–Das oscillation shifts by 180° as expected. Depending on the magnetization direction, the polarization has the opposite direction and the spin Hall transistor behaves as an n - or p -type transistor. Thus, we can compose the complementary transistors which are analogous to the conventional complementary metal oxide semiconductor field effect transistors. Using the experimental data extracted from the spin Hall transistor, the logic operation is also presented.