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Electrical injection and detection of spin accumulation in Si at 500 K with magnetic metal/SiO_2 contacts

CONNIE H. LI, Naval Research Lab

Electrical spin injection into Si (001) from a ferromagnetic metal through an Al_2O_3 tunnel barrier has been demonstrated.[1] However, the utilization of SiO_2 as the tunnel barrier can have significant impact on the development of Si based spintronics. Here we demonstrate the electrical injection, detection and precession of spin accumulation in Si, via injection from ferromagnetic contacts such as $Ni_{0.8}Fe_{0.2}$ and $Co_{0.9}Fe_{0.1}$ through a SiO_2 tunnel barrier.[2] The injection of spin-polarized carriers produce a net spin polarization and an imbalance in the spin-dependent electrochemical potential under the contact, which is detected as a voltage at the same contact. The decrease of this voltage with increasing out-of-plane magnetic field due to spin dephasing, i.e., Hanle precession of the electron spin, is observed up to 500 K. We observe Hanle precession of electron spin accumulation in Si for a wide range of bias, and demonstrate that the spin lifetime (extracted from the Lorentzian fit to the Hanle data) varies with Si carrier density. Details of the bias and temperature dependence of the spin lifetime and spin diffusion length will also be presented at the meeting. These results confirm spin accumulation in the Si transport channel up to 500 K rather than trapping in localized interface states, and demonstrate the practical aspect of spin-based semiconductor device technology. Supported by ONR.

[1]B. T. Jonker et al., Nature Phys. 3, 542 (2007); S. P. Dash et al., Nature 462, 491 (2009).
[2]C. H. Li et al., Appl. Phys. Lett. 95, 172102 (2009).