Electrical spin injection into Si(001) through a SiO$_2$ tunnel barrier

C.H. LI, G. KIOSEOGLOU, O.M.J. VAN 'T ERVE, P.E. THOMPSON, B.T. JONKER, Naval Research Lab — We recently demonstrated successful injection of spin-polarized electrons from an Fe film through an Al$_2$O$_3$ tunnel barrier into Si (001) [1]. However, the utilization of SiO$_2$ as the spin tunnel barrier can prove technologically important owing to the prevalence of SiO$_2$ and the SiO$_2$/Si interface in the CMOS industry. Here we demonstrate spin polarized tunneling from Fe through a SiO$_2$ tunnel barrier into a Si $n-i-p$ heterostructure [2]. Transport measurements indicate an effective barrier height of $\sim$1.7 eV and barrier thickness of $\sim$21 Å for 10 K, and that single step tunneling is the dominant transport mechanism. The electroluminescence from the Si exhibits circular polarization that tracks the Fe magnetization, confirming electrical injection from Fe. A rate equation analysis provides a lower bound of 30% for the electron spin polarization in the Si at 5 K. These results demonstrate that an ultra thin layer of SiO$_2$, readily fabricated on Si through UV-ozone oxidation, can be used as a viable tunnel barrier for electrical spin injection from a ferromagnetic contact into Si.