Abstract Submitted
for the MAR12 Meeting of
The American Physical Society

Comparing nonlocal and three terminal Hanle experiments in Silicon OLAF VAN 'T ERVE, CONNIE LI, AUBREY HANBICKI, PHILLIP THOMPSON, BEREND JONKER, Naval Research Laboratory — We have recently shown electrical spin injection in the technologically important material Si up to 500K and demonstrated a dependence of the spin lifetime with carrier concentration. In previous work on GaAs, we have seen excellent agreement between the spin lifetime derived from Hanle data measured directly at the injector contact using a three terminal measurement and the simultaneously measured nonlocal signal outside of the charge path. Unfortunately, simultaneous measurement of three terminal and nonlocal measurements is impractical on the Silicon devices due to the high resistance of the 6x100 μm^{2}Fe/AlO$_x$/2e18 n-type Si injector contact. Instead we used a separate 150x100 μm^{2}Fe/AlO$_x$/Si contact on the same substrate to do three terminal measurements and nonlocal measurements independently. Lorentzian fits to the data shows a spin lifetime of 280 ps measured directly underneath the spin injecting contact. This data is in excellent agreement with the spin lifetime vs. carrier concentration for NiFe/SiO$_2$/Si contacts, however it is a factor of 3 lower than the spin lifetime of $\sim$ 1ns measured at the nonlocal contact. We discuss this observed difference and other properties such as temperature dependence and bias dependence of the three terminal vs. nonlocal experiments.

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Date submitted: 16 Nov 2011 Electronic form version 1.4