SPIN TRANSPORT IN THE PERSISTENT PHOTOCONDUCTOR $Al_{0.3}Ga_{0.7}As:Si$

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Electrical spin injection, manipulation, and detection are the necessary ingredients for realizing spin based field effect transistors (FETs) which may offer transformative new functionalities not present in a conventional FET. In order to examine spin transport and understand the spin dynamics in a semiconductor, we have fabricated spin injection/detection devices with patterned Fe electrodes as the injector and detector, and $Al_{0.3}Ga_{0.7}As:Si$, a persistent photoconductor, as the channel. Fe/AlGaAs heterostructures were grown by MBE, in which an AlGaAs graded junction forms thin Schottky tunnel barrier between the ferromagnetic electrode and the semiconductor channel for optimal spin injection. 3-terminal (3T) [1] and 4-terminal nonlocal [2] Hanle measurements were used to measure the spin accumulation and determine the spin lifetimes in the AlGaAs channel. *In situ* incremental photo-doping enabled direct comparison of the 3T and 4T Hanle results on the same device over a broad range of carrier densities across the insulator-metal transition (IMT) in the AlGaAs channel [3-5]. Even though the magnitudes of 3T and 4T Hanle signals showed about an order of magnitude difference, they exhibit broad similarities in their dependencies of the injection current and carrier density. Specifically, the magnitude of both 3T and 4T Hanle signals are observed to decrease exponentially with increasing carrier density of the AlGaAs channel. The spin lifetimes extracted from the 3T and 4T Hanle curves, both via the FWHM of the Lorentzian fit and the 1D spin drift-diffusion model analysis, show similar values and evolution with the carrier density.

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