Imaging Drift and Diffusion of Accumulation from the Spin Hall Effect

N.P. STERN, D.W. STEUERMAN, S. MACK, A.C. GOSSARD, D.D. AWSCHALOM, Center for Spintronics and Quantum Computation, University of California, Santa Barbara, CA 93106 — The spontaneous generation of spin polarization near sample edges by the spin Hall effect when electron currents flow in a metal or semiconductor with spin-orbit coupling has attracted recent attention due to the elegant and complex spin-orbit physics as well as the potential for all-electrical spin generation in spintronics devices. Optical techniques in semiconductors allow for spatial resolution of the electrically generated spin accumulation, a feature not present in all-electrical measurements. We use Kerr rotation microscopy to image the spatial and temporal evolution of spin accumulation produced by the extrinsic spin Hall effect in n-GaAs devices. Measurements in a variety of device geometries, including arms transverse to a channel, reveal the unambiguous contribution of longitudinal spin drift in accumulation profiles. We develop one- and two-dimensional drift-diffusion modeling to explain the observed features, providing a more complete understanding of observations of spin accumulation and the spin Hall effect.

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