

Current-induced polarization and the spin Hall effect in semiconductors

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As a consequence of relativity, an electric field transforms into a magnetic field in the frame of a moving electron, and influences the spin of the electron. This is known as spin-orbit coupling, and it gives rise to interesting spin phenomena in non-magnetic semiconductors. Using Faraday and Kerr rotation spectroscopies with temporal and spatial resolution, we observe two such phenomena in III-V semiconductors: current-induced spin polarization [1] and the spin Hall effect [2]. Strain-induced spin-orbit coupling gives rise to an internal magnetic field [3], which can be used to polarize the spins, offering a pathway to electrically generate spin polarization within non-magnetic semiconductors. More recently, we have observed the spin Hall effect, which refers to an appearance of a pure spin current transverse to an applied electric field in the absence of applied magnetic fields. The spin Hall effect results in accumulation of spins at the edges of a sample, similar to charge accumulation in the conventional Hall effect. Such polarization is detected and imaged using Kerr rotation microscopy in both unstrained and strained samples. The polarization is out-of-plane and has opposite sign for the two edges, consistent with the predictions of the spin Hall effect. This work was supported by DARPA SPINS and QuIST programs, NSF, and ONR.

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