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Current-Induced Polarization and the Spin-Hall effect in Semiconductors[1]

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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[3] and the spin Hall effect[4]. Strain-induced spin-orbit coupling gives rise to an internal magnetic field[5], which can be used to electrically 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.

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[2]In collaboration with Y. K. Kato, A. C. Gossard, and D. D. Awschalom.
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