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**Imaging electrical spin generation and spin Hall dynamics in semiconductors**[1]

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The capability to generate and manipulate spin polarization through the spin-orbit interaction drives interest in all-electrical techniques to exploit electron spins for semiconductor spintronics. The spin Hall effect refers to the generation of a pure spin current transverse to a charge current, resulting in a spontaneous spin accumulation near sample boundaries without the need for magnetic fields or materials. Recent experiments toward imaging this electrically generated spin polarization with both spatially and temporally resolved Kerr rotation microscopy in bulk zincblende semiconductors are discussed. Both current-induced in-plane spin polarization and out-of-plane spin accumulation from the spin Hall effect are observed in ZnSe up to room temperature[3]. In GaAs devices, spatially resolved measurements of steady-state spin Hall accumulation and associated modeling clarify the important role of drift and diffusion in transporting spins generated at sample boundaries to the device interior[4]. In these typical optical experiments, electrically-generated spin accumulation is measured using steady-state techniques that do not directly observe dynamics at timescales important for device operation. Here we discuss a time- and spatially-resolved measurement of the spin Hall effect using a pulsed current to drive spin accumulation[5]. The dynamical processes of spin accumulation and diffusion reveal spatially-dependent nanosecond timescales comparable to the electric-field dependent spin coherence time. A time-dependent diffusion analysis reconciles the observed spatial and temporal dynamics of spin accumulation from the spin Hall effect in one coherent picture.

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[2]In collaboration with D. W. Steuerman, S. Mack, A. C. Gossard, and D. D. Awschalom.
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