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Spatial imaging of the spin Hall effect and current-induced polarization in two-dimensional electron gases[1]

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Spin-orbit coupling in semiconductors relates the spin of an electron to its momentum, and provides a pathway for electrically initializing and manipulating electron spins in zero magnetic field for applications in spintronics and spin-based quantum information processing. This coupling can be regulated with strain in bulk semiconductors and quantum confinement in semiconductor heterostructures. Using Faraday and Kerr rotation spectroscopies with temporal and spatial resolution, current-induced spin polarization[3] and the spin Hall effect[4] have been observed in bulk semiconductors. More recently, we have investigated the spin Hall effect and current-induced spin polarization in a two-dimensional electron gas confined in (110) AlGaAs quantum wells using Kerr rotation microscopy[5]. In contrast to previous measurements, the spin Hall profile shows complex structure and the current-induced spin polarization is out-of-plane. The experiments map the strong dependence of the current-induced spin polarization to the crystal axis along which the electric field is applied, reflecting the anisotropy of the spin-orbit interaction. These results reveal opportunities for tuning a spin source using quantum confinement, strain and device engineering in non-magnetic materials.

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