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Electrical manipulation of spin-orbit coupling in semiconductor heterostructures[1]

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Spin-orbit coupling provides a pathway for electrically initializing and manipulating electron spins. This coupling creates momentum-dependent spin-splittings related to the inversion asymmetries of the semiconductor heterostructure. We demonstrate that we can regulate these spin-splittings in semiconductor epilayers with strain[2] and in heterostructures using quantum confinement and orbital quantization[3]. These spin-splittings can provide a mechanism for electrically generating spin polarization without magnetic materials or magnetic fields. Using Kerr rotation microscopy, current-induced spin polarization and the spin Hall effect have been observed in bulk semiconductors and in a two-dimensional electron gas confined in (110) AlGaAs quantum wells[4]. In contrast to measurements on bulk systems, the data for the quantum wells reveal that the spin Hall profile exhibits a complex structure and that the current-induced spin polarization is out-of-plane. The current-induced spin polarization is dependent on the direction along which the electric field is applied, reflecting the anisotropy of the spin-orbit interaction. More recently, we demonstrate that the observed spin accumulation due to the spin Hall effect is due to a bulk electron spin current[5]. Channels with transverse arms allow us to observe that this spin current can drive spin transport over macroscopic distances in bulk GaAs.

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[2]V. Sih, H. Knotz, J. Stephens, V. R. Horowitz, A. C. Gossard and D. D. Awschalom, *Phys. Rev. B* **73**, 241316(R) (2006).

[3]V. Sih, W. H. Lau, R. C. Myers, A. C. Gossard, M. E. Flatté and D. D. Awschalom, *Phys. Rev. B* **70**, 161313(R) (2004).

[4]V. Sih, R. C. Myers, Y. K. Kato, W. H. Lau, A. C. Gossard and D. D. Awschalom, *Nature Physics* **1**, 31 (2005).

[5]V. Sih, W. H. Lau, R. C. Myers, V. R. Horowitz, A. C. Gossard and D. D. Awschalom, *Phys. Rev. Lett.* **97**, 096605 (2006).