Electrical detection of ballistic spin Hall and Rashba effects in a semiconductor channel

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The spin-orbit interaction in a semiconductor channel provides an exceptionally fascinating area. Coherent spin precession in a Rashba effective magnetic field in the channel of a spin injected field effect transistor (spin-FET) and the spin Hall effect (SHE) are the two most important topics in this area. The original Datta-Das prediction [1] of a gate voltage controlled conductance oscillation in a spin injected field effect transistor (Spin-FET), caused by coherent spin precession in a Rashba spin-orbit system, is the cornerstone of semiconductor spintronics research. Our previous report [2] was the first experimental observation and confirmation of the Datta-Das prediction. In this research [3], we combine spin Hall and Rashba effects to provide two novel results: a direct demonstration of the ballistic SHE and a new technique for an all-electric measurement of the Datta–Das conductance oscillation. We confirm our model of both results by fitting the measured precession spin phase of the conductance oscillation with the Datta–Das wavelength calculated using independently measured parameters. Finally, we use the original Datta–Das technique with a single inverse SHE detector and measure the channel conductance oscillation as gate voltage is varied. Our experiments show that the ballistic SHE can be used for efficient electric injection or detection of spin polarized electrons in a spin transistor or other semiconductor spintronic structures.

References

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