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A Quantitative Analysis of the Electrical Detection of Spins Via the Spin Hall Effect and the Non-Local Spin Valve Effect Within a Semiconductor Microchannel VIVEK AMIN, JAIRO SINOVA, Department of Physics, Texas A&M University, JOERG WUNDERLICH, Hitachi Cambridge Laboratory, ANDY IRVINE, Microelectronics Research Centre, Cavendish Laboratory, RICHARD CAMPION, School of Physics and Astronomy, University of Nottingham, KAMIL OLEJNIK, TOMAS JUNGWIRTH, Institute Of Physics ASCR — Recently, the manipulation of spins via a gate electrode, and their subsequent detection through the Spin Hall Effect, has led to the experimental realization of a spin-based semiconductor transistor. While in this experiment, spin injection was achieved optically via circularly-polarized light, we consider a similar experiment using electrical injection by means of a ferromagnetic contact into a GaAs microchannel instead. The spin current in a lateral semiconductor channel is then detected through the Spin Hall Effect, while the spin accumulation nearby is simultaneously measured through the Non-Local Spin Valve Effect (using another Fe electrode). The spins within the channel are manipulated through the Hanle Effect via an external magnetic field, and through a drift induced by an applied electrical bias. To analyze these results, we use analytical and numerical solutions to the steady-state drift-diffusion equations with a constant magnetic field and a drift velocity modeled by a Heaviside Theta function. Combining these results with the anomalous Hall response function, which takes into account the geometry of the Hall probe in order to obtain the correct Hall angle, we obtain results that are in quantitative agreement with experiments.

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