Electric field modulation of spin transport in silicon

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Spintronics aims to develop spin-based devices in bulk Si to enhance the functionalities of CMOS-compatible circuits without altering the electronics supply chain. However, the manipulation of the spin degree of freedom of carriers directly inside Si remains a difficult task if one excludes the application of magnetic fields. We created a non-local architecture for spin current generation, modulation, and detection in lightly *n*-doped bulk Si devoid of ferromagnets. Spin-polarized electrons are optically oriented exploiting circularly polarized light at resonance with the Si indirect gap. A bias voltage is applied and spin drift is investigated for electric fields up to 35 V/cm. Spin currents are detected by means of the Inverse Spin Hall Effect that mediates spin-to-charge conversion inside a Pt stripe. The device is kept at room temperature and the voltage drop ΔV across the Pt detector is measured in open circuit conditions. We directly measure the spin diffusion length L_{s} and the *spin transport length* $L_{\mathrm{s,t}}$ (typical distance travelled by spin-polarized electrons before depolarizing when an external electric field is applied). These quantities are also modeled within a 1D spin transport model. We observe an increase (decrease) of a factor 3 of $L_{\mathrm{s,t}}$ with respect to L_{s} when the electric field is antiparallel (parallel) to the electron diffusion velocity. Finally, we observe that the signal ΔV can be electrically driven between two logic states when the spins are injected at a distance larger than L_{s}, demonstrating that our architecture can act as a spintronic logic gate.