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Electrical characterization of spin-charge conversion in nanodevices of SrTiO3 two-dimensional electron gases

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Spin-orbitronics is a wide field that takes advantage of the effect of spin-orbit coupling (SOC) on the spintronic response of materials. SOC is the responsible for the spin-charge interconversion through effects such as Edelstein effect, which occurs naturally in topological insulators and Rashba systems. One recently proposed spin-orbitronic device is the Magnetoelectric Spin-Orbit (MESO) technology that brings logic into memory by combining a ferromagnet with a magnetoelectric (ME) element for information writing and a SOC element for information read-out [1-3]. Key to the operation of MESO is to use a SOC system able to generate a large output voltage (up to 100 mV). Among candidate materials, oxide 2DEGs have shown very large spin-charge conversion efficiency but only in spin-pumping experiments and at low T [4,5]. Here we report all-electrical spin-injection and spin-charge conversion experiments in nanoscale devices harnessing the inverse Edelstein effect of STO Rashba 2DEGs. We have designed, patterned and fabricated T-shaped nanodevices where a spin current is injected from a cobalt layer into the 2DEG and is converted into a charge current. By taking advantage of the large tunability of the electronic structure of 2DEGs, we optimized the spin-charge conversion signal by applying back-gate voltages and studied its temperature evolution. We further disentangled the inverse Edelstein contribution from numerous spurious effects, namely planar Hall effect, anomalous Hall effect or anisotropic magnetoresistance [6]. We found encouraging results in terms of future applications for alternative computing approaches based on spin logic. The combination of non-volatility and high energy efficiency of these devices could potentially lead the new technology paradigm in beyond-CMOS computing devices.

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