Tunable spin transfer in low-loss graphene interconnects on semiconductor

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Graphene spintronics has gained momentum with the development of magnetologic gates and spin transistors. Incorporating the spintronic features of graphene into semiconductor technologies promises breakthroughs in creating spin-based logic systems with low power consumption and high operational speed. However, the perspective role of graphene in next-generation spintronic devices faces challenges due to its poorly characterized spin transport properties and the yet unexplored spin transfer between semiconductors and graphene. In this study, we investigate a graphene/Ge-based spintronic device, free of any ferromagnetic building blocks. Highly-localized spin populations are optically oriented in Ge, efficiently transferred to graphene at room temperature, and detected through spin-to-charge conversion via the inverse spin-Hall effect in a Pt pad spatially separated from the spin injection point. By raster scanning a focused laser beam on the sample surface, we vary the spin injection/detection distance, thus directly determining a diffusion length of spin-polarized carriers in graphene of ≈180 μm – about ten times larger than Ge and six times larger than achieved in previous graphene studies. The key ingredient for improving the spin transport in graphene seems therefore to be the absence of magnetic impurities, rather than pursuing single-crystal layers. This is particularly encouraging given the established industrial use of chemical vapor deposition techniques for polycrystalline graphene growth. Additionally, we demonstrate that slightly biasing the graphene/Ge junction enables the selective injection of either spin-polarized electrons or holes with opposite spin, maintaining comparable spin-transport performances. This offers new possibilities for leveraging graphene in spintronics, potentially advancing spin interconnects and logic devices.