Enabling practical two-dimensional spintronic circuits

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Abstract
The rise of atomically thin two-dimensional (2D) materials brought new excitement in nanotechnology, particularly the field of spintronics got a fresh boost with 2D materials presenting diverse spin-linked abilities. In terms of exploring spin-polarized electrons or spin currents, graphene stands out as a material where spin currents can travel over tens of microns at room temperature, up to hundreds of times longer than in typical metals. However, charge transfer and spin-orbit coupling at the contact interfaces cause spin relaxation, lowering the spin diffusion length and spin lifetime in graphene. In addition, a key challenge towards practical circuits is their large-scale realization using scalable chemical vapor-deposited graphene, determining eventual high current densities that graphene can sustain, and achieving a cleaner, stable, and more resilient system that can serve as a base platform for 2D material spintronic applications. In this talk, I will explain our efforts in this direction, in particular, device engineering techniques to minimize the contact-induced spin relaxation that led us to the observation of the highest spin parameters with the longest spin communication of 45 μm at room temperature[1], high current carrying capacity[2], and other unique effects of widely used metal-oxides on charge transfer in graphene[3] and how such oxide layers can be used for surface passivation with enhanced performance. Further, I will discuss how these results augment our recent developments of flexible ferromagnetic nanowires [4] and flexible graphene spin devices with high diffusive spin transport [5], providing new opportunities for flexible-integrated large-scale 2D spintronic circuits.

References

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