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GMAG Dissertation Award Talk: Spin Injection and Relaxation in Graphene

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Graphene is a unique and promising candidate for spintronics due to its high mobility, low intrinsic spin-orbit and hyperfine couplings, which should lead to long spin lifetimes and relaxation lengths. Experimentally, the gate-tunable spin transport has been achieved at room temperature. However, the spin injection efficiency has been low and the spin lifetime is still much shorter (50- 200 ps) than expected theoretically (∼micro seconds). To fulfill the potential of graphene for spintronics, two major advances are needed to be accomplished; enhance the spin injection efficiency and extend the spin lifetime. In this talk, I will focus on the contributing results for these advancements in graphene spintronics during my Ph. D. study. First, I develop a method to grow atomically smooth MgO tunnel barrier using Ti seeding layer prior the MgO growth on graphene. Then tunneling spin injection into graphene is achieved. The nonlocal spin signal is observed to be as high as 130 ohms at 300 K, with a spin injection efficiency of 30%. Second, using tunneling contacts to suppress the contact-induced spin relaxation, we observed the spin lifetimes as long as 771 ps at 300 K, 1.0 ns at 4 K in SLG, and 6.2 ns at 20 K in bilayer graphene (BLG). Furthermore, contrasting spin relaxation mechanisms are found in SLG and BLG. Third, the spin lifetimes on the same SLG spin valve with tunable mobilities are investigated. These results are important advances for graphene to be used for spin computing or spin logic applications.