MAR17-2016-020291
Abstract for an Invited Paper
for the MAR17 Meeting of
the American Physical Society

Magnetic proximity control of spin currents and giant spin accumulation in graphene[1]

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Two dimensional (2D) materials provide a unique platform to explore the full potential of magnetic proximity driven phenomena. We will present the experimental study showing the strong modulation of spin currents in graphene layers by controlling the direction of the exchange field due to the ferromagnetic-insulator (FMI) magnetization in graphene/FMI heterostructures. Owing to clean interfaces, a strong magnetic exchange coupling leads to the experimental observation of complete spin modulation at low externally applied magnetic fields in short graphene channels. We also discover that the graphene spin current can be fully dephased by randomly fluctuating exchange fields. This is manifested as an unusually strong temperature dependence of the non-local spin signals in graphene, which is due to spin relaxation by thermally-induced transverse fluctuations of the FMI magnetization. Additionally, it has been a challenge to grow a smooth, robust and pinhole free tunnel barriers on graphene, which can withstand large current densities for efficient electrical spin injection. We have experimentally demonstrated giant spin accumulation in graphene lateral spin valves employing SrO tunnel barriers. Nonlocal spin signals, as large as 2 mV, are observed in graphene lateral spin valves at room temperature. This high spin accumulations observed using SrO tunnel barriers puts graphene on the roadmap for exploring the possibility of achieving a non-local magnetization switching due to the spin torque from electrically injected spins.

[1]Financial support from ONR (No. N00014-14-1-0350), NSF (No. DMR-1310661), and C-SPIN, one of the six SRC STARnet Centers, sponsored by MARCO and DARPA.