Magnetoresistance and spin-to-charge-current conversion in yttrium iron garnet-graphene hybrid structure

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Abstract

The use of graphene in spintronic devices depends, among other things, on its ability to convert a spin excitation into an electric charge signal, a phenomenon that requires a spin-orbit coupling (SOC). As ideal graphene has extremely small intrinsic spin-orbit interaction, the extrinsic enhancement of SOC in graphene has been a key challenge in this area. In this work we report the observation of two effects that show the existence of SOC in large-area CVD grown single-layer graphene (SLG) deposited on a single crystal film of the ferrimagnetic insulator yttrium iron garnet (YIG). While the single layer of graphene was grown by the chemical vapor deposition technique, the YIG film was grown by means of the liquid phase epitaxy technique. The first is a magnetoresistance of graphene induced by the magnetic proximity effect with YIG. The second is the detection of a DC voltage along the graphene layer resulting from the conversion of the spin current generated by spin pumping from microwave driven FMR into charge current. We interpret the spin-to-charge conversion as arising from the inverse Rashba-Edelstein effect (IREE) made possible by the extrinsic spin-orbit coupling in graphene. These observations show that spin orbit coupling can be extrinsically enhanced in graphene by the proximity effect with a ferromagnetic layer. This result opens new possibilities for the use of graphene in spintronic devices with unique functionalities [1]. Research supported in Brazil by the agencies CNPq, CAPES, FINEP, FAPEMIG, FACEPE, INCT de Nanocarbono and Rede de Nanoinstrumentação, and in Chile by FONDECYT No. 1130705.

References

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