Proximity-Induced Spin Polarization of Graphene in Contact with Half-Metallic Manganite and Magnetic Insulator

Zakhar I. Popov
Seiji Sakai, Sergei V. Erohin, Sayani Majumdar, Pavel V. Avramov, Shiro Entani, Yuri Hasegawa, Yoichi Yamada, Hannu Huhtinen, Hiroshi Naramoto, Satoshi Haku, Takahhiro Watanabe, Kazuo Ando, Pavel B. Sorokin, Yasushi Yamauchi

National University of Science and Technology MISiS, Leninskiy prospekt 4, Moscow, Russian Federation

zipcool@bk.ru

A combined approach of topmost-surface sensitive spin-polarized metastable atom deexcitation spectroscopy (SPMDS) and *ab initio* calculations provides us direct evidence for the magnetic proximity effect in the junctions of single-layer graphene (SLG) with half-metallic manganite $La_{0.7}Sr_{0.3}MnO_3$ (LSMO) and magnetic insulator yttrium iron garnet (YIG). As was shown in our work [1] the indirect exchange interaction between SLG and LSMO under the strong electrostatic interactions at the interface is responsible for the large magnetic proximity effect (figure1). In the next work [2] we shown pronounced spin polarization of graphene deposited on YIG. The graphene π band is found to be negatively spin-polarized in parallel to the minority spins of YIG with large and non-negligible polarization degrees of the SLG carriers at low and ambient temperatures, respectively, without significant change in the π band structure. It is expected that the use of that's types of contacts in graphene-based devices allows us to improve the spin injection efficiency into graphene with minimizing the conductivity mismatch and also the declination of the spin transport properties of graphene at the interface. The work was carried out with financial support from the Ministry of Education and Science of the Russian Federation in the framework of Increase Competitiveness Program of NUST «MISiS» (№ K2-2015-033).

References

[1] S. Sakai, S. Majumdar, Z. I. Popov et al. ACS Nano,10 (2016) 7532-7541
[2] S. Sakai, S.V. Erohin, Z.I. Popov et al. submitted (2017)

Figures

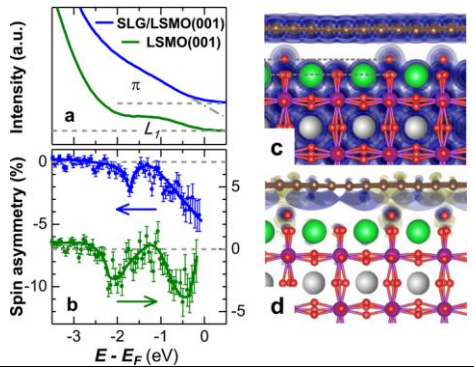

Figure 1: Magnified (a) SPMDS and (b) spin asymmetry spectra of SLG/LSMO(001) (blue) and LSMO(001) (green) as a function of the binding energy $E - E_F$ in the energy region near the Fermi level. (c) Total charge density, and (d) differential charge density of the SLG/LSMO(001) structure.

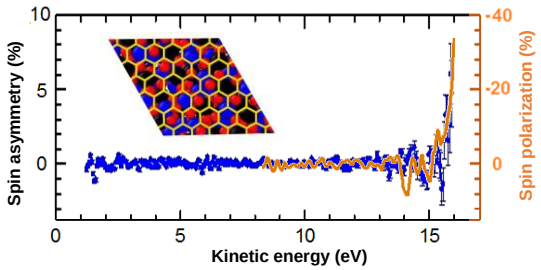

Figure 2: Comparison between behavior of experimentally derived spin asymmetry and theoretically calculated graphene spin

polarization. In the inset the simulated atomic structure of SLG/YIG(111) is presented