

Spin polarization of the Dirac cone in graphene- and topological insulators-based systems

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Abstract

This series of papers is devoted to the experimental investigations of the electronic and spin structure of the systems, based on the contact of graphene with heavy metals (Pb, Ir, Pt) and 2D and 3D topological insulators. Analysis had been carried out with the purpose of the effective application in spintronics and quantum computations.

The most attractive branch of the solid state physics is the novel materials, which have unique electronic, optic, magnetic or mechanic properties, described by new fundamental laws. One of those systems are Dirac materials, where the dynamics of the electrons is described by Dirac equation instead of Shrodinger equation. In this case the relativistic mass of the fermions can be zero, leading to the linear dispersion law, so called Dirac cone. This types of materials are graphene and topological insulators, perspective for applications in the various fields owing to non-classical effects.

Graphene and topological insulators attract increasing attention of the researchers owing to the Nobel prizes (2008 an 2016 years). Besides devices application interest these systems are expected to realize such phenomena as magnetic monopole or Majorana fermions. Their realization and application require the possibility of the managing of the electronic and spin structure of topological insulators and graphene.

In order to study the contacts of graphene with various substrates Klimovskikh I.I had proposed and realized the new method of the graphene synthesis on Pt(111)[1] and intercalation of the Pt and Pb atoms underneath graphene on Pt(111) and Ir(111). Moreover, by means of photoelectron spectroscopy the electronic and spin structure of the systems had been studied, showing the spin polarization of the Dirac cone. The spin current generator device had been proposed based on these results [2]. Finally, system graphene/Pb/Pt(111) exhibits the gap between the Dirac cones and the spin-orbit character of the gap had been established [5]. This effect leads to the topological phase I graphene and opens the new perspectives for graphene application in quantum computers.

For investigation of the 3D topological insulators Klimovskikh I.I. had measured photoemission data for the series of compounds with various stoichiometry. It was shown that variation of the composition leads to the changes of the bulk gap value and Dirac point position. [3,7,8] This allows to manage the surface transport properties for the spintronics. In Ref.[6] it was demonstrated that spin currents and magnetization, that are needed for spintronic devices, can be created by circularly-polarized synchrotron radiation at the temperatures higher that critical.

The experiments had been carried out at the modern equipment in synchrotron radiation centers BESSY II, Elettra, SLS, HiSOR and at the Research resource center "Physical methods of surface investigations". Results had ben presented at 15 international conferences, including invited and oral talks.

Results are published in 8 paper in the high-impact journals, including ACS Nano (IF=13.942) and Scientific Reports (IF=5.228, Nature publishing group). Based on

these results Klimovskikh I.I. had defended PhD thesis «Electronic and spin structure of the graphene- and topological insulator-based systems»