High 2D Conductivity of Graphene on Relaxor Film

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A successful attempt [1] was made recently to use graphene as a technological transparent electrode for probable applications to photovoltaics, organic light-emitting diodes, touch screens, displays, and so forth. The main task at the solution of this problem is to obtain the best combination of the transparency (97.3% for a monoatomic graphene layer in the optical and near IR ranges) and the 2D resistivity. In [1] the high 2D graphene channel conductivity was obtained due to graphene doping by the dipoles of the transparent poly[vinylidenefluoride-co-trifluoroethylene] (PVDF-TrFE) relaxor with extremely high spontaneous polarization.

The resistivity, for those systems to be competitive with available indium tin oxide (ITO) coatings, has to be less than 100 Ω, which was in fact observed experimentally. However, the quantitative (and, in some cases, even qualitative) understanding of physical processes that govern the conductivity in such system is still absent, which makes it impossible to talk about directions of the effective improvement of their parameters.

In our work, a quantitative theory is developed for the conductivity in graphene doped with the relaxor PVDF-TrFE dipoles. The theory is based on the model of charge carrier scattering by large-scale static nonuniformities proposed in work [2], with regard for the charge carrier scattering at such nonuniformities arising owing to both the domain structure of the ferroelectric and the nonuniformities in the distribution of chemical dopants over the CVD fabricated graphene surface.

It is shown that the increase of the nonuniformity correlation length gives rise to the decrease of the resistivity. In the case where the distribution of chemical impurities is sufficiently uniform, and the domains in the ferroelectric are large enough, the resistivity can reach a value of 100 Ω and less [3]. Such values make the system "graphene on ferroelectric" competitive against standard conducting transparent ITO coatings for photovoltaics.

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