Conductivity of Suspended Graphene

I.V. Gornyi, V.Yu. Kachorovskii, and A.D. Mirlin

Institut für Nanotechnologie, Karlsruhe Institute of Technology, Germany

Poster presentation at "Graphene Week 2013", Chemnitz, 03.06-07.06.2013

Keywords: transport theory, flexural phonons, Coulomb interaction, disorder

We have explored transport properties of suspended graphene, with a particular focus on the case of zero chemical potential (Dirac point) [1]. In the absence of the e-e interaction, the main contribution to resistivity comes from interaction with flexural (out-of-plane deformation) phonons. We have shown that, despite a high bending rigidity, flexural phonons play central role in determining the graphene resistivity in a broad range of temperatures. We also demonstrate that the anharmonicity crucially affects the magnitude and the temperature dependence of the resistivity. We have found that the phonon-limited conductivity scales with the temperature as $T^{-\eta}$, where η is the critical exponent (equal to ≈ 0.7 according to numerical studies) that describes the renormalization of flexural-phonon correlation functions due to anharmonic coupling with the in-plane phonons. The electron-electron (e-e) interaction induces an additional scattering mechanism and also affects the electron-phonon (e-ph) scattering by screening the deformation potential. We have demonstrated that the combined effect of both e-e and e-ph interactions results in a conductivity that can be expressed as a dimensionless function of two temperature-dependent dimensionless couplings which characterize the strength of e-ph and e-e interactions. We have also discussed the behavior of conductivity away from the Dirac point as well as the role of the impurity potential. With increasing the chemical potential μ (or, else, with lowering impurity concentration at fixed nonzero μ), the behavior of the Drude conductivity in the disorder-controlled low-temperature regime changes from insulating (conductivity decreases at lowering T) to metallic. Our predictions agree reasonably well with available experimental data [2].

References:

[1] I.V. Gornyi, V.Yu. Kachorovskii, and A.D. Mirlin, Phys. Rev. B **86** (2012) 165413.

[2] K.I. Bolotin, K.J. Sikes, J. Hone, H.L. Stormer and P. Kim, Phys. Rev. Lett. **101** (2008) 096802; E.V. Castro, H. Ochoa, M.I. Katsnelson, R.V. Gorbachev, D.C. Elias, K.S. Novoselov, A.K. Geim, and F. Guinea, Phys. Rev. Lett. **105** (2010) 266601.