Ion beam modification of monolayer graphene: Optical and electrical properties

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Monolayer graphene (MG) exhibits intriguing properties, such as massless Dirac fermion nature of charge carriers, high carrier mobility, good optical transparency, high thermal conductivity and many others, which endow graphene with great potential for a number of applications. However, the potential of graphene for practical applications is restricted due to the absence of a band gap and difficulty of doping. Ion irradiation is considered an effective tool for modification of the MG properties by manipulating the parameters of ion beams (energies, species, fluencies, *etc*.).

In this presentation we will review the results of measurements of optical properties (Raman scattering) and electrical properties (conductivity, mobility, magnetoresistance, quantum Hall effect) of polycrystalline MG samples before and after irradiation by different doses of heavy and light ions, followed by the long term aging of irradiated samples in ambient atmosphere and high temperature annealing of radiation damage in vacuum or forming gas.

The following phenomena will be discussed: 1) changes of the height and position of the main Raman lines induced by ion irradiation, aging and annealing; 2) significant rise of resistance and transformation of conductivity mechanisms caused by an increase of localization with increasing radiation dose; 3) asymmetry of the electron and hole mobility due to difference in the scattering cross-sections for Dirac fermions in attractive and repulsive charged impurity potentials; and 4) differences between carrier concentrations obtained from regular Hall effect measurements and from Shubnikov-de Haas oscillations in the quantum Hall regime.