Ion beam modification of CVD grown monolayer graphene

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We will review the results of measurements of optical properties (Raman scattering) and electrical properties (conductivity, mobility, magnetoresistance, quantum Hall effect) of polycrystalline CVD grown monolayer graphene (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 in 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-section for Dirac fermions in attractive and repulsive charged impurity potential; 4) differences between carrier concentrations obtained from regular Hall effect measurements and from Shubnikov-de Haas oscillations in the quantum Hall regime.

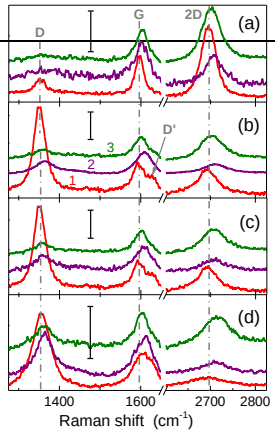

Figure 1: Raman spectra of Xe^+-irradiated MG samples before annealing in vacuum (1) and after annealing at 500°C (2) and 1000°C (3). $N_D(10^{13}cm^{-2})$: a – 0.01, b – 0.4, c – 0.8, d – 1.6

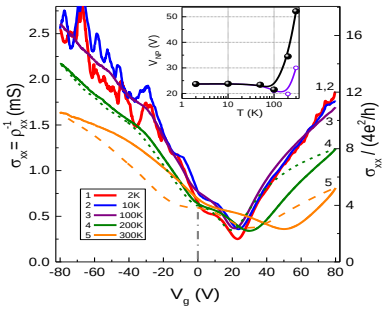

Figure 2: Conductivity of MG samples before irradiation as a function of gate voltage at different T, K: 1 – 2, 2 – 10, 3 – 100, 4 - 200, 5 – 300. Insert shows shift of the Dirac point.

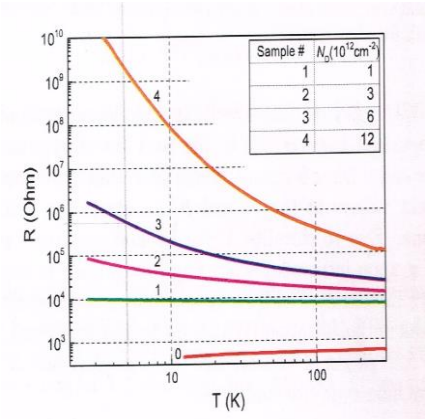

Figure 3: Transformation of electron transport mechanism with increase of irradiation dose: from metallic conductivity (0) through weak localization (1), to variable-range hopping conductivity (2,3,4) for strongly localized carriers