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Structure and electron transport in monolayer graphene gradually disordered by ion irradiation

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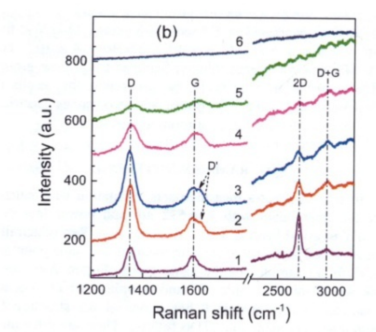
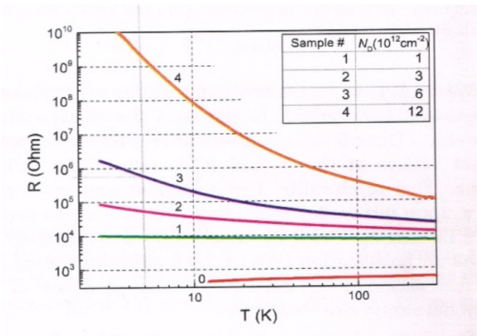
Abstract:

Raman scattering (RS) and film resistance R were measured in six series of micro-samples fabricated by using electron-beam lithography on the surface of a large size (5x5 mm) monolayer graphene film. Samples were irradiated by C^{+} ions with 5 different doses Φ up to 10^{15} cm^{-2}. It was observed that in highly irradiated samples, the RS disappear





(Fig. 1) which is accompanied by exponential increase of R and strongly non-linear current-voltage characteristics [1]. These facts are interpreted as an evidence that highly irradiated graphene film ceases to be a continuous and splits into small-size fragments.

Fig. 1 **Fig. 2**

Measurements of the temperature dependence $R(T)$ and magnetoresistance (MR) reveal the gradual transition of conductivity with increase of Φ: from metallic conductivity in initial samples through the weak localization (and antilocalization) regime (WL) at small degree of disorder to the variable-range-hopping conductivity (VRH) of strongly localized carriers (Fig. 2). Fitting theoretical curves with experimental data showed a good agreement and allowed to determine dephasing length in the WL regime and the width of the Coulomb gap and radius of localization for the case of strong localization [2]. It is suggested that the strengthening of localization with increase of N_D could be explained by assuming that structural defects in graphene are of amphoteric nature, i.e. they can be either donors or acceptors and compensate each other.

Measurements of hopping MR showed that R decreases (NMR) in perpendicular field, while in parallel field R increases (PMR). NMR is explained on the basis of the "orbital" model [3], in which perpendicular field suppresses the destructive interference of many paths in the long-distance tunneling in VRH regime. PMR in parallel fields is explained by alignment of spins which results in suppression of hopping via double occupied states.

References:

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