## Nanocomposites and nanomaterials

# Structural modification of single-layer graphene under laser irradiation featured by micro-Raman spectroscopy

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In the present work we used confocal micro-Raman spectroscopy as a sensitive tool to study the nature of defects in single-layer graphene induced by laser irradiation at varied laser power densities and dozes. Appearance and drastic intensity increase of zone-edge D-like modes caused by introduction of structural defects in the graphene layer were observed in the Raman spectra at high powers of excitation. The minimal power threshold of the exciting radiation of the structural defects generation is found. Time- and dose-dependent evolution of Raman spectra is studied. From the analysis of intensities of defective D and D' bands relative to G-band, the structural defects generated under laser irradiation of graphene with power density higher than threshold are shown to be mainly vacancy-type defects.[1] The surface density of structural defects is estimated from the intensity ratio of D and G bands using the D band activation model [2, 3]. At powers of laser irradiation higher than 4 mW unusual broadening of the D band and splitting of the G band into $G^-$ and $G^+$ components with redistribution of their intensities are observed. Position of the additional $G^+$ band is discussed in the relation with non-uniform doping of graphene with charge impurities. Simultaneous presence in the Raman spectra of heavily irradiated graphene of rather narrow G band and broaden D band can be explained by coexistence within the Raman probe of more and less damaged graphene areas. This assumption is additionally confirmed by confocal Raman mapping of the heavily irradiated area.

1. *Eckman A. et al.* Probing the nature of defects via Raman spectroscopy // Nano Lett.-2012.**-12.-**P. 3925-3930.
2. *Cancado L.G. et al.* Quantifying defects in graphene via Raman spectroscopy at different excitation energies // Nano Lett.-2011.**-11.-**P. 3190.
3. *Lucchese M.M. et al.* Quantifying ion-induced defects and Raman relaxation length in graphene // Carbon.-2010.-**48.**-P. 1592-1597.