Laser-induced modification of electronic and optical properties of graphene/hexagonal boron nitride heterostructures

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In recent years planar two-dimensional heterostructures attract significant attention of the research and industrial communities alike due to their unique properties, which are attractive to use in various nanoelectronic, optoelectronic and spintronic devices. This is possible, among others, due to possibility of nanostructurization of those materials. In our presentation we will discuss the possibility of tailoring the properties of graphene by nanostructurizing hexagonal boron nitride with focused laser beam.
In our communication we will discuss the effect of the laser irradiation on h-BN material based on Raman spectroscopy (Fig. 1) and Electrostatic Force Microscopy results. They show that the laser illumination leads to emergence of stable, local electric fields. The phenomenon is related to the light-enabled redistribution of the electrons on the defect center levels and the conduction band as described by a presented proposed theoretical model.
We show that the effect of photo-ionization of hexagonal boron nitride can be used to control the electron concentration and electrical conductivity in graphene within h-BN/graphene heterostructures, as shown in Fig. 2.

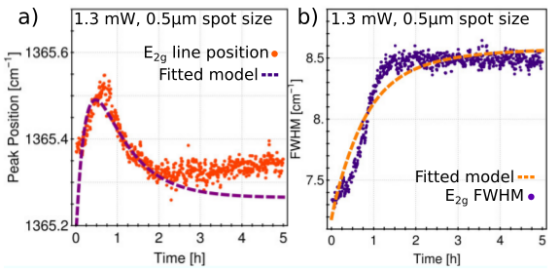

Fig. 1: Changes of a) position and b) FWHM of E_{2g} Raman line of h-BN during the illumination with 532 nm laser with of 1.3 mW power and 0.5 μm spot size [1].

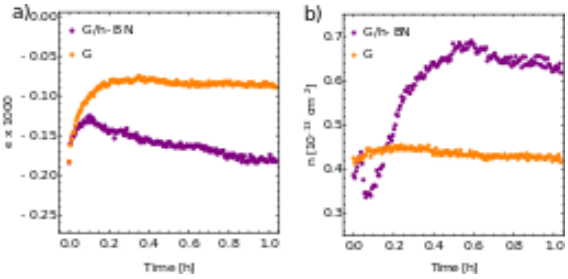

Fig. 2: Changes of the a) strain and b) charge carrier concentration in graphene/h-BN heterostructure under illumination with 532 nm laser with of 1.3 mW power and 0.5 μm spot size [1].

Our results show a novel approach to the non-invasive nanostructurization of hexagonal boron nitride and the h-BN-based planar devices, which can be performed using focused light.

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