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Modification of Hexagonal Boron Nitride Induced by Focused Laser Beam

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Abstract : Hexagonal boron nitride is a representative of a widely popular class of two-dimensional Van Der Waals materials. It finds its uses, among others, in construction of complexly layered heterostructures. Hexagonal boron nitride attracts great interest because of its properties characteristic for wide-gap semiconductors as well as an ultra-flat surface.Van Der Waals heterostructures composed of two-dimensional layered materials, such as transition metal dichalcogenides or graphene give hope for miniaturization of various electronic and optoelectronic elements. In our presentation, we will show the results of our investigations of the not previously reported modification of the hexagonal boron nitride layers with focused laser beam. The electrostatic force microscopy (EFM) images reveal that the irradiation leads to changes of the local electric fields for a wide range of laser wavelengths (from 442 to 785 nm). These changes are also accompanied by alterations of crystallographic structure of the material, as reflected by Raman spectra. They exhibit high stability and remain visible after at least five months. This behavior can be explained in terms of photoionization of the defect centers in h-BN which influence non-uniform electrostatic field screening by the photo-excited charge carriers. Analyzed changes influence local defect structure, and thus the interatomic distances within the lattice. These effects can be amplified by the piezoelectric character of hexagonal boron nitride, similar to that found in nitrides (e.g., GaN, AlN). Our results shed new light on the optical properties of the hexagonal boron nitride, in particular, those associated with electron-phonon coupling. Our study also opens new possibilities for h-BN applications in layered heterostructures where electrostatic fields can be used in tailoring of the local properties of the structures for use in micro- and nanoelectronics or field-controlled memory storage. This work is supported by National Science Centre project granted on the basis of the decision number DEC-2015/16/S/ST3/00451.

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