# Influence Of Gamma Rays And Neutron Irradiation On Excitonic Transitions In Epitaxial Boron Nitride Layers

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Hexagonal boron nitride (hBN) has been lately growing in popularity due to its multi-functional applications connected to van der Waals heterostructures, which are composed of atomically thin layers of 2D materials. Recently, it has been shown that hBN is an excellent host for optically active spin defects [1]. The prime example of such defect is the negatively charged boron vacancy $V_B^-$, which due to two-dimensional nature of hBN may overcome limitations of popular nitrogen vacancy (NV) center in diamond that mainly result from the 3D structure of the diamond host matrix [2]. Therefore hBN with $V_B^-$ could be used as spin-active, magnetic field sensitive thin layer within van der Waals heterostructure. The key element is to create these defects in an hBN samples without damaging the crystal structure of the material, since it would significantly influence spin relaxation time which is the crucial factor. This requirement can be fulfilled by neutron irradiation of hBN samples. However, neutron irradiation is always accompanied by gamma radiation.

To evaluate an effect induced by gamma and neutron irradiation, we studied excitonic absorption in set of epitaxial boron nitride samples grown on 2-inch sapphire substrates by Metal-Organic Vapor Phase Epitaxy (MOVPE). A series of samples was exposed to gamma radiation with a dose of about 250 kGy and another series was exposed to it with the thermal neutron fluence of $2.2\times10^{16}$ cm$^{-2}$, accompanied by a fast neutron fluence of $3.4\times10^{14}$ cm$^{-2}$. The neutron irradiation time was chosen to achieve the gamma radiation dose of 250 kGy. The absorption spectra were collected at room temperature before and after each irradiation We found that both types of irradiation influenced absorption spectra in the excitonic range. As would be expected, energy shifts as well as broadening of the excitonic absorption peaks are larger after neutron irradiation, which is assisted by gamma rays. The obtained results constitute the reference for the further experiments involving hBN enriched with $^{10}$B isotope. This isotope exhibits much higher cross-section for the thermal neutron capture in comparison to $^{11}$B isotope, which is dominant in natural BN. Different strategies of the reduction of undesired radiation damages will be discussed.

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[2] P. Kumar et al. Phys. Rev. Applied 18, L061002 (2022).