Tunneling effect in graphene/h-BN/graphene heterostructures

Igor Wlasny[1], Roman Stepniewski[1], Wlodzimierz Strupinski[2,3], Jacek M. Baranowski[2], and Andrzej Wysmolek[1]

[1] *Institute of Experimental Physics, Faculty of Physics, University of Warsaw, Pasteura 5, 02-093 Warsaw, Poland*
[2] *Institute of Electronic Materials Technology, Wolczynska 133, 01-919 Warsaw, Poland*
[3] *Faculty of Physics, Warsaw University of Technology (WUT), Koszykowa 75, 00-662 Warsaw,Poland*

One of the most prominent and widely researched applications of two-dimensional nanomaterials lie in the planar electronics, where the basic devices, such as diodes or transistors are based on 2D materials, such as grapheme, hexagonal boron nitride or transition metal dichalcogenides. In recent years the heterostructures constructed by two layers of grapheme separated by h-BN show a high promise as a junction, where a resonant characteristics of the tunneling current can be found. They offer extremely short switching times (within femtosecond range) at room temperatures. However, in order to fully utilize the quantum phenomenon in planar devices, it needs to be thoroughly investigated and understood. Particularly in light of recently discovered photoionization of deep defect centers in h-BN by visible spectrum light, which influence the Fermi level of graphene [1,2].

We present the results of our investigation of the tunneling in macroscale-sized graphene-hBN-graphene heterostructures based on the CVD material. In particular we focus on the environmental sensitivity of such a device, and what in the most interesting - the effect of illumination of the junction on its electric characteristics, such as emergence of maxima in the tunneling current, which we associate with electron transitions involving deep defect centers of h-BN (Fig. 1).

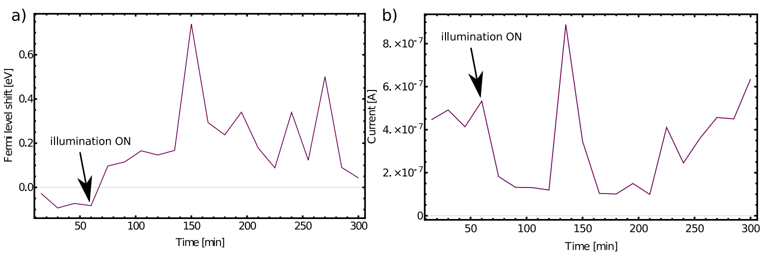

Figure 1: Changes in a) Fermi level (based on I-V curve measurements) and b) current at U = 0.5V in graphene/h-BN/graphene junction during illumination with 532 nm laser. Maxima in the both images are associated with electron transitions involving defect levels in h-BN.

[1] I. Wlasny, R. Stepniewski, Z. Klusek, W. Strupinski, A. Wysmolek, *Appl. Phys. Lett.* **123**, 235103 (2018).
[2] I. Wlasny, K. Pakula, R. Stepniewski, W. Strupinski, I. Pasternak, J.M. Baranowski, A. Wysmolek, *Appl. Phys. Lett.* **114**, Manuscript Accepted (2019).

This work was supported by National Science Centre project granted on the basis of the decision number DEC-2015/16/S/ST3/00451.