

Supplementary information

8-pmmn borophene: Edge states in competition with landau levels and local vacancy states

N. Deily Nazar^{1,2}, F.M. Peeters^{2,3}, R. N. Costa Filho³, and T. Vazifeshenas¹

¹Department of Physics, Shahid Beheshti University, G. C., Evin, Tehran 1983969411, Iran; E-mail: deilynazar@gmail.com

²Department of Physics, University of Antwerp, Groenenborgerlaan 171, B-2020 Antwerpen, Belgium; E-mail: francois.peeters@uantwerpen.be

³Departamento de Física, Universidade Federal do Ceará, Caixa Postal 6030, 60455-760 Fortaleza, Ceará, Brazil.

November 20, 2023

The density of state (DOS) for borophene ribbons including XBNR-zigzag, -armchair, YBNR-chain and -armchair, in clean (blue color) and disorder (red color) structures, in the presence of magnetic field ($B = 60$ T). In Fig. 1, DOS plots for inner and ridge single vacancy (SV) in left and right panels respectively. In inner SV distribution plots, we indicated some localized (semi-localized) vacancy states, with A, B and C indexes, which all are in the range of conduction band. In inner DOS plots: we can observe more localized vacancy states (LVS) in XBNR-armchair and YBNR-chain as compared to XBNR-zigzag and YBNR-armchair. These can be attributed to the non-existence of edge bands in the conduction region in XBNR-armchair and YBNR-chain (see Fig. 4 in the paper). But in XBNR-zigzag and YBNR-armchair, less vacancy states appear due to presence of edge conduction bands. In YBNR-armchair, edge-vacancy interaction is so strong because ribbon has an edge band which expand within the conduction region, so vacancy states mostly quenched by the edge band. Moving to right panels: we have ridge SV structures, here the position of vacancy states are changed (also intensity). A comparison between LVS's in inner and ridge SV distributions show that the kind of removed atom is a key parameter which effects on the SV energy and also on it's intensity. Thus, edge-vacancy interaction depends on the kind of edge and the kind of removed atom. LVS's are indexed just in the ridge SV in all ribbons.

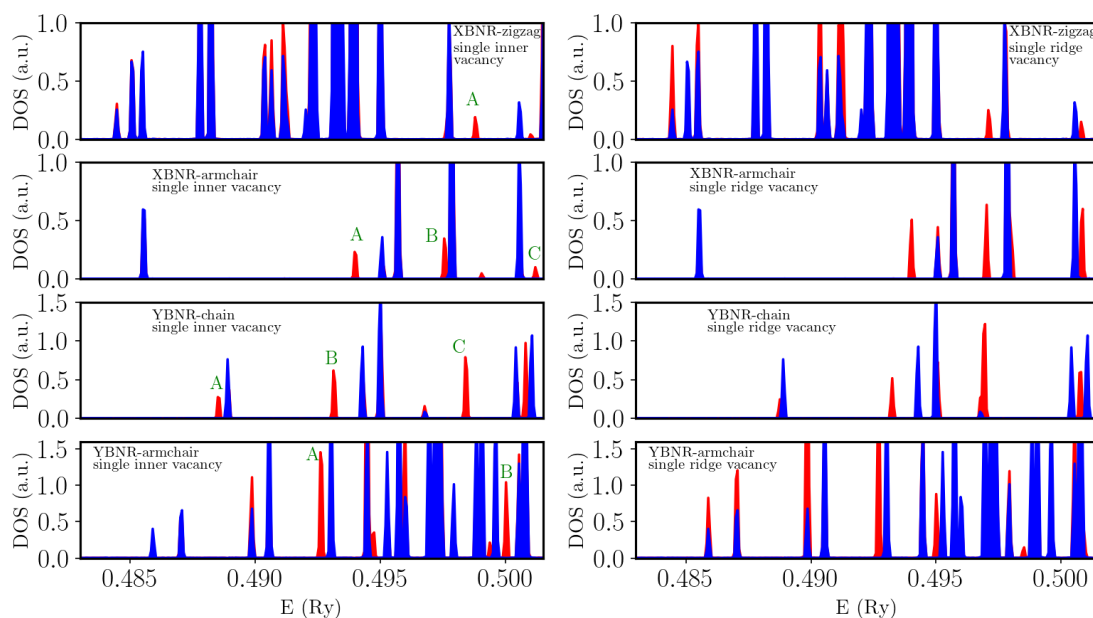


Figure 1: DOS for XBNR-zigzag, -armchair, YBNR-chain and -armchair in clean(blue) and SV(red) structures in the presence of magnetic field ($B = 60$ T). Left panels represent DOS for inner SV and right panels show ridge SV structure. Some of the LVS's marked with A, B and C in inner structure plots.