Probing the dielectric response of exfoliated black Phosphorus in free standing conditions

Annick Loiseau[1]
E. Gaufrès[1], F. Fossard[1], A. Favron[2], V. Gosselin[2], M. Côté[2], R. Martel[3]

[1] *Laboratoire d'Etude des Microstructures, UMR 104 CNRS-Onera, Châtillon, France*

[2] *Regroupement québécois sur les matériaux de pointe (RQMP) and Département de Physique, Université de Montréal, Montréal QC H3C 3J7, Canada*

[3] *RQMP and Département de Chimie, Université de Montréal, Montréal QC H3C 3J7, Canada*

Annick.Loiseau@onera.fr

Ultra-thin Black Phosphorus (BP) is a 2D semiconductor characterized by a direct and tunable band gap associated to high carriers mobility (1-3). Studying suspended thin layers of pristine BP is however challenging due to its strong degradation through a thickness dependent and photo-assisted oxidation reaction by adsorbed moisture oxygen (4). Using a protective transfer procedure from glovebox to our TEM-STEM equipped with a monochromator operating at 40kV, we probe the dielectric response of suspended BP down to the monolayer in the range 0.5-40 eV (Figure 1), that include measurements of band gaps threshold and surface/volume plasmons energies for BP. The dispersion of the plasmons as a function of the momentum is also measured and simulated for both in-plane and orthogonal crystallographic directions (5) .

References

[1] H. Liu et al, ACS Nano 8 (2014), 4033
[2] J. Qiao et al, Nature Comm. 5 (2014), 4475
[3] G. Long et al, Nano Letters 16 (2016), 7768.
[4] A. Favron, E. Gaufrès et al, Nature Mat. 14 (2015) 826.
[5] E. Gaufres et al, submitted (2017)

Figures

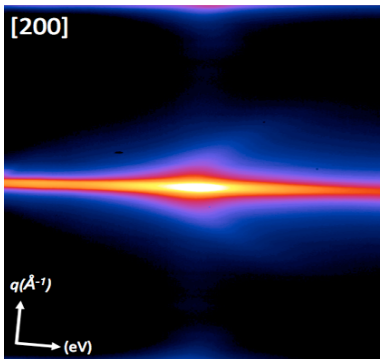

Figure 1: w-q map of the energy and momentum dependence along the in-plane [200] q direction of the low losses in few layer black phosphorus