Confinement effects and spectroscopic properties in exfoliated BN and Black Phosphorus layers

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Here we probe the interplay between structure and spectroscopic properties of both BN and Black Phosphorous (P(black)) exfoliated thin layers and how these properties can be further exploited in 2D layered heterostructures.

BN displays original optical properties governed, in the energy range 5.5 – 6 eV, by strong excitonic effects, consisting of D and S lines [1]. From cathodoluminescence experiments at 4K, D lines are proved to be due to structural defects and S lines are identified as the intrinsic luminescence of the material [1]. We will show how exfoliated layers could be prepared with no D band and that their S-emission dramatically changes when reducing the number of layers, providing with a unique signature of a progressive 2D confinement from 100 layers [2].

P(black) thin layers have recently raised interest for their original electronic properties. Their study is however challenging due to its fast degradation under ambient conditions. Thanks to Raman and core-loss EELS spectroscopy, we have shown that this phenomenon is due to a thickness dependant photo-assisted oxidation reaction with absorbed oxygen in water and found appropriate manipulation procedures opening a route to first the Raman measurements on pristine 1 to 5 layers [3].

Spectroscopic properties were also using Electron Energy Loss Spectroscopy (EELS). Low-loss-EELS represents an alternative approach to study the nature of electronic excitations. One can indeed access to the onset of optical transitions and investigate their angular dependence. We will show that we can probe the whole Brillouin zone of BN and BP layers and represent for example the plasmon dispersion as a function of the q momentum.

[1] A. Pierret et al, Phys. Rev. B, 89 (2014) 035414.
[2] L. Schué et al, in preparation
[3] A. Favron et al, Nature Materials, Advance online publication, May 2015