Structural and optical characterisation of h-BN layers

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Abstract

Hexagonal boron nitride is a wide band gap semiconductor (~ 6.5 eV), which meets a growing interest for graphene engineering [1]. In particular electron mobility of graphene is shown to be preserved when graphene is supported by a h-BN film. We attempt to have a better comprehension of the optical and electronic properties of thin BN layers, in correlation with their structural properties and to better know how electronic properties of graphene can be impacted by underlying BN layers.
Until recently, these properties were poorly known due to both the scarcity of crystals and suitable investigation tools. This situation has changed thanks, first, to the development of dedicated cathodoluminescence (CL) experiments running at 5K and adapted to the detection in the far UV range [2], and second to the avaibility of high quality single crystals [3].
H-BN has been shown to display original optical properties, governed, in the energy range 5.2 – 6 eV, by strong Frenkel-type excitonic effects [2, 4]. In this work, we first investigate by CL the luminescence properties of hBN samples synthesized by three different processes (HPHT, PDCs and a commercial powder). We observe in CL spectra the same features of the S series, in the energy range 5.7 – 6 eV. This reveals the intrinsic origin of these excitonic recombinations unlike the D series previously attributed to excitons trapped on defects such as dislocations or grain boundaries and observed at lower energy (5.2 – 5.7 eV) [5].
Besides, thin hBN layers have been obtained by mechanical exfoliation from small crystallites of a commercial powder and single crystal. We performed CL measurements on several flakes with various thicknesses from 100L to 6L and observed a significant effect of the confinement on the luminescence of hBN, especially in the energy range 5.7 – 6 eV previously mentioned. Indeed, CL spectra exhibit S series with different features depending on the hBN thickness. This strongly suggests that this signal (S series) could arise from distinct contributions that we will discuss.

References

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