

Synthesis of self-standing highly crystallized hexagonal boron nitride (h-BN)

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Abstract

2D-nanomaterials present a remarkable potential to be used for electronic applications and they have been intensively studied in the past few years. Among these materials, graphene appears as the next potential superstar material for the electronics industry, with a thinner, stronger and much faster electron conductor than silicon. However, while graphene shows promise for transistors, it has one major problem: graphene is vulnerable to perturbations from its supporting substrate and graphene devices on standard SiO₂ substrates are highly disordered, exhibiting characteristics that are far inferior to the expected intrinsic properties of graphene. Therefore, the promising future development of practical graphene devices seems strongly linked to the choice of a substrate that does not disturb the electronic structure of graphene. One of the most suitable substrates appears to be hexagonal boron nitride (h-BN, also called “white graphite”), which is isostructural / isoelectronic with graphene with a lattice matching with that of graphene. Since many years, our group is particularly interested in the preparation of such h-BN based 2D nanomaterials and we recently demonstrated that self-standing highly crystallized h-BN few-layers and monolayers can be easily obtained by a versatile method modifying the original synthesis by using an additive agent and, as a consequence, decreasing the temperature for the ceramization step (1200– 1400°C) [1, 2]. This synthesis is based on the polymer-derived ceramics (PDCs) route using liquid-state polyborazylene (PBN) mixed with lithium nitride (Li₃N) micro-powders as additive agent. We have demonstrated that incorporation of Li₃N as a crystallization promoter allows the onset of crystallization of h-BN at lower temperatures. Consequently, a high crystallization rate can be obtained from 1000 °C for bulk boron nitride, whereas the temperature has to be 1600–1800 °C under classical conditions. A series of samples incorporating Li₃N (5 wt.-%) and annealed at various temperatures from 600 to 1400°C was prepared and structurally characterized by Raman spectroscopy, XRD analysis, and TEM. A simple ultra sonication process has been used to obtain nanostructures. Hence, we were able to produce highly crystallized hexagonal boron nitride (h-BN) sheets. The hexagonal structure was confirmed by both electron and X-ray diffraction (Figure 1).

References

[1] S. Yuan, B. Toury, C. Journet, A. Brioude, *Nanoscale* **6** (2014) 7838.

[2] S. Yuan, B. Toury, S. Benayoun, R. Chiriach, F. Gombault, C. Journet and A. Brioude, *Eur. J. Inorg. Chem.* **2014** (2014) 5507.

Figures

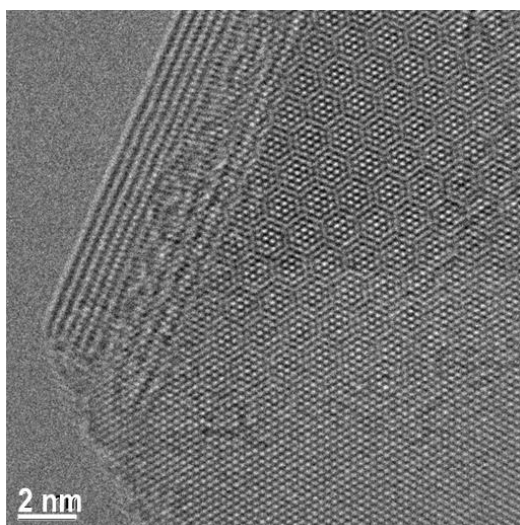


Figure 1: HRTEM image of h-BN few-layers presenting an atomic-scale Moiré pattern typical from the hexagonal atomic network