



HAL
open science

CVD synthesis and characterization of hexagonal boron nitride thin films

A. Andrieux, N. Dorval, F. Fossard, L. Schué, P. Lavenus, A. Loiseau

► **To cite this version:**

A. Andrieux, N. Dorval, F. Fossard, L. Schué, P. Lavenus, et al.. CVD synthesis and characterization of hexagonal boron nitride thin films. 18th International Microscopy Congress, Sep 2014, PRAGUE, Czech Republic. hal-01111569

HAL Id: hal-01111569

<https://hal.science/hal-01111569>

Submitted on 30 Jan 2015

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

CVD SYNTHESIS AND CHARACTERIZATION OF HEXAGONAL BORON NITRIDE THIN FILMS

A. Andrieux¹, N. Dorval², F. Fossard¹, L. Schué¹, P.Lavenus² and A. Loiseau¹

¹LEM, ONERA-CNRS, 29 avenue de la Division Leclerc, Châtillon, France

²DMPH, ONERA, Chemin de la Hunière, Palaiseau, France

As a typical two-dimensional material, graphene has attracted great interest due to its remarkable optical, mechanical and electronic properties. It has been demonstrated that substrates supporting graphene have a high impact on its electronic properties, especially on its electron mobility [1]. Hexagonal boron nitride (h-BN), as a graphene analogue, seems to be an excellent candidate to serve as a graphene substrate. Indeed, this layered material, made of a stacking of planar BN hexagonal networks, is a semiconductor with a large band-gap (~ 6 eV) and with an atomically smooth surface [2]. It has been confirmed that the on-substrate mobility of graphene is preserved on h-BN and is very close to that of suspended graphene [3]. As a consequence, h-BN could be useful as a complementary two-dimensional dielectric substrate for high-performance graphene electronics. However, synthesis of high-quality and large-area h-BN with controllable number of layers remains a great challenge and thus the implementation of h-BN/graphene hybrid structures is still limited.

In this context, our goal is to optimize an ONERA made LPCVD installation suited to the synthesis of h-BN films to be able to obtain graphene and ultra thin film of h-BN, less than 10 nm thick, uniform, with high quality and smooth surface. Here, we report the first results on the growth of h-BN on nickel substrate under our LPCVD method, using borazine ($B_3N_3H_6$) as precursor. In order to further characterize the grown h-BN layers, a direct method was used to transfer them from

their growth substrate onto a carbon-coated gold TEM grid [4]. HRTEM (ARM 200 CF) and Fast Fourier Transform (FFT) were used to probe the structure and crystallinity of our sample. Electron energy loss spectroscopy (EELS) performed on a monochromated Libra 200 was used to determine the chemical composition and valence states of the h- BN film.

Additional Raman spectroscopy was performed in order to have macroscopic measurements on the structural quality of our hBN.

Only a few Raman modes are active in h-BN. The main mode is the E_{2G} mode at 1367 cm^{-1} and its FWHM gives a good idea of the crystalline quality. In this paper, we present h-BN exhibiting a narrow peak (13 to 20 cm^{-1}) close to other “state of the art” CVD h-BN (11cm^{-1}).

[1] A.K. Geim, K.S. Noselov. *Nat. Mater.* **2007**, 6, 183-191.

[2] K.H. Lee, H.J. Shin, J. Lee, I. Lee, G.H. Kim, J.Y. Choi, S.W. Kim. *Nano Lett.* **2012**, 12, 714–718.

[3] C.R. Dean, A.F. Young, I. Meric, C. Lee, L. Wang, S. Sorgenfrei, K. Watanabe, T. Taniguchi, P. Kim, K.L. Shepard, J. Hone. *Nat. Nanotechnol.* **2010**, 5, 722–726.

[4] W. Regan, N. Alem, B. Alemán, B. Geng, C. Girit, L. Maserati, F. Wang, M. Crommie, A. Zettl, *Appl. Phys. Lett.* **2010**, 96, 113102.

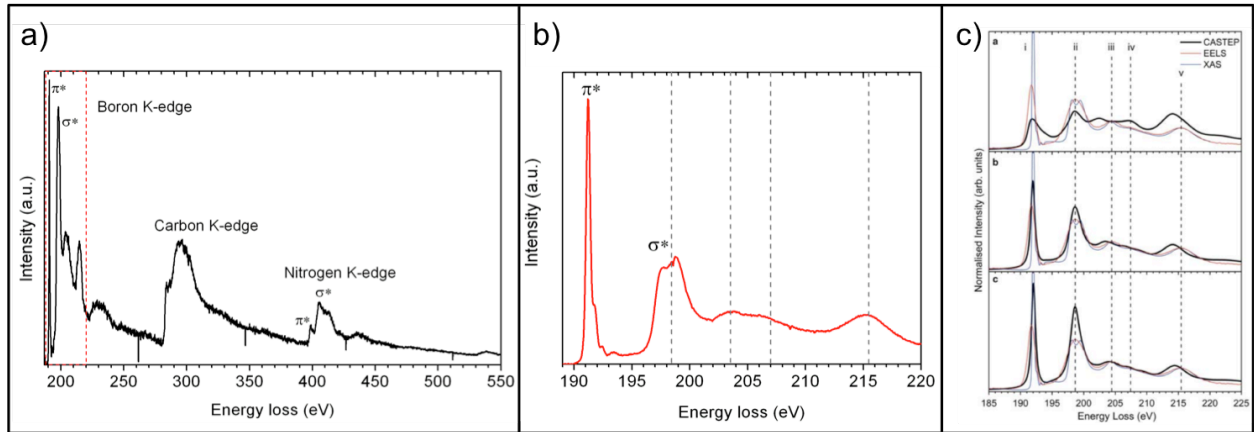
Acknowledgement

Flagship

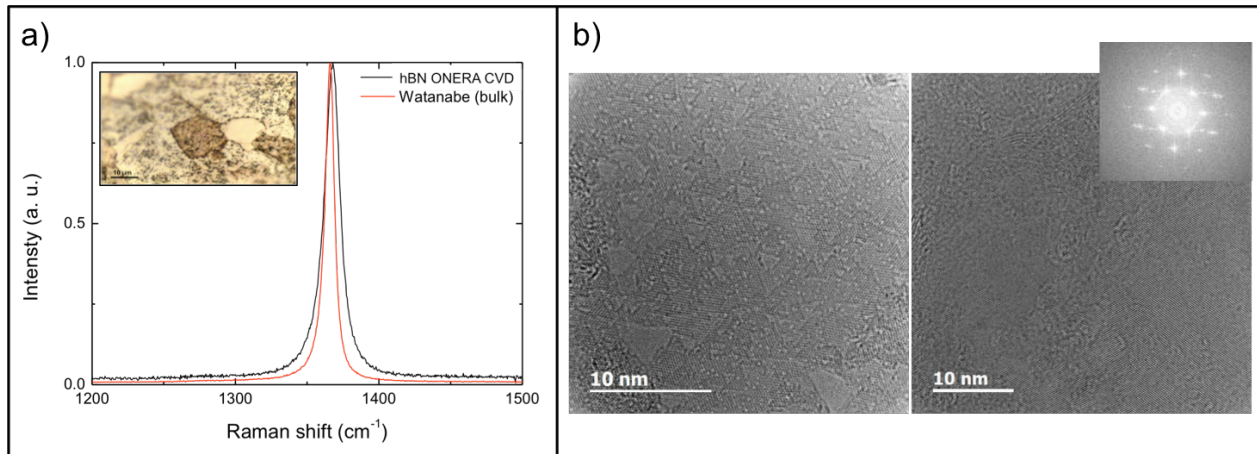
Authors want to thank Jean-Claude Daux, Jean-François Justin, Bruno Passily for their technical assistance in the CVD synthesis. Financial support PRF

Raman : Ingrid Stenger GEMAC, Université Versailles St Quentin – CNRS, 45 avenue des Etats Unis, Versailles, France

Guillaume Wang, MPQ



a) EELS spectrum of ONERA CVD hBN film.
 b) EELS spectrum of the B K-edge of ONERA CVD hBN film.
 c) The calculated B K-edge for AB configuration compared with EELS and XAS experimental spectra [McDougall et al. Microsc. Microanal. 2014]



a) Raman spectrum of ONERA CVD hBN film on nickel substrate
 b) High resolution TEM images of ONERA CVD hBN film
 The corresponding FFT showing a set of hexagonal patterns from hBN film