Supporting Materials

Synthesis of Few-Layer Hexagonal Boron Nitride Thin Film by Chemical Vapor Deposition

Yumeng Shi,[†,‡] *Christoph Hamsen,*[†,⊥] *Xiaoting Jia,*[|] *Ki Kang Kim,*[†] *Alfonso Reina,*[|] *Mario Hofmann,*[†] *Allen Long Hsu,* [†] *Kai Zhang,* [†] *Henan Li,* [‡] *Zhen-Yu Juang,*[§] *Mildred. S. Dresselhaus,*[†,#] *Lain-Jong Li,*[§,*] *and Jing Kong*[†,*]

[†]Department of Electrical Engineering and Computer Sciences, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139, USA

[‡]School of Materials Science and Engineering, Nanyang Technological University, 50 Nanyang Ave., Singapore 639798, Singapore

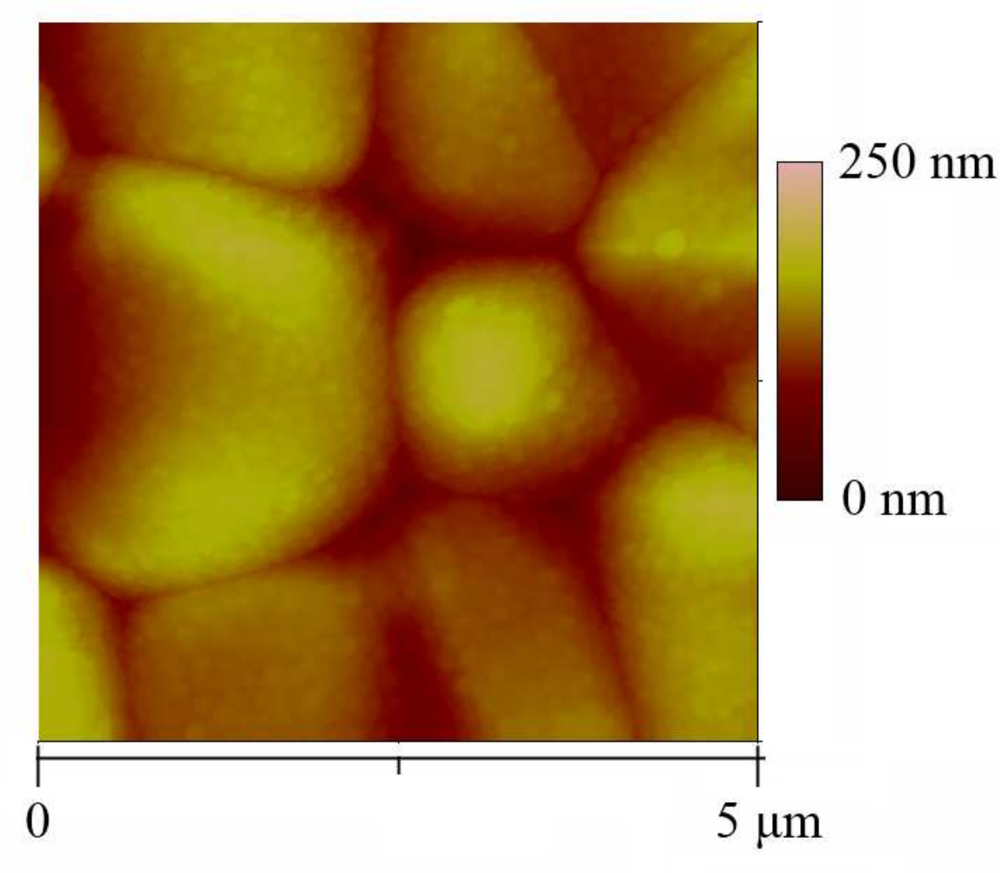
[⊥]Department of Physics, Technische Universität München, Arcisstraße 21, München80333, Germany

[|]Department of Materials Science and Engineering, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139, USA

[#]Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139, USA

[§]Research Center for Applied Science, Academia Sinica, Taipei 11529, Taiwan

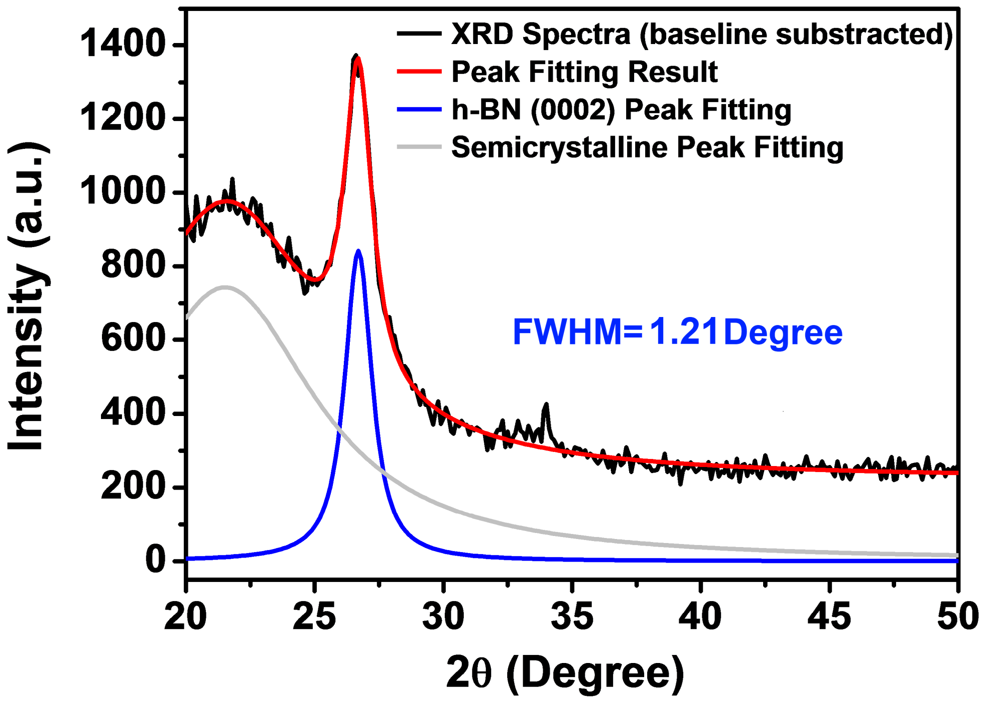
1. **Figure S1. AFM image of *h*-BN on Ni.** Sample obtained by flashing 1 sccm borazine vapor under 900 °C. Many nano-size particles can be observed.



2. **Figure S2. Peak fitting result of XRD.** The full width half maximum (FWHM) of *h*-BN (0002) peak is 1.21 degree. Using the Scherrer equation:

$$\tau = \frac{K\lambda}{\beta cos\theta}$$

Here τ is the thickness of the film, K is the dimensionless shape factor (typical value 0.9), λ is the X-ray wavelength (0.154 nm), β is the line broadening at half the maximum intensity (FWHM), θ is the Bragg angle. The thickness of *h*-BN film is estimated to be ~ 6.5 nm.



3. CVD Synthesis Methods:

The ambient pressure for CVD synthesis is 760 Torr. 300 nm Ni thin film is deposited on SiO_2/Si substrates before the synthesis of *h*-BN. Then the Ni coated SiO_2/Si substrate is placed into a quartz tube CVD chamber. The substrate is annealed at 900 °C for 30 minutes using 580 sccm N_2 and 500 sccm H_2 as protection gas. After the thermal annealing, single crystalline Ni grain with atomically flat surfaces develope in the Ni film. The lateral size of the Ni grain can be up to ~20 μm. The CVD growth of the *h*-BN is carried out after the temperature is cooled down from 900 °C to 400 °C. When the desired temperature is reached, the flow rates of the protection gases are adjusted to 100 sccm for N_2 and H_2 respectively. Then 1-10 sccm flow of N_2 is supplied through a glass bubbler which contains 20 mL borazine. The bubbler with borazine is kept at 5 °C by a water chiller. The borazine vapor is carried out by the low flow rate of N_2 and is mixed well with the protection gas before entering the growth chamber. When borazine vapor reaches the surface of Ni, a dehydrogenation reaction occurs. This reaction is maintained for 30 minutes to 1 hour. After this, the low flow of N_2 is turned off and the temperature is slowly increased to 1000 °C at a rate of 5 °C /min. The as-grown film is annealed at 1000 °C for another 1 hour. Finally the CVD furnace is turned off, and the sample is left in the chamber to cool down to room temperature.

4. Transfer of the as-grown *h*-BN thin film to arbitrary substrates.

Once the CVD synthesis is finished, the *h*-BN film is transferred by coating the *h*-BN/Ni substrates with a thin layer (~100 nm) of Poly[methylmethacrylate] (PMMA). After etching the underlying polycrystalline Ni with a commercial Ni etchant (TFB etchant from the *Transene Company*), the PMMA/*h*-BN film is detached from the SiO_2/Si substrate and is transferred to DI water and is suspended on the surface of water to remove the Ni etchant residue. Subsequently, the *h*-BN film can be transferred to any substrate or TEM grids for analysis and characterization. Finally, the top layer of PMMA is removed by annealing the samples in an N_2 and H_2 atmosphere at 450 °C for 40 minutes.