Supporting Information

Smoothening of wrinkles in CVD-grown hexagonal boron nitride films

Jinjun Lin,¹,¹ Roland Yingjie Tay,¹,¹ Hongling Li,¹ Lin Jing,² Siu Hon Tsang,² Hong Wang,²
Minmin Zhu,¹ Dougal G. McCulloch,³ and Edwin Hang Tong Teo¹,²,*

¹School of Electrical and Electronic Engineering, Nanyang Technological University, 50 Nanyang Avenue, Singapore 639798, Singapore

²Temasek Laboratories@NTU, 50 Nanyang Avenue, Singapore 639798, Singapore

³School of Materials Science and Engineering, Nanyang Technological University, 50 Nanyang Avenue, Singapore 639798, Singapore

³School of Science, Physics, RMIT University, Melbourne, Victoria 3001, Australia

These authors contributed equally to this work.

*Corresponding author. Tel: +65 67906371. E-mail address: HTTEO@ntu.edu.sg
Fig. S1 (a) SEM image of as-grown h-BN film on Cu. (b,c) Magnified SEM images in (a) showing the different orientation of the step bunches on different Cu grains.
Fig. S2 (a) SEM image of a partially continuous monolayer h-BN film. (b–d) Magnified SEM images revealing the Cu corrugation across multiple h-BN grain boundaries.
Fig. S3 (a) Optical and (b) AFM images of transferred h-BN film after annealing at 840 °C for 2 h. The onset of oxidation can be observed by the presence of nanoscale pits and the elongated etch lines along the wrinkled structures.\textsuperscript{1}
Fig. S4 Optical images of (a) as-transferred h-BN film on SiO$_2$/Si substrate and after annealing in air at (b) 550 °C, (c) 800 °C and (d) 840 °C. (e,f) Raman spectra and their corresponding fitted peaks of the respective h-BN films in (a – d).
**Fig. S5** Representative Raman spectrum in some regions of the annealed h-BN film with multilayers indicating the presence of carbonaceous contamination by the presence of D and G bands.
**Fig. S6** AFM images of (a) as-transferred h-BN film and after annealing at 550 °C under 200:20 sccm of Ar/H₂ for (b) 10 min and (c) 1 h. The h-BN wrinkles are still prevalent even after 1 h of annealing in Ar and H₂.
Fig. S7 (a) UV-vis absorbance spectra and its corresponding (b) Tauc’s plot of an as-transferred monolayer h-BN film (black trace), after annealing in air at 550 °C for 10 min (red trace) and after another week of inactivity (blue trace), on quartz substrate.

To convert the absorbance spectra into Tauc’s plots for bandgap extraction, we use the derived formula for a direct band gap semiconductor:

\[ \alpha = C(E - E_g)^{1/2}/E \]  

(1)

Where \( \alpha \) is the absorption coefficient, \( C \) is a constant and \( E \) is the photon energy. \( \alpha \) is calculated by the measured optical absorption divided by the film thickness. By plotting \((\alpha E)^2\) against \(E\), a straight line can be extrapolated from the energy dispersion curves and their bandgaps, \(E_g\), can be extracted at the intersection of the extrapolated lines and the x-axis.
Fig. S8 CA of DI water droplets on SiO$_2$/Si substrate (a) before and after annealing in air for 10 min at (b) 250 ºC, (c) 350 ºC, (d) 450 ºC, (e) 550 ºC, respectively.
Fig. S9 CA of DI water droplets on quartz substrates (a) before and (b) after annealing in air at 550 °C for 10min.

REFERENCES
