

## Supporting Information

# Growth of High Crystalline, Single-Layer Hexagonal Boron Nitride on Recyclable Platinum Foil

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## EXPERIMENTAL METHODS

**Growth of h-BN using CVD.** h-BN was prepared by a LPCVD method. Platinum foil (99.95 % purity, 0.125 mm thick, Goodfellow) was placed at the middle of a 2 inch quartz tube CVD system and ammonia borane (97 % purity, Sigma-Aldrich) was placed at a sub-chamber. The furnace was heated to 1100 °C in flow of a hydrogen gas (10 sccm), and the sub-chamber was heated to 130 °C for the decomposition of ammonia borane. The Pt foil was pre-annealed at 1100 °C for 30 min in flow of H<sub>2</sub> gas to remove some impurity. The growth of h-BN on Pt foil was initiated by opening a valve of the sub-chamber. During the growth, the pressure was maintained at 0.1 Torr. After finishing the growth, the furnace was quickly cooled down to room temperature under H<sub>2</sub> gas condition.

**Electrochemical bubbling method for transfer of h-BN.** The front side of the h-BN film on the Pt foil was covered with PMMA. The Pt foil was immersed in an aqueous solution of 1 M NaOH for an electrochemical delamination. The PMMA/h-BN/Pt foil and a bare Pt foil were utilized as a cathode and an anode, respectively. The bubbling transfer was performed under a constant current of 1 A (corresponding electrolytic voltage of 5 - 12 V) for 1 - 5 min. After peeling off the PMMA/h-BN film from the Pt foil, it was rinsed with deionized water in order to remove residual NaOH solution. Then, it was transferred into a SiO<sub>2</sub>(300 nm)/Si substrate, and finally was dipped into acetone to remove PMMA.

**Characterization.** The surface morphology of the single layer h-BN was characterized by optical microscope (Axio Scope.A1, Carl Zeiss), scanning electron microscope (S-4800, Hitachi), and atomic force microscope (Dimension 3100, Veeco). Raman spectra were measured using a micro Raman spectrometer (Alpha 300s, WITec GmbH) with a 532 nm laser. UV-visible absorption spectrum (Cary 5000 UV-Vis-NIR, Agilent) was measured to estimate the optical

band gap of single-layer h-BN transferred into a quartz substrate. The optical band gap energy was determined by the formula of a direct band gap semiconductor;  $\alpha = C(E - E_g)^{1/2}/E$  (where  $\alpha$  is the absorption coefficient,  $C$  is a constant,  $E$  is the photon energy and  $E_g$  is the optical bandgap energy). The plot of  $(\alpha E)^2$  as a function of  $E$  should be a straight line. Therefore, when  $(\alpha E)^2 = 0$ , the  $E$  value should be equal to  $E_g$ . X-ray photoelectron spectra (K-Alpha, Thermo Fisher) were measured to identify boron and nitrogen atoms of h-BN. Low voltage Cs aberration-corrected transmission electron microscopy (Titan Cube G2 60-300, FEI), which was operated at 80 kV with monochromated electron beam, was used for ultra-high-resolution imaging of the h-BN along with selected area electron diffraction (SAED) pattern and electron energy loss spectroscopy (EELS).

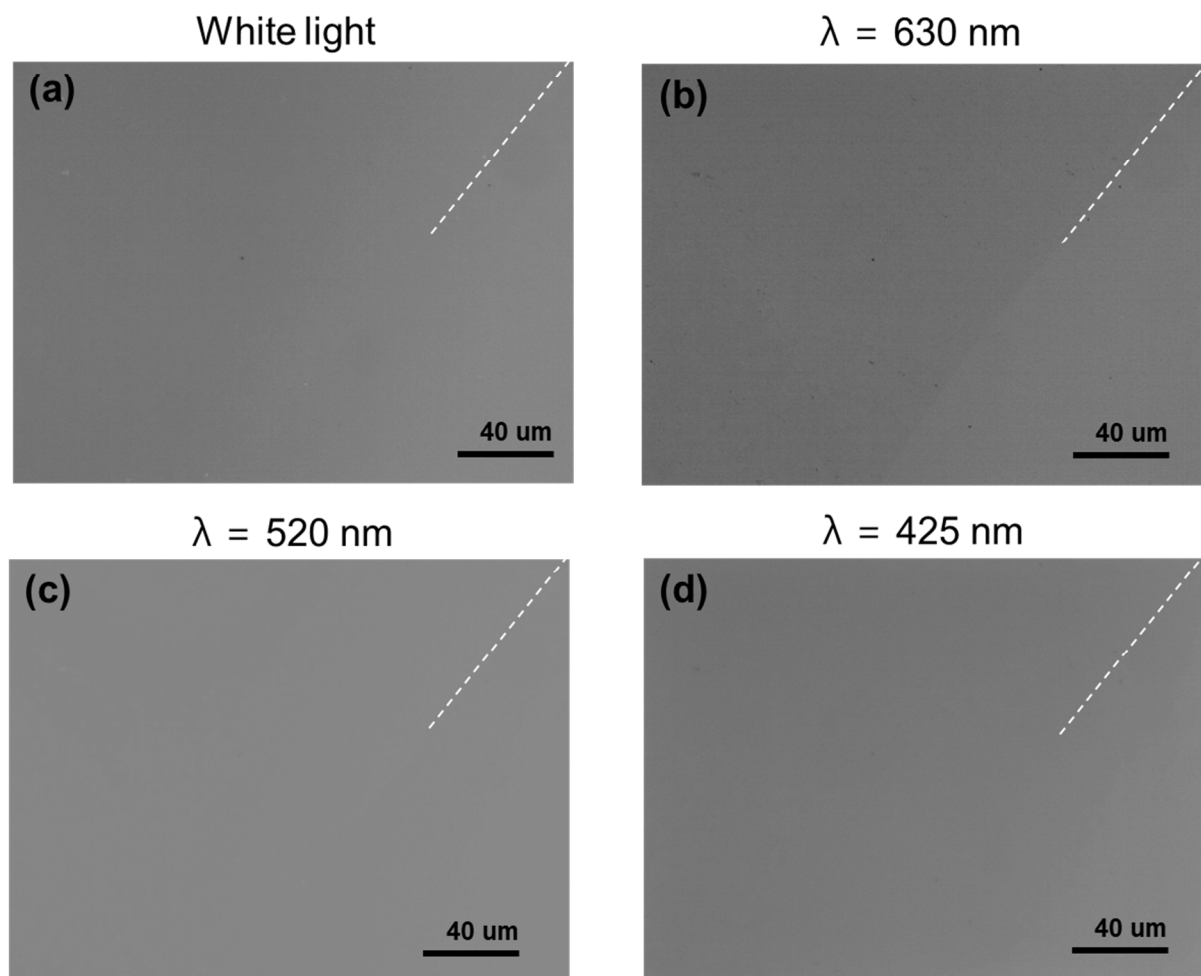


Figure S1. Optical microscope images for single-layer h-BN on top of Si substrate with a 300 nm thermal oxide layer under various light wavelengths: (a) white light, (b) 630 nm, (c) 520nm, and (d) 425 nm band-pass filtered light.

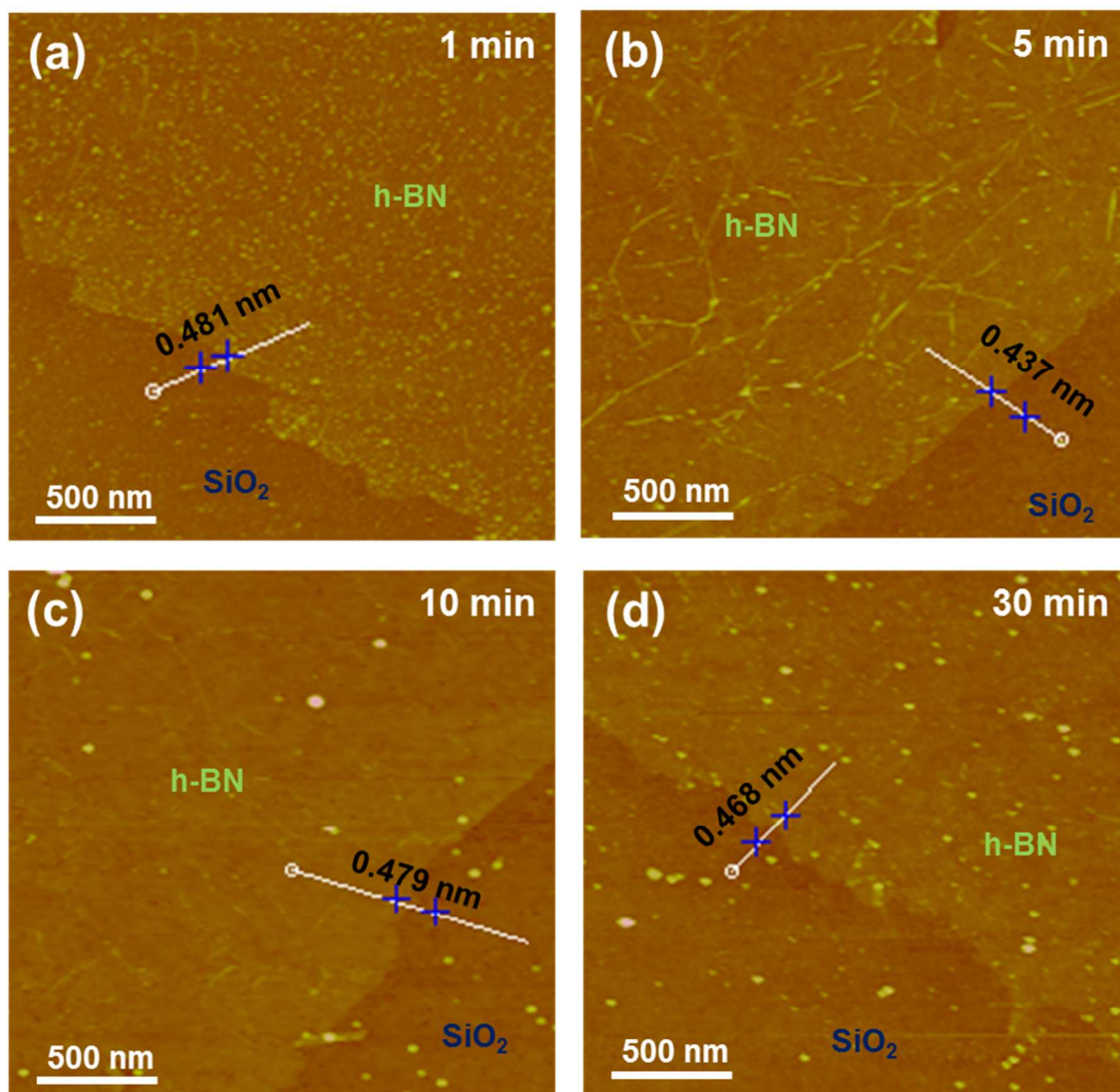


Figure S2. AFM images of h-BN transferred onto SiO<sub>2</sub>/Si substrate after it was grown on Pt foil at different growth period: (a) 1 min, (b) 5 min, (c) 10 min, and (d) 30 min.

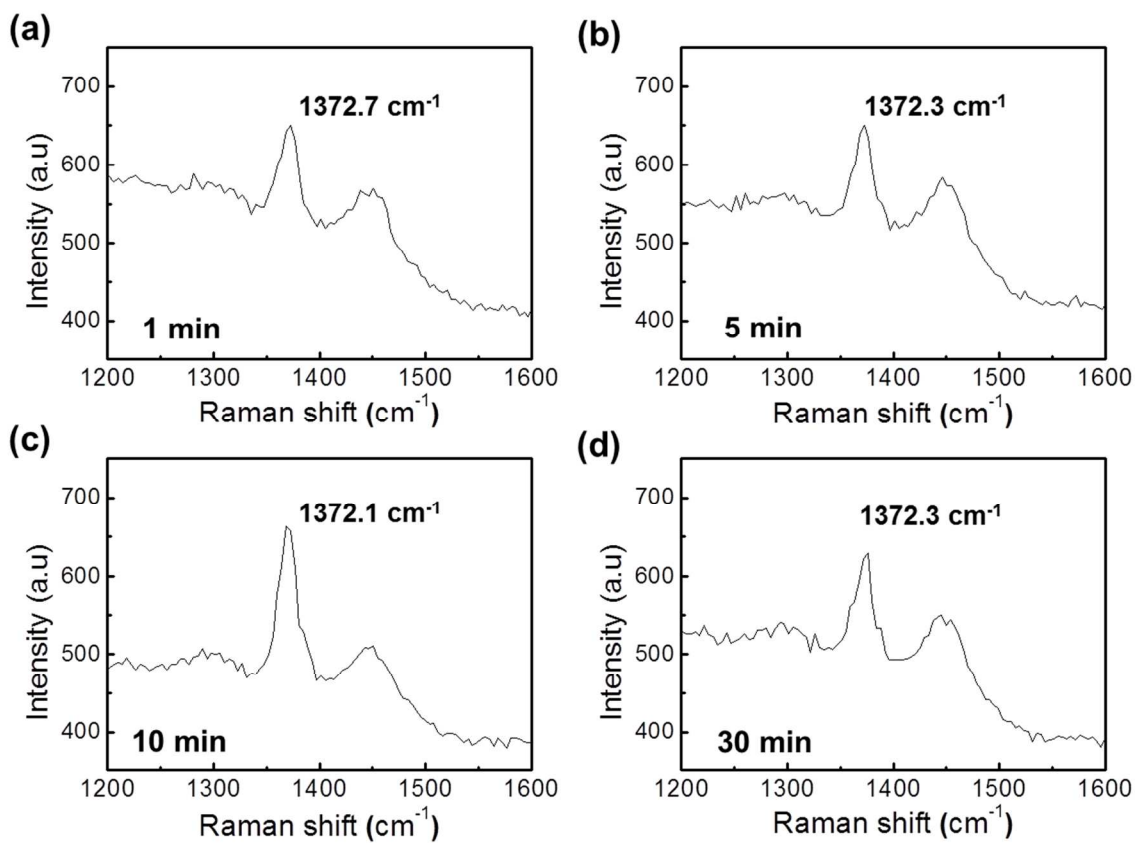


Figure S3. Raman spectra of h-BN transferred onto  $\text{SiO}_2/\text{Si}$  substrate after it was grown on Pt foil at different growth period: (a) 1 min, (b) 5 min, (c) 10 min, and (d) 30 min.

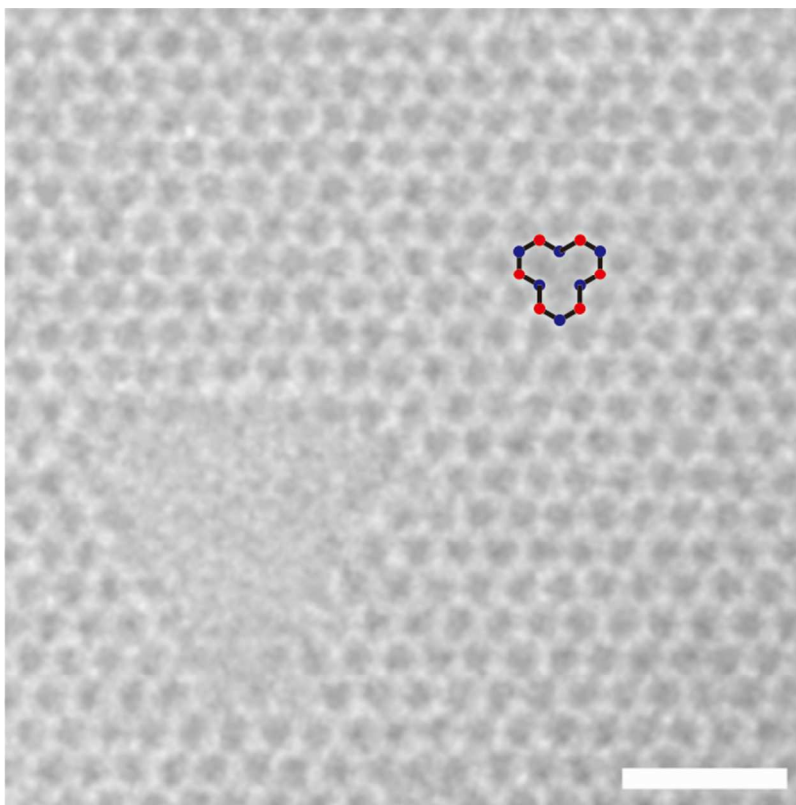


Figure S4. Atomic-resolution TEM image of h-BN. A triangular defect of single boron vacancy in single layer h-BN is indicated. Red and blue dots represent B and N, respectively. (Scale bar: 1 nm)

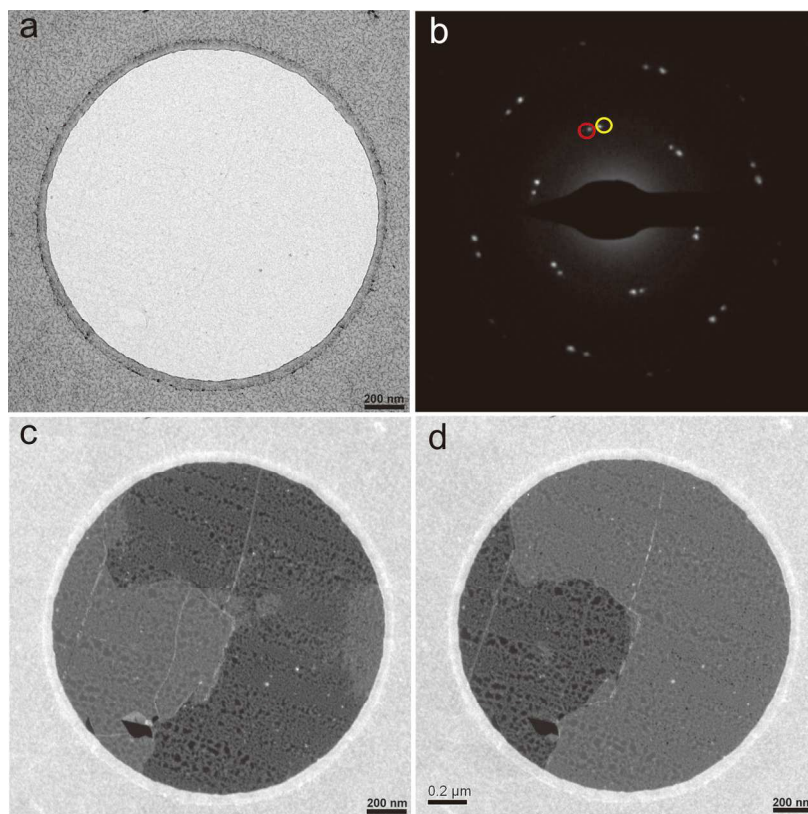


Figure S5. (a) Bright-field TEM (BFTEM) image of single-layer h-BN. (b) The corresponding diffraction pattern of single-layer h-BN. (c) Dark-field TEM (DFTEM) image taken from the diffraction spot marked with the red circle in (b). (d) DFTEM image taken from the diffraction spot marked with the yellow circle in (b).



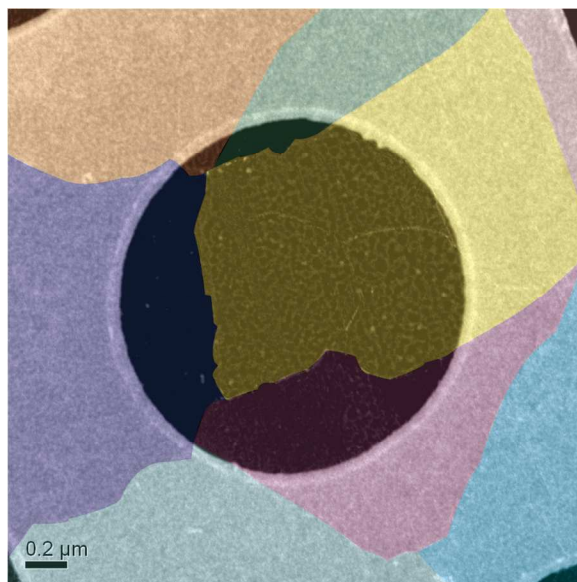


Figure S6. Single-layer h-BN grain mapping image with an over-laid background of the dark-field TEM image.

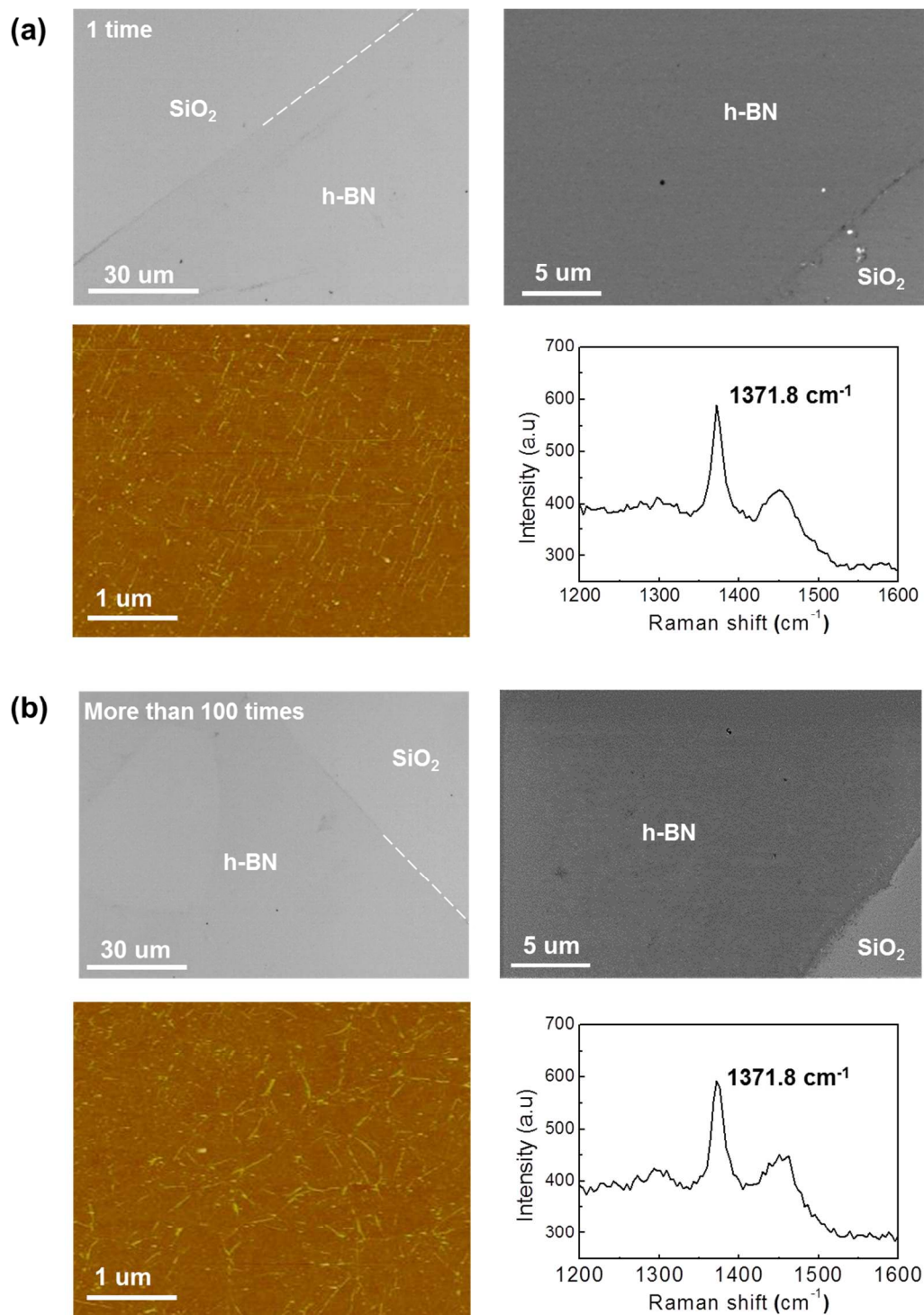


Figure S7. OM, SEM, and AFM images and Raman spectrum of single-layer h-BN grown on fresh Pt foil (a) and 100 times recycled Pt foil (b).

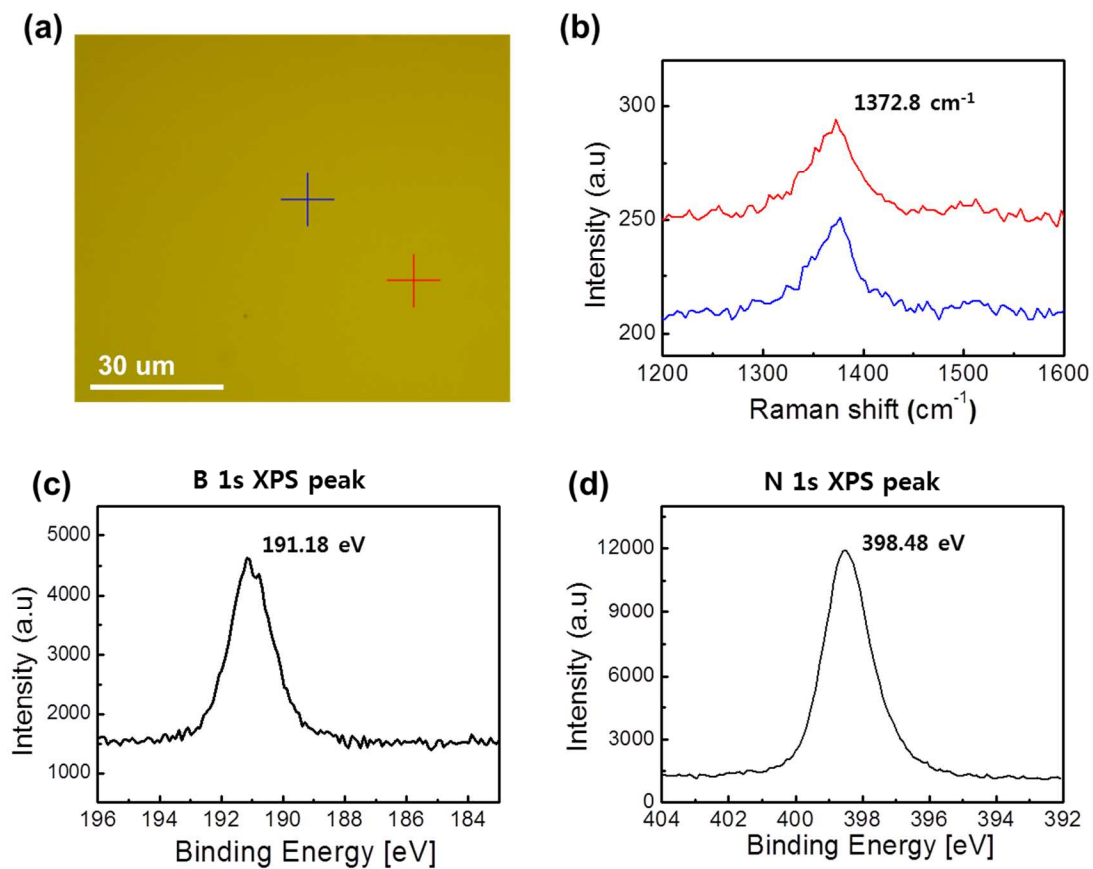


Figure S8. Growth of single-layer h-BN on c-plane sapphire. (a) OM image, (b) Raman spectra obtained at two positions in (a), (c) B 1s binding energy region, and (d) N 1s binding energy region of XPS.