Supplementary Information

High-Temperature Molecular Beam Epitaxy of Hexagonal Boron Nitride Monolayers on Carbon Nanotubes

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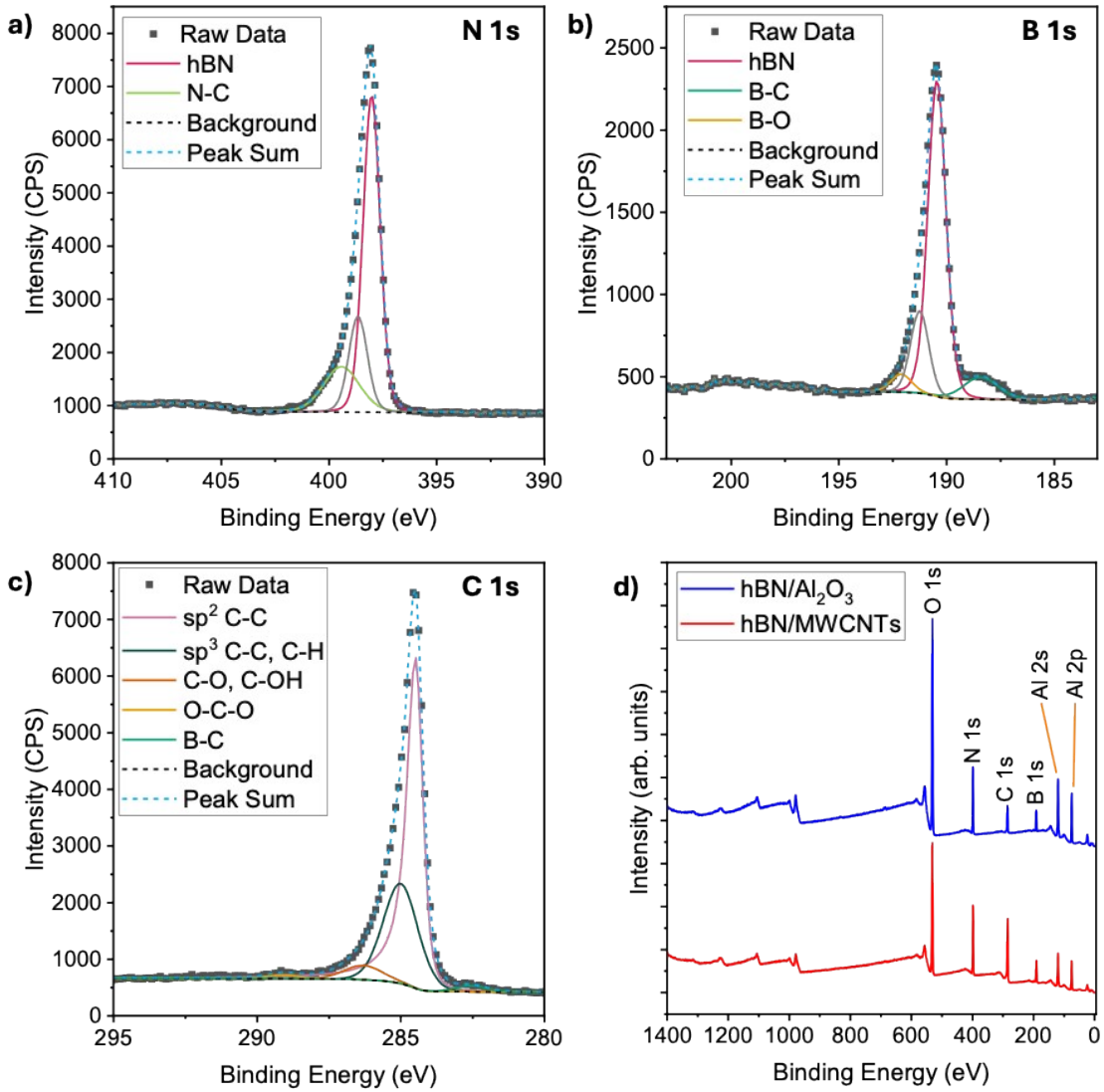

Figure S1. High resolution XP spectra of the (a) N 1s, (b) B 1s and (c) C ls core levels of hBN grown on MWCNTs/sapphire. The grey curve in (a) and (b) is of unknown origin but is required to achieve a good fit to the experimental data. Speculatively, it could be related to additional bonding B-N configurations or could be indicative of an asymmetric line shape for hBN (although this would be unexpected since hBN is an insulator). (d) Comparison of survey spectra for hBN grown on sapphire (blue) and MWCNTs (red).

Table S1. N 1s Components

Peak Identity	Position (eV)	FWHM (eV)	Area (%)
hBN	398.0	0.9	61.23±3.27
N-C	399.4	2.0	18.56±4.43
Unknown	398.6	1.0	20.21±1.57

Table S1. B 1s Components

Peak Identity	Position (eV)	FWHM (eV)	Area (%)
hBN	190.4	1.0	77.93±3.98
B-C	188.4	1.9	10.36±1.51
B-O	192.1	1.2	5.11±2.74
Unknown	191.2	1.0	6.60±1.54

Table S1. C 1s Components

Peak Identity	Position (eV)	FWHM (eV)	Area (%)
sp^2 C-C	284.4	0.6	62.19±3.13
sp^3 C-C, C-H	285.0	1.4	30.37±2.98
C-O, C-OH	286.3	1.6	4.8±1.09
O-C-O	289.1	1.2	1.00±0.89
C-B	282.6	1.3	1.65±0.49

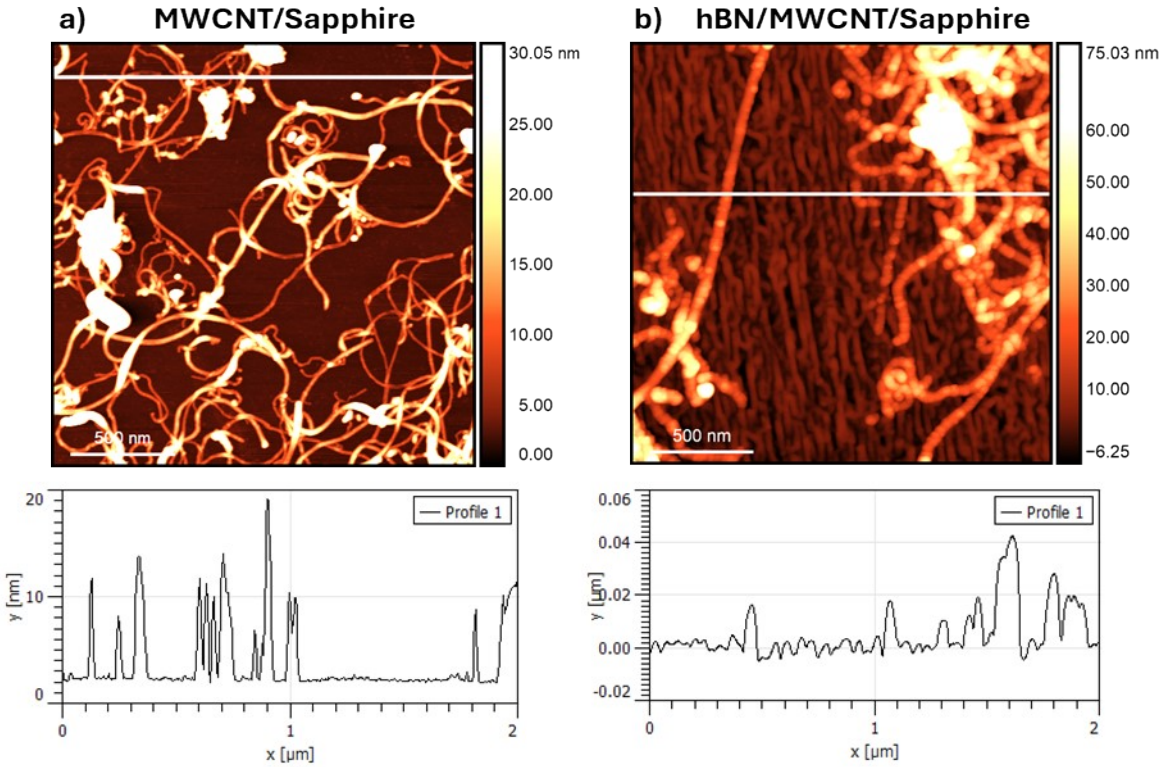

Figure S2. Tapping mode AFM images of the MWCNTs on sapphire (a) before and (b) after growth of hBN my HT-MBE. The tip height profiles taken from left to right along the solid white lines are shown below the images.

Figure S2a and S2b show the surface morphology of the MWCNTs on the sapphire substrate before and after hBN growth by HT-MBE, respectively. In both instances the MWCNTs are present in bundles with some single nanotubes separated. After HT-MBE surface roughness increases due to hBN being deposited on the sapphire. While it's difficult to accurately determine the diameter of the nanotubes by AFM due to tip convolution effects, the images before and after show an increase in the observed height of the nanotubes, as shown in the line profiles in Figure 1c which indicates that hBN has grown on the nanotubes in some form. We note that there is an inconsistency between the perceived height difference of the nanotubes before and after growth and the thickness of the grown layers, which we attribute to tip-sample induced artefacts.

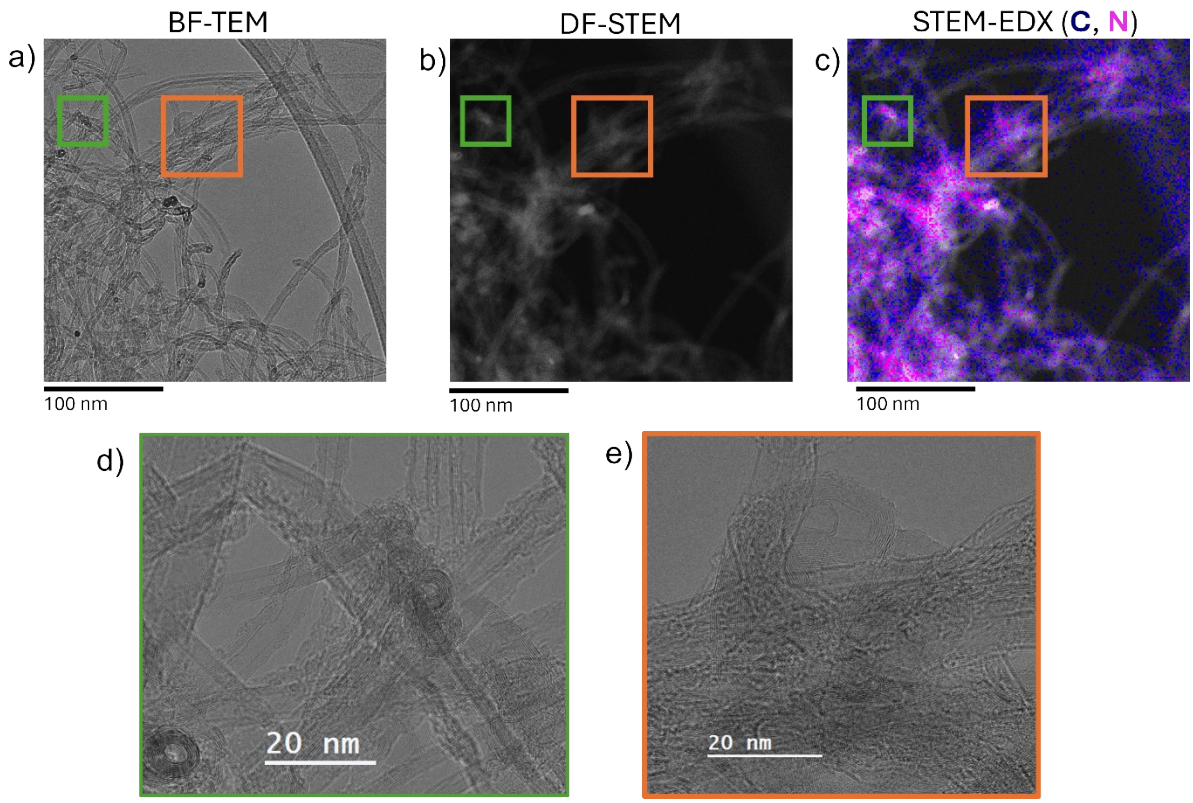

Figure S3. Imaging and analysis of MBE-grown BNNT on MWCNT. (a) 200 kV Bright field HR-TEM, (b) HAADF-STEM and (c) STEM-EDX map showing the distribution of carbon (blue) and nitrogen (magenta) in the sample. (d) and (e) 200 kV HR-TEM images of the areas highlighted with green and red boxes, respectively.

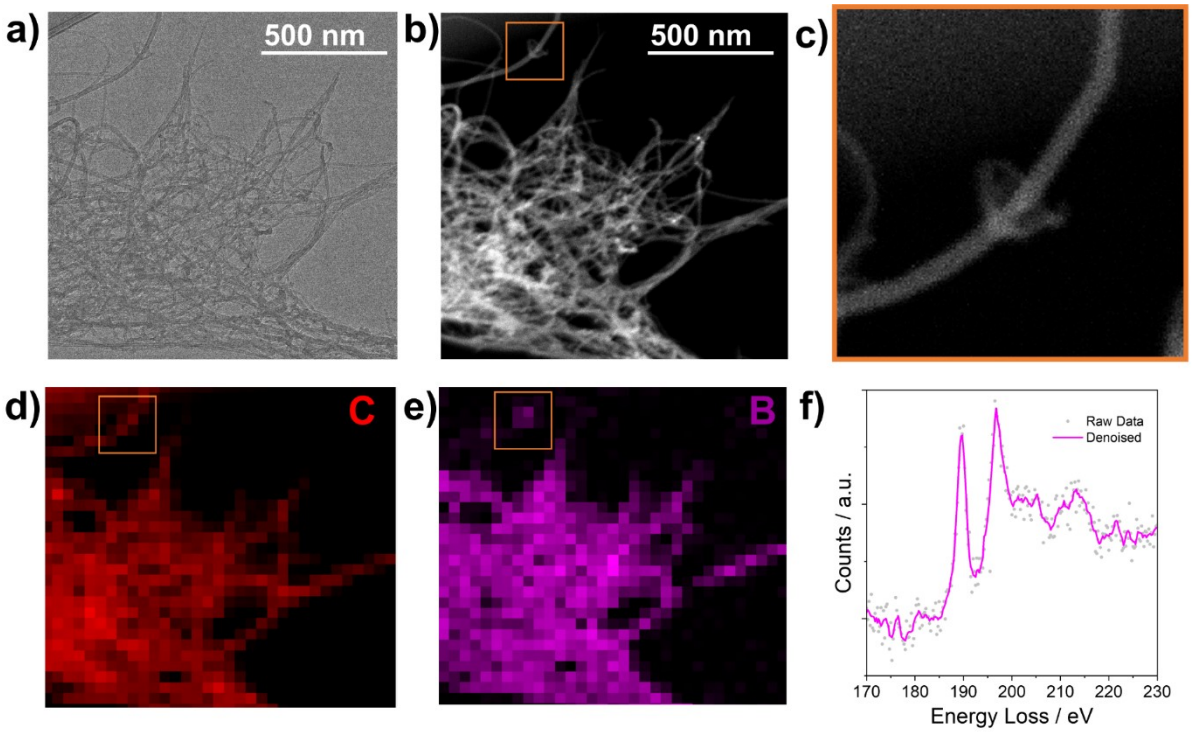

Figure S4. Imaging and analysis of MBE-grown BNNT on MWCNT. (a) 200 kV bright field TEM and (b) HAADF-STEM images of a large area. (c) Digitally magnified 200 kV HAADF STEM image of MWCNT-BNNT 'corkscrew' structure (highlighted in the box in (b)). STEM-EDX maps showing the distribution of (d) carbon (red) and (e) boron (magenta) in the sample. (f) EELS spectrum of the boron edge recorded for the area in the box in (e).

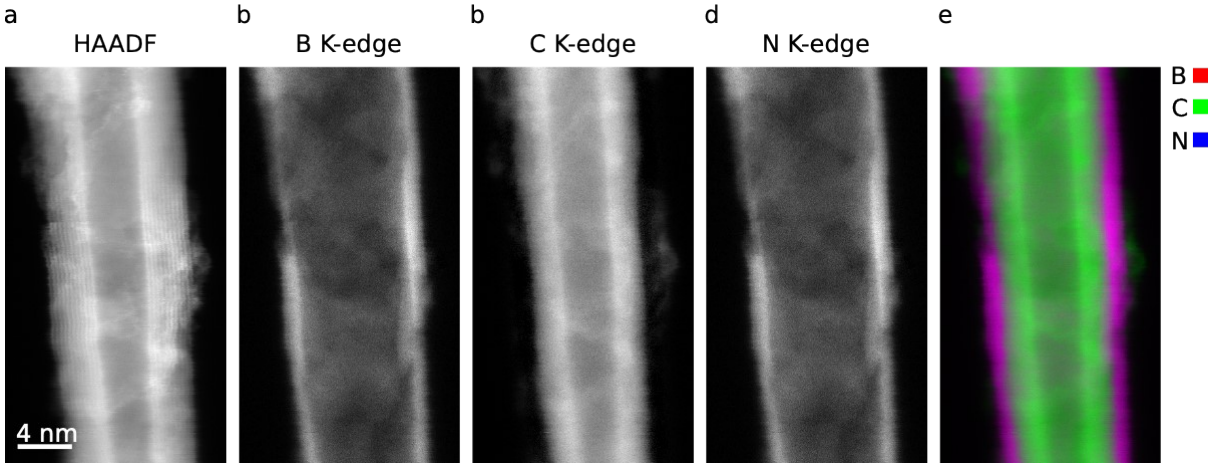

Figure S5. STEM-EELS analysis of the a multiwalled C nanotubes after HT-MBE of boron nitride for 4 hours. (a) High angle annular dark field image (b-d) elemental maps extracted from integration of the B, C and N K-edges, respectively. (e) Composed elemental map.

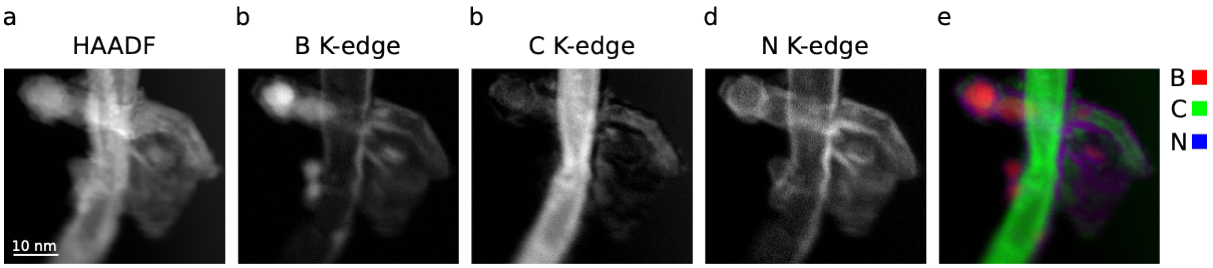

Figure **S6**. STEM-EELS chemical maps of the nanotubes in a 'corkscrew' configuration after HT-MBE of boron nitride for 4 hours. (a) High angle annular dark field image (b-d) elemental maps extracted from integration of the B, C and N K-edges, respectively. (e) Composed elemental map.