Electronic Supplementary Information

Remote heteroepitaxy of atomic layered hafnium disulfide on sapphire through hexagonal boron nitride

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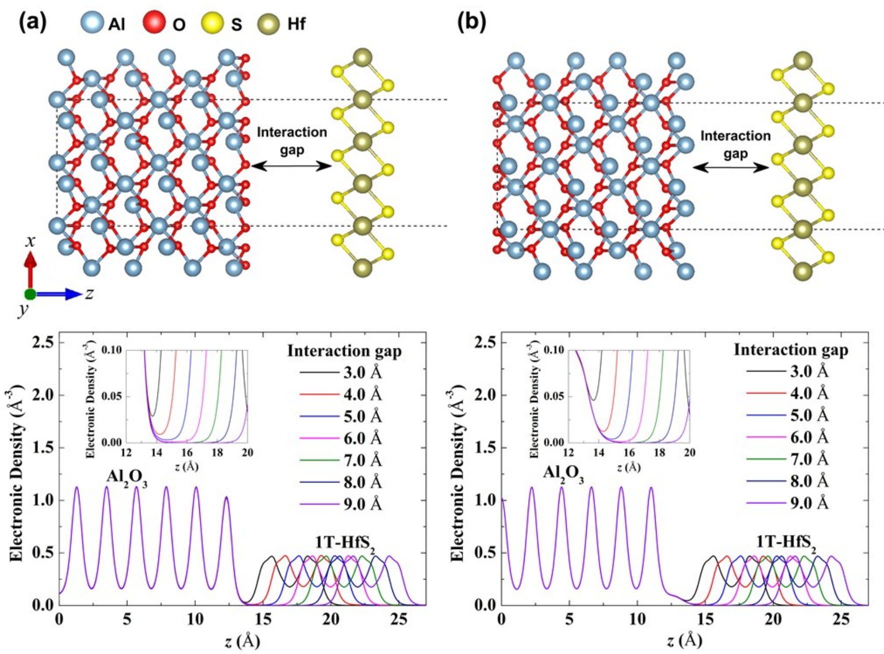

Fig. S1 Substrate-epilayer remote interaction with different gaps created by different numbers of stacked h-BN interlayer. Results of DFT calculations of averaged electron density along separated slabs for (a) O- and (b) Al-terminated sapphire. Periodic boundary conditions were imposed along the dashed lines of simulation model. Both plots show the existence of significant electron charge density between separated slabs within a gap of about 7 Å.

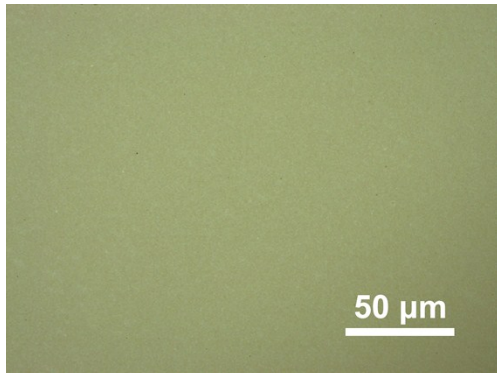

Fig. S2 Large-area optical microscopy image of HfS_2/h-BN layer on *c*-sapphire.

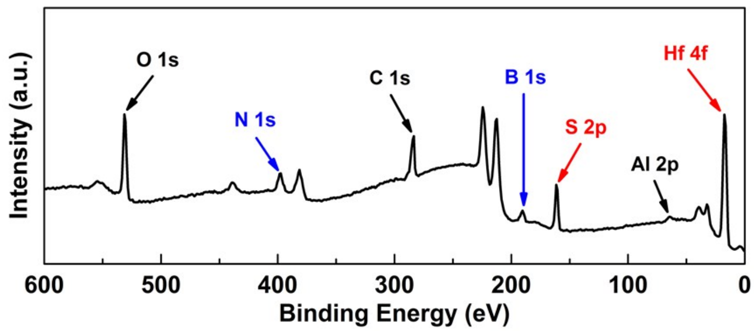

Fig. S3 Full XPS spectrum of remote epitaxial HfS_2 layer on *c*-sapphire through a monolayer h-BN.

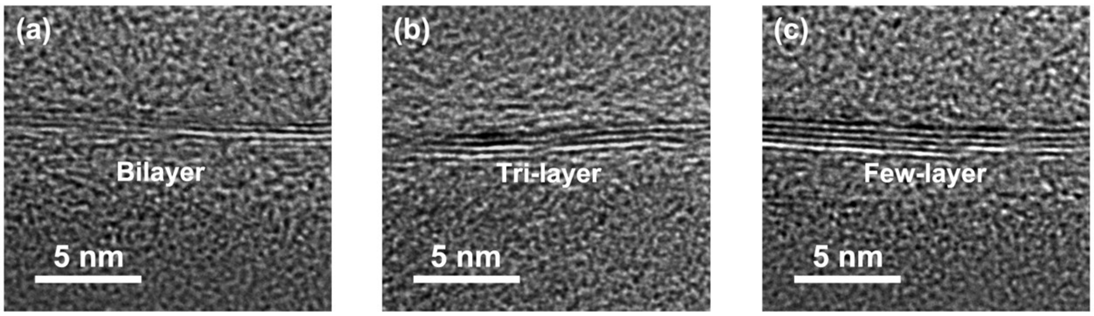

Fig. S4 TEM measurements. Cross-sectional TEM images of as-grown h-BN layer with the growth time of (a) 10 min, (b) 15 min and (c) 20 min, labeled by bilayer, tri-layer and few-layer, respectively.

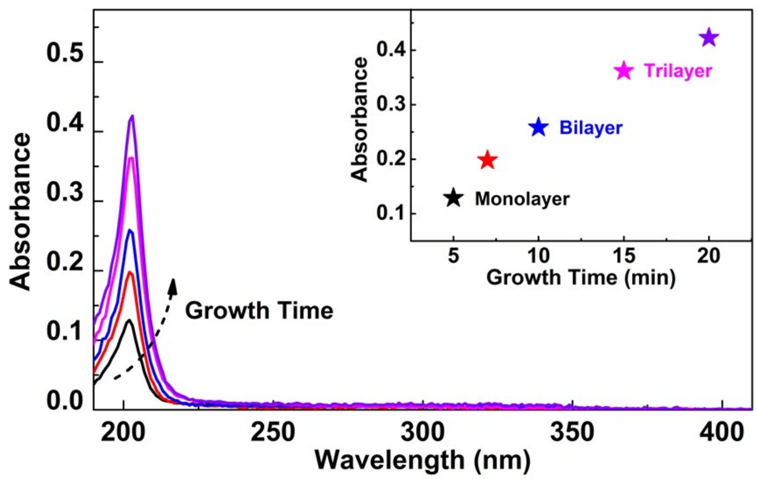

Fig. S5 UV-vis absorption spectra of h-BN layers on sapphire with different growth time. It can be seen that the absorbance of h-BN increases with increasing growth time, which is consistent with the increased layer number of h-BN.

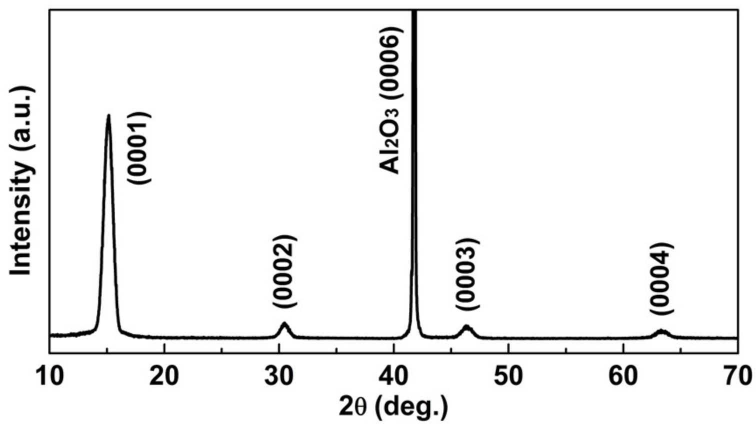

Fig. S6 XRD pattern of remote epitaxial HfS_2 layer on *c*-sapphire through a monolayer h-BN.

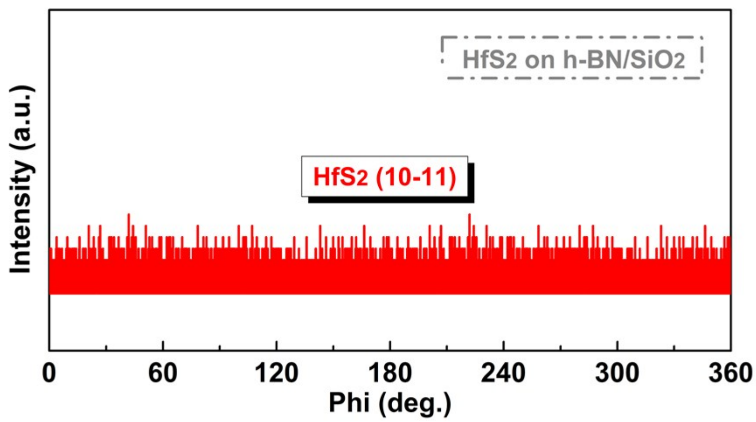

Fig. S7 XRD azimuthal scan of HfS_2 (10-11) reflection. Here, the HfS_2 layer was grown on SiO_2/Si substrate through a monolayer h-BN by CVD under the same conditions.

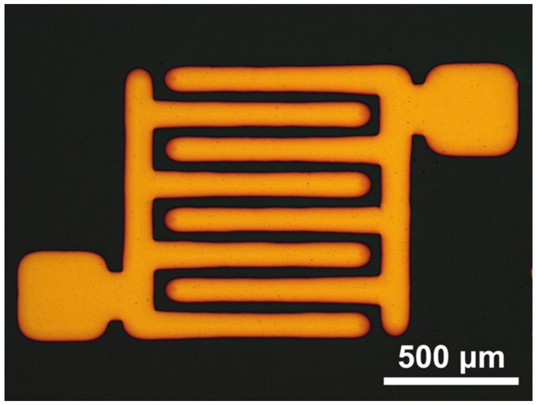

Fig. S8 Optical microscope image of HfS_2/h-BN photodetector on *c*-sapphire. The distance between two adjacent Au electrodes is determined to be ~70 µm.

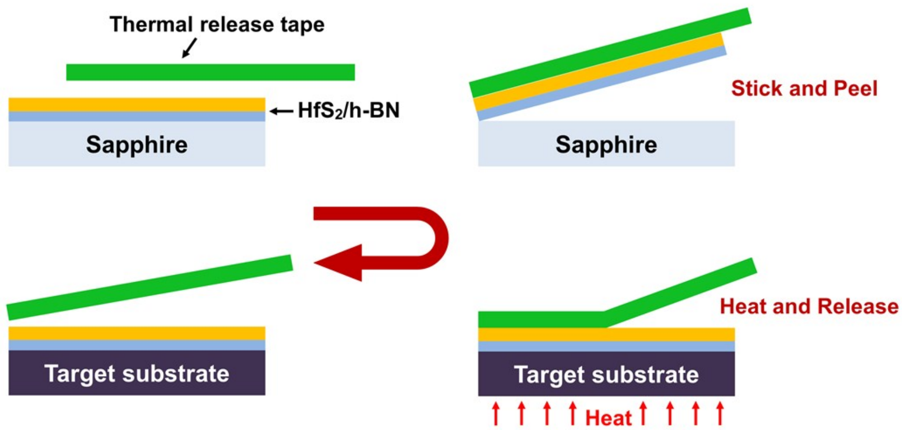

Fig. S9 Schematic diagrams of dry-transferring HfS_2/h-BN layer from sapphire substrate using a thermal release tape.

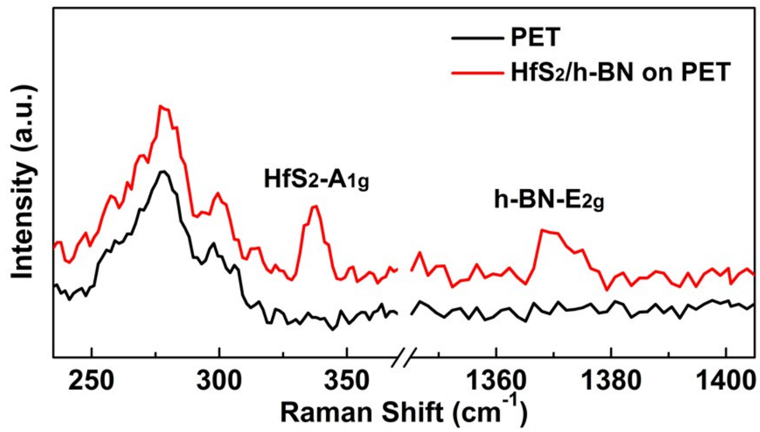

Fig. S10 Raman spectra acquired from HfS_2/h-BN heterostructure on a PET substrate. The results confirm the coexistence of h-BN and HfS_2 after dry-transfer.