

SUPPLEMENTARY INFORMATION

Atomic layer deposition of Al₂O₃ on MoS₂, WS₂, WSe₂, and *h*-BN: surface coverage and adsorption energy

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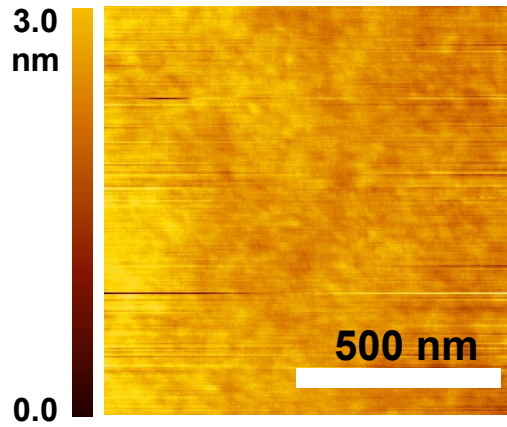


Fig. S1. AFM topography image of the thick ALD- Al_2O_3 film (~ 10 nm) deposited on Si at 250 °C.

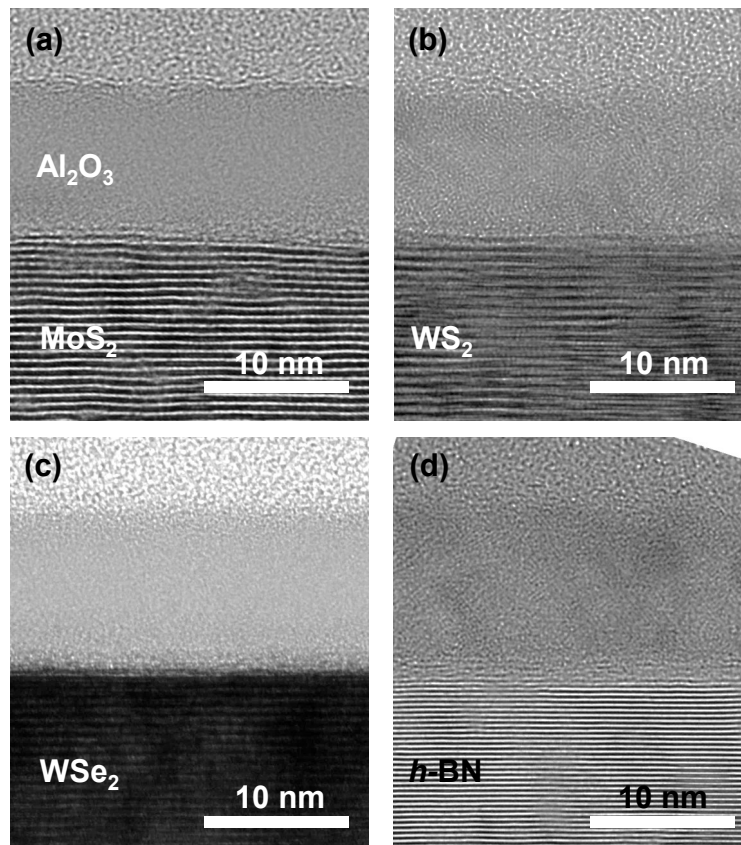


Fig. S2. Selected local cross-sectional TEM images of the thick ALD- Al_2O_3 films (~ 10 nm) conformally deposited on (a) MoS_2 , (b) WS_2 , (c) WSe_2 , and (d) $h\text{-BN}$ flakes at 250 °C.

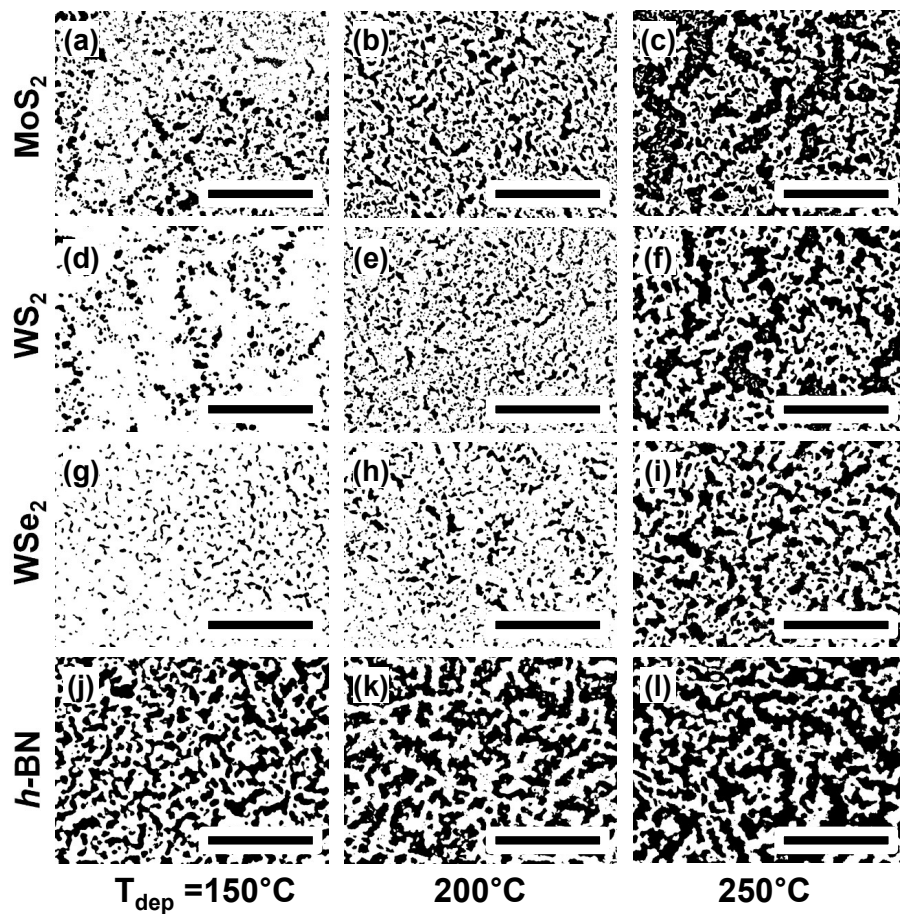


Fig. S3. Binary contrast images converted from the SEM images in Fig. 3. The ALD-Al₂O₃ films (0.9–1.1 nm) were deposited on (a–c) MoS₂, (d–f) WS₂, (g–i) WSe₂, and (j–l) *h*-BN flakes at various temperatures (150, 200, and 250 °C). The scale bar is 500 nm.

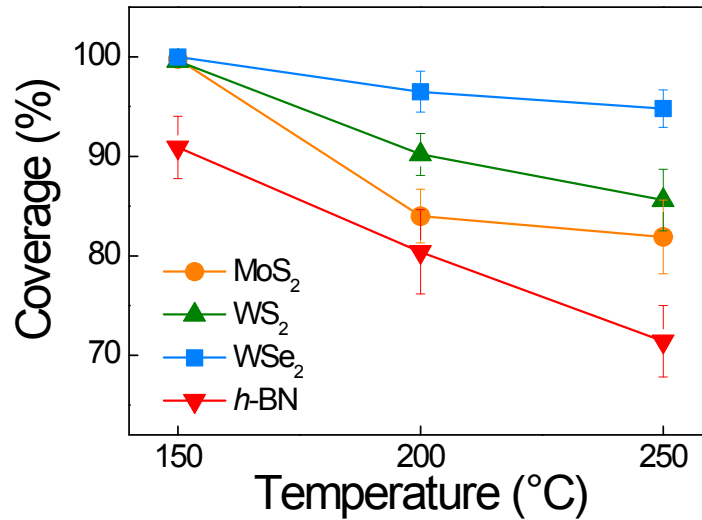


Fig. S4. AFM-measured surface coverage of the thick ALD-Al₂O₃ films (~10 nm) deposited on MoS₂, WS₂, WSe₂, and h-BN flakes at various temperatures (150, 200, and 250 °C). The coverage was quantified using 10 line (height) profiles arbitrarily selected from the measured AFM data (Fig. 2) using the following criteria. The standard deviation (σ) was defined as a root mean square (RMS) surface roughness obtained from the local regions with conformal film coating for each samples (see Table S1), and we defined deposition failure when the film thickness at a specific point was less than the expected thickness (10 nm) by 3σ .

Table S1. RMS values obtained from the AFM images in Fig. 2. The thick ALD-Al₂O₃ films (~10 nm) were deposited on MoS₂, WS₂, WSe₂, and *h*-BN flakes at various temperatures.

Substrate	Temp. (°C)	RMS _{total} * (nm)	RMS _{local} ** (nm)
MoS ₂	150	0.315	0.224
	200	2.879	0.329
	250	2.880	0.347
WS ₂	150	0.410	0.306
	200	1.211	0.355
	250	2.098	0.359
WSe ₂	150	0.389	0.312
	200	0.544	0.295
	250	0.507	0.333
<i>h</i> -BN	150	0.947	0.440
	200	1.867	0.363
	250	2.420	0.451

* RMS values obtained from a total scanned area of 1 μm × 1 μm.

** RMS values obtained from selected local areas with a conformal ALD-Al₂O₃ (~10 nm) coating.

Table S2. Parameters ($1-\theta$ and E_{ads}) extracted from the SEM-measured surface coverage of the thin ALD- Al_2O_3 films (0.9–1.1 nm) deposited on MoS_2 , WS_2 , WSe_2 , and h -BN flakes at various temperatures (150, 200, and 250 °C). $1-\theta$ was directly obtained from the SEM image (Fig. 3 and S3) , whereas E_{ads} was extracted from the slope in Fig. 4(b).

Substrate	Temp. (°C)	$1-\theta$	$ E_{\text{ads}} $ (J)	R^2 *
MoS_2	150	0.245	2.29×10^{-20} (0.14 eV)	0.99
	200	0.343		
	250	0.522		
WS_2	150	0.144	3.50×10^{-20} (0.22 eV)	0.98
	200	0.235		
	250	0.458		
WSe_2	150	0.107	4.09×10^{-20} (0.26 eV)	0.98
	200	0.189		
	250	0.412		
h -BN	150	0.439	7.15×10^{-21} (0.05 eV)	0.93
	200	0.474		
	250	0.557		

* R^2 is the coefficient of determination after the linear fitting.