Electronic Supplementary Material (ESI) for CrystEngComm.

Supplementary Information

Horizontally and Vertically Aligned Growth of Strained MoS_2 Layers with Dissimilar Wetting and Catalytic Behavior

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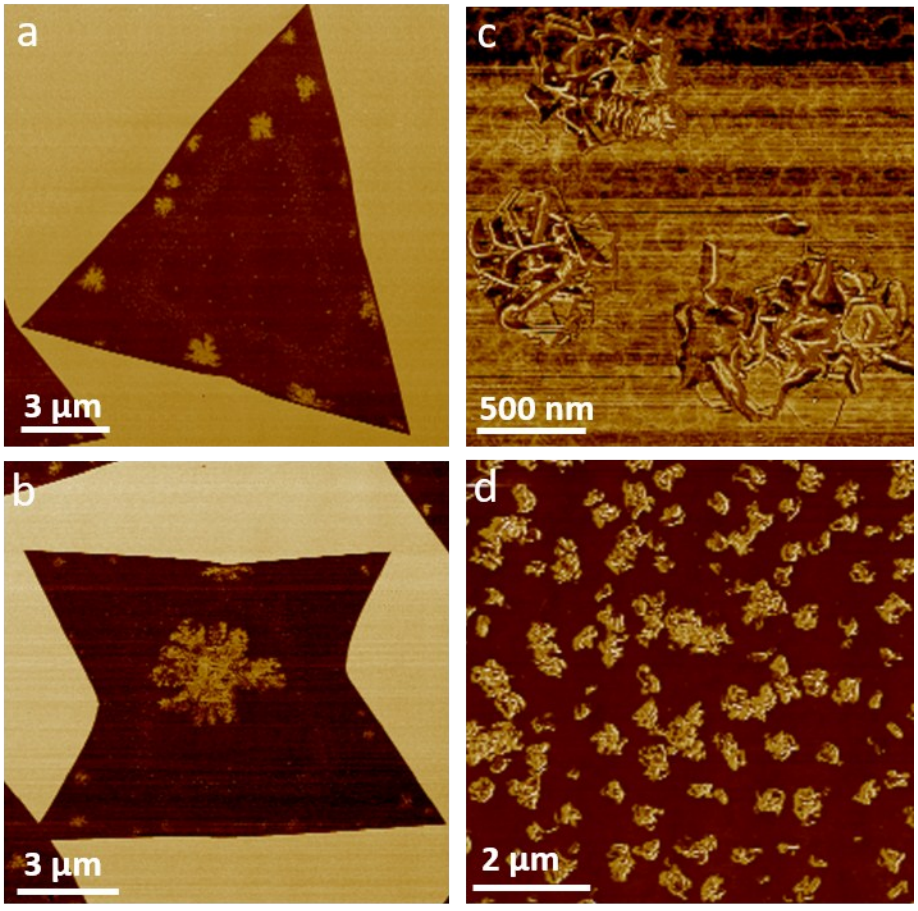


Figure S1: AFM phase imaging of horizontally aligned (a, b) and (c, d) vertically aligned MoS_2 nanostructure. Formation of new seed layer on top of horizontally grown MoS_2 flake is evident from (b). As grown vertical standing MoS_2 on top of horizontally aligned MoS_2 nanostructures are shown in (c).

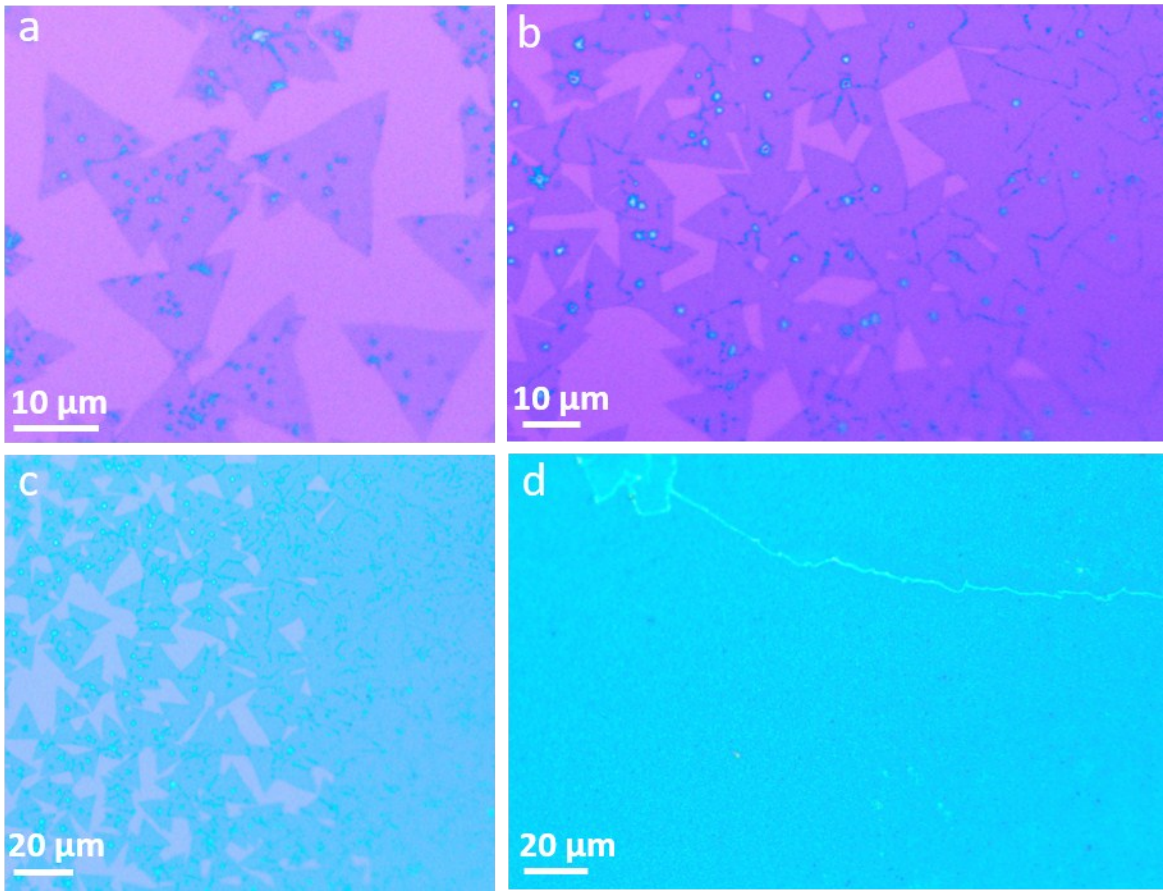


Figure S2: Visible light microscope (VLM) imaging carried out at different location showing individual as well as interconnected MoS_2 flakes with different coverage. (a, b) Monolayer MoS_2 flakes with lateral dimension of ~ 15 µm undergoing coalescence and forms interconnected structure. Formation of continuous film consisting of interconnected MoS_2 flakes with full coverage of 1x1 cm^2 on SiO_2/Si substrate are shown in (c, d).

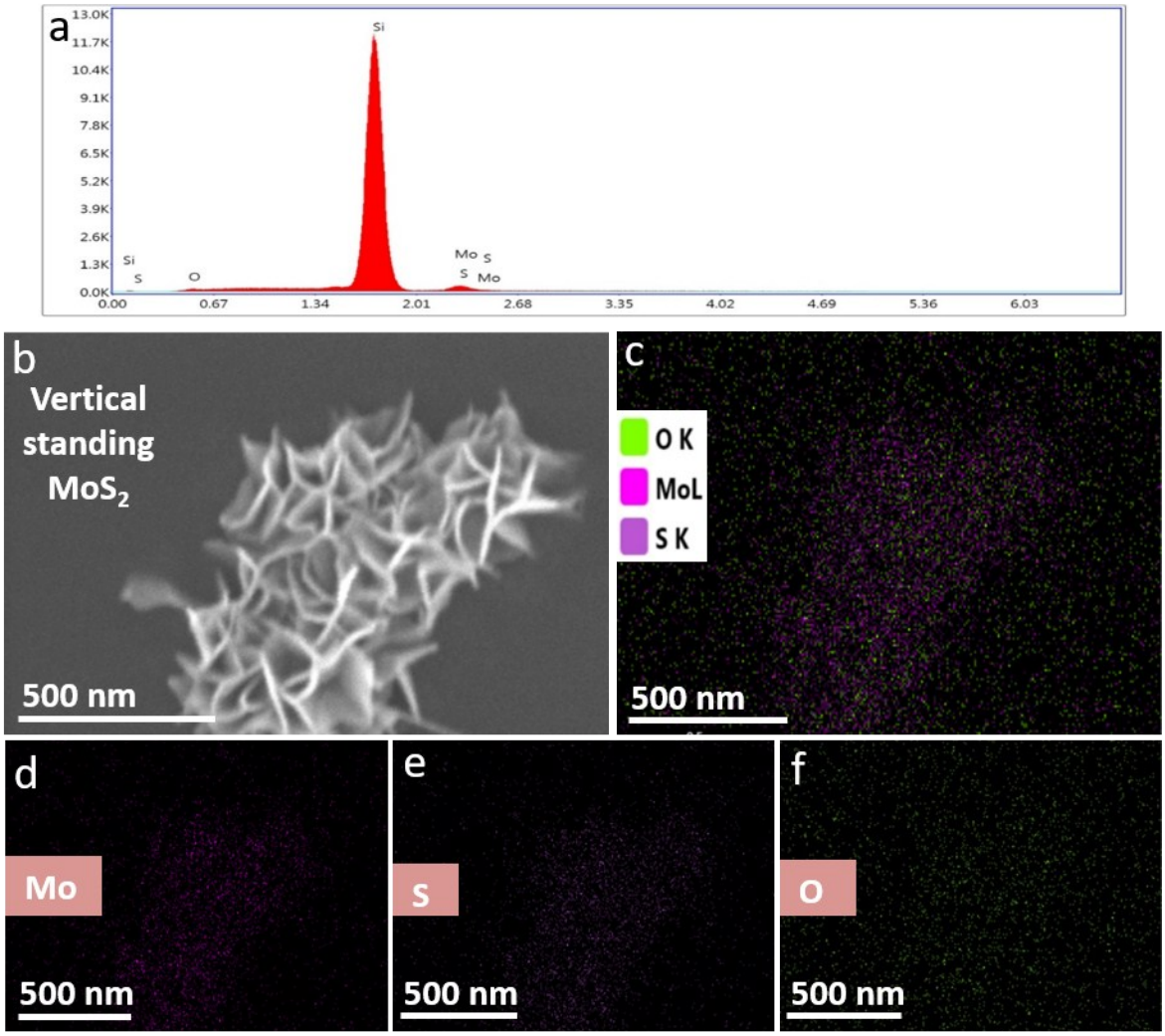


Figure S3: Elemental mapping of vertically aligned MoS_2 using EDS-FESEM system; Spectrum shown in (a) has clear elemental analysis for presence of MoS_2 on Si substrate. FESEM micrograph of vertically grown MoS_2 nanostructure and the corresponding elemental mapping are shown in (b) and (c). Images depicting individual elements (Mo, S & O) are shown in (d) Molybdenum (e) Sulfur and (f) Oxygen.

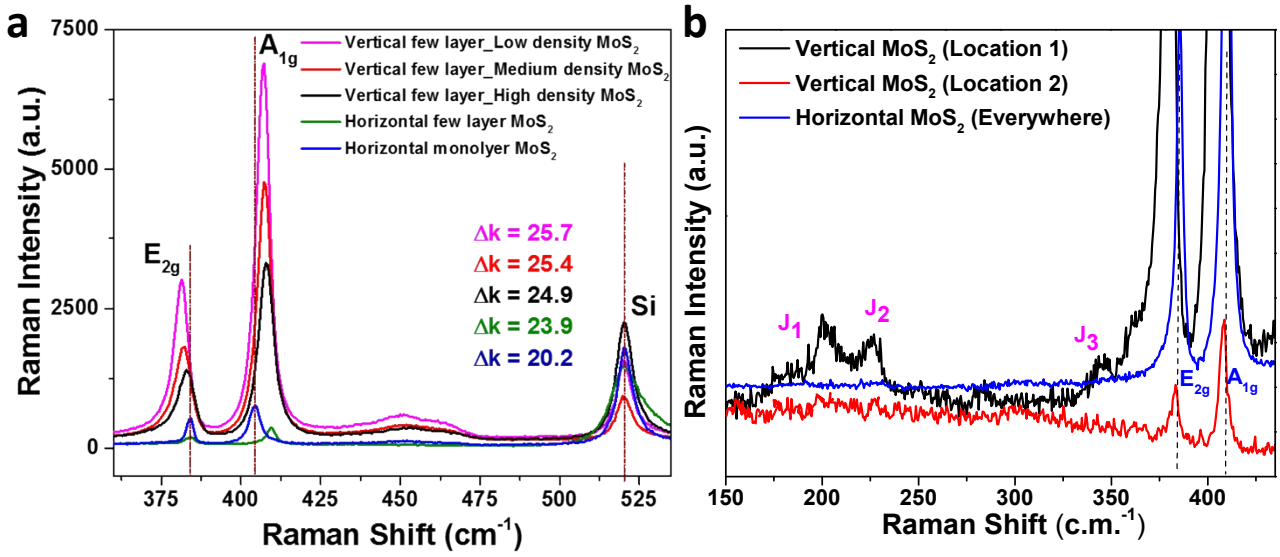


Figure S4: (a) Raman modes observed for different anisotropic aligned MoS_2 nanostructures with varying density. Raman shift and intensity variation influenced by the observed density variation in vertically aligned MoS_2. (b) Presence of 2H and 1T phase in vertically aligned MoS_2 measured at different locations whereas only 2H phase significantly present in horizontally aligned MoS_2.

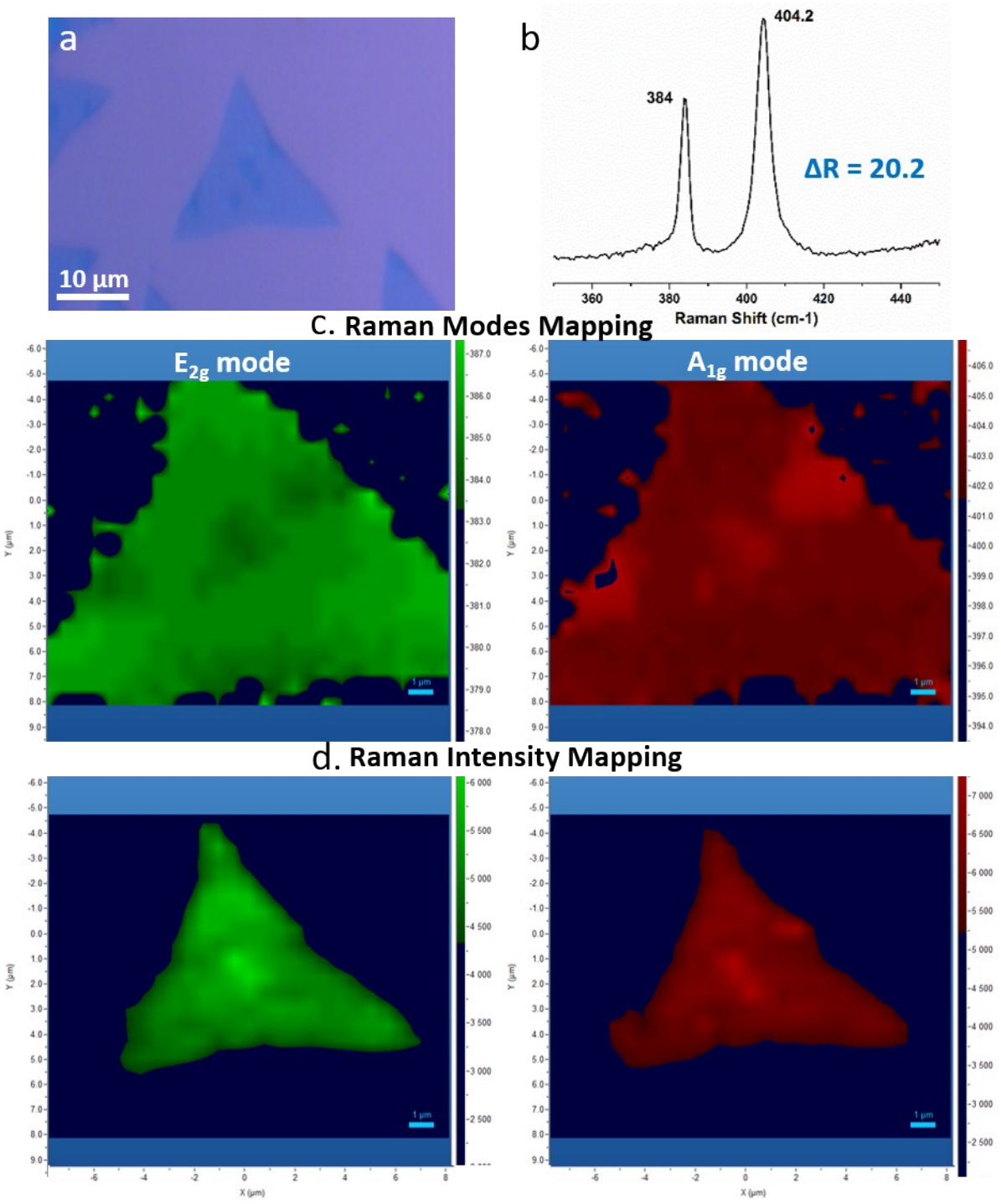


Figure S5: (a) Visible light microscope imaging along with Raman spectrum confirms the growth of monolayer MoS_2 on Si substrate. (b) Difference in Raman shift ($\Delta R \sim 20.2$ cm^{-1}) observed between E_{2g} and A_{1g} Raman vibration modes is consistent with earlier reports. Slight contrast variation observed in the Raman mode and intensity mapping indicates the nucleation of seed layers on top of MoS_2 monolayer(c, d).

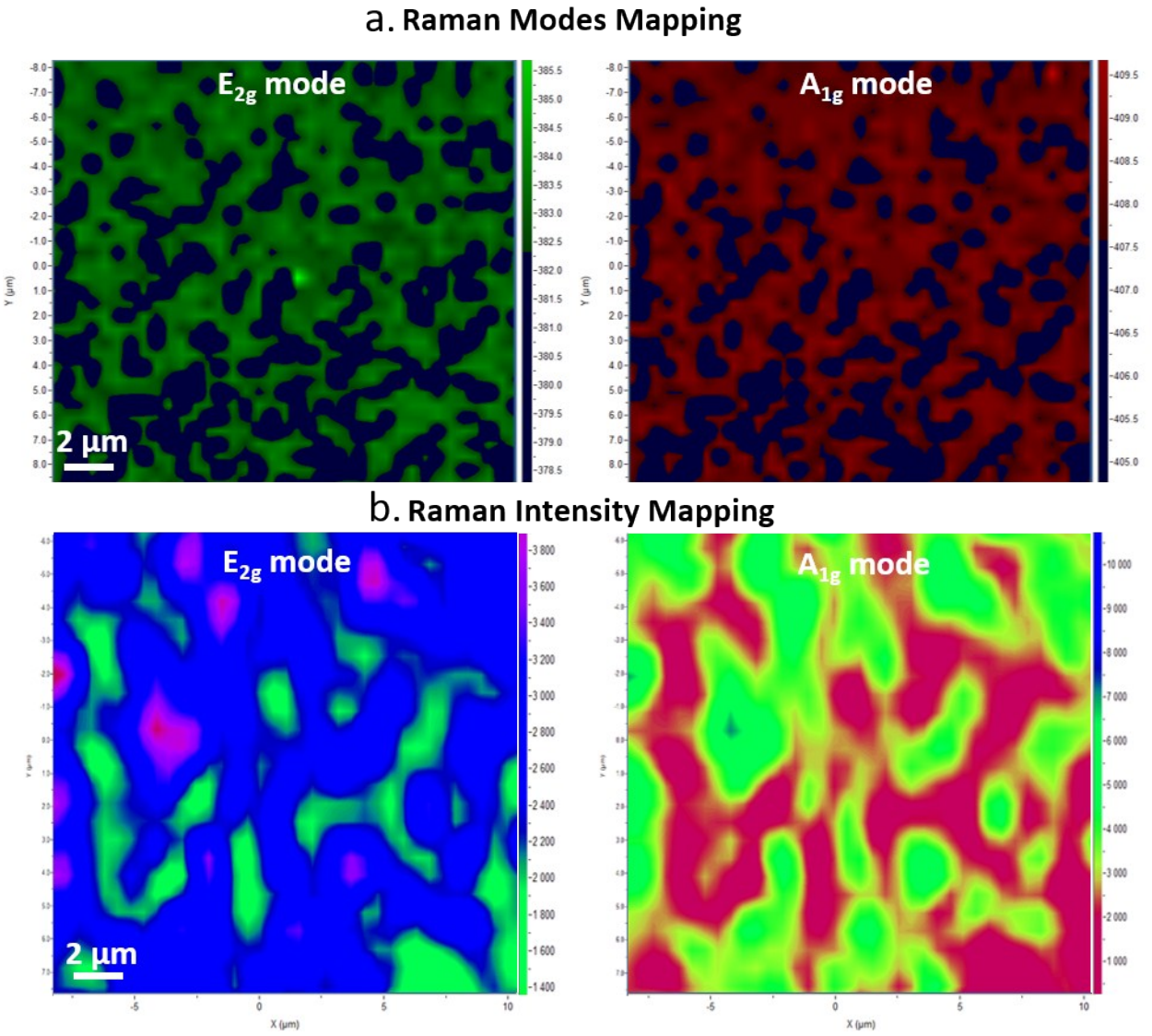


Figure S6: (a) Raman mapping of E_{2g} and A_{1g} vibration modes for few layer vertical standing MoS_2 and their corresponding (b) Raman intensity maps. Intensity mapping of A_{1g} mode shows two fold increase compared to E_{2g} mode intensity for the same position in vertically aligned MoS_2.

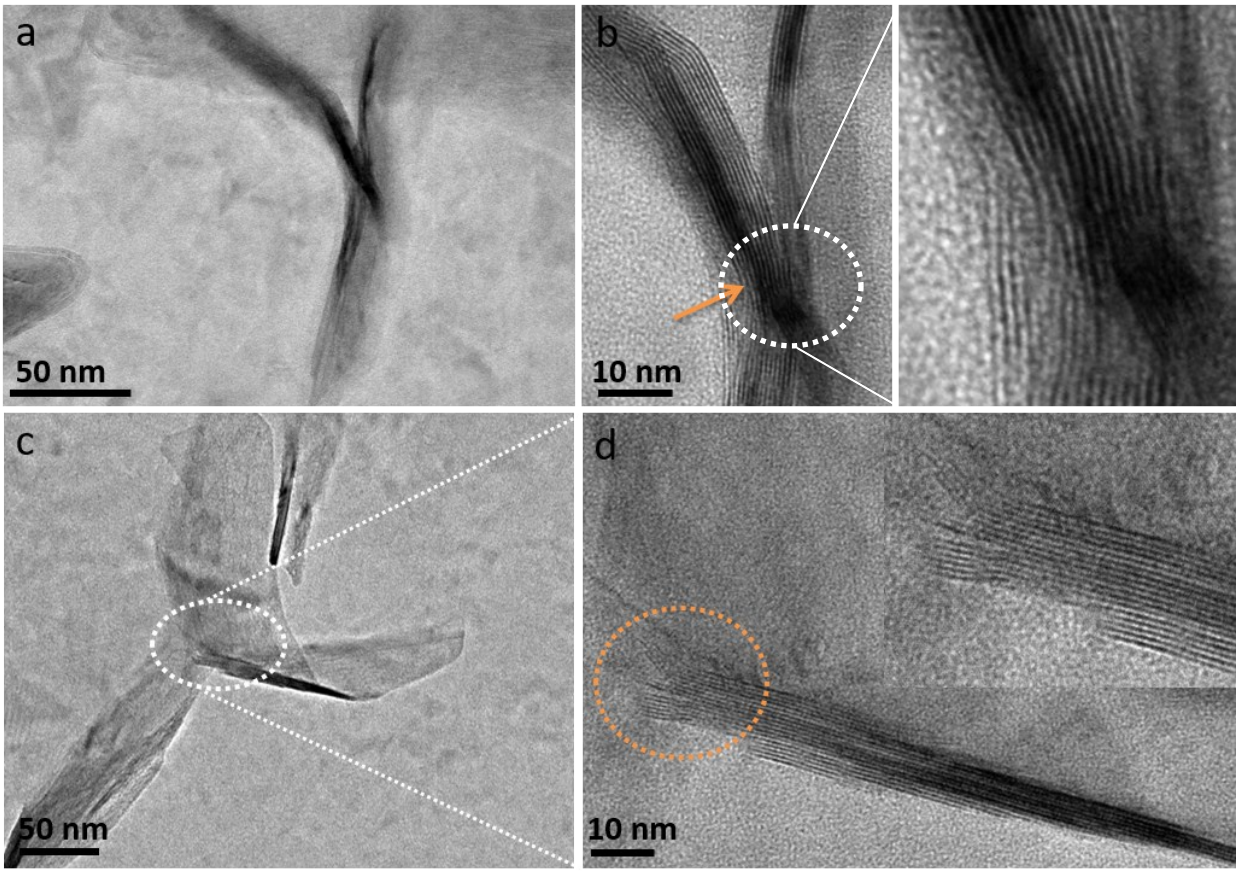
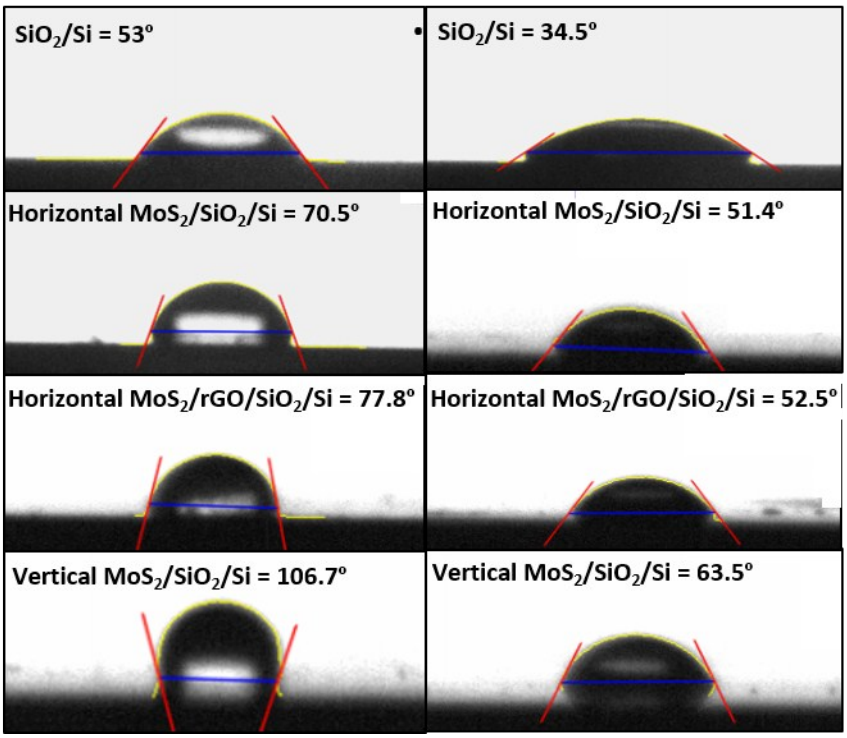


Figure S7: TEM bright field and lattice images of vertically standing MoS_2 layers undergoing coalescence are shown in (a - c) respectively. Number of atomic thin layers present in each MoS_2 flake and coalescence induced deformation is evident in (b) along with high resolution image of marked circular portion. Similarly, bending in atomic thin MoS_2 flakes causes strain between intra layers lead to mechanical deformation (crack) as indicated by circular marked region in figure (d) with inset showing high resolution TEM micrographs.

a Water b Ethylene Glycol



c

S. No.	Sample description	Contact Angle		Total Surface Energy (mJ/m^2)	Surface Energy (mJ/m^2) (Polar)	Surface Energy (mJ/m^2) (Dispersive)
		Water	Ethylene Glycol			
1.	SiO_2/Si (Bare Substrate)	53º	34.5º	51.19	47.04	4.15
2.	Flat $MoS_2/SiO_2/Si$	70.5º	51.4º	33.39	27.99	5.40
3.	Vertical $MoS_2/SiO_2/Si$	106.7º	63.5º	22.39	0.26	22.14

Figure S8: Contact angle measurement for horizontally and vertically aligned MoS_2 nanostructure with respect to two different liquid (a) Water and (b) Ethylene glycol having known surface tension. (c) Corresponding calculated surface energies for both oriented MoS_2 nanostructures.

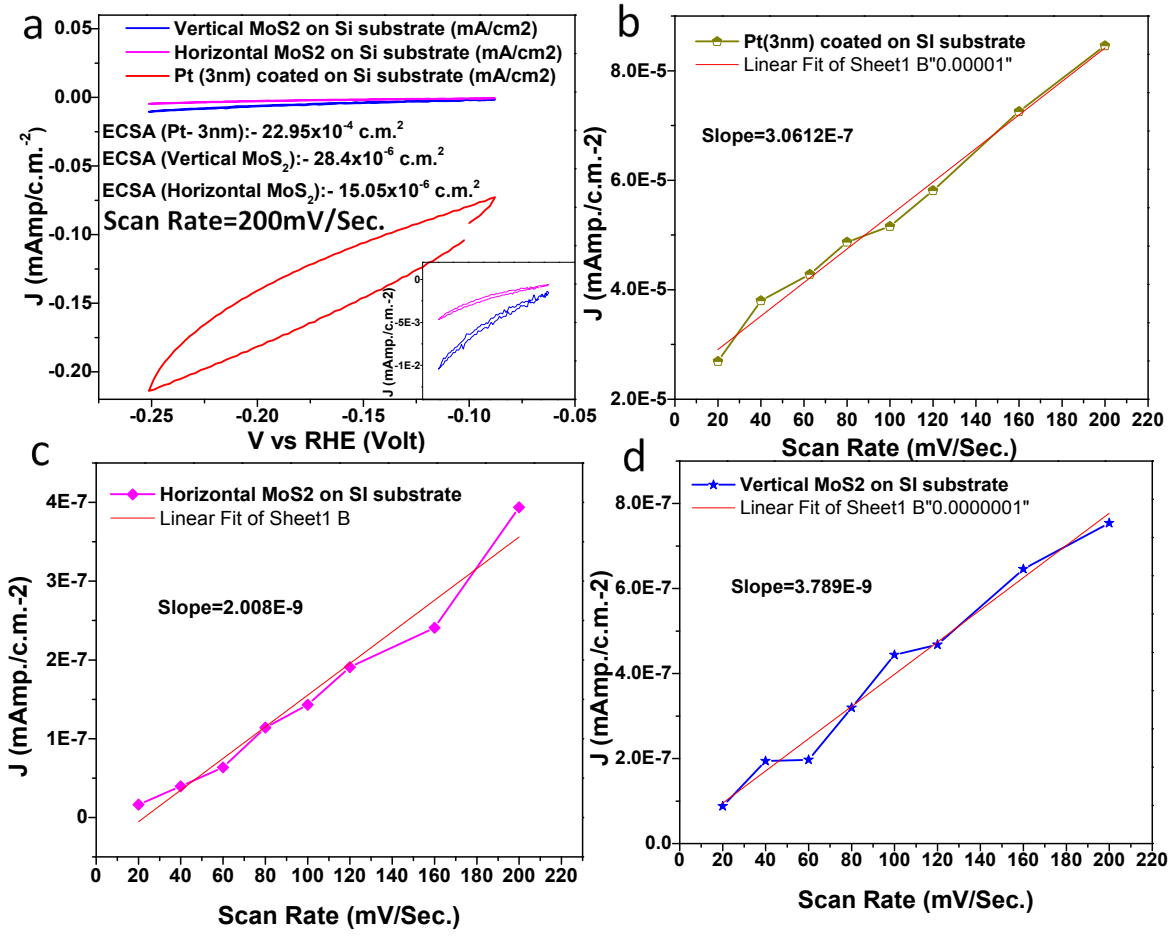


Figure S9: Comparative CV measurement plot at scan rate of 200 mV/sec. and fitted curves for the different scan rate based CV measurement across both nanostructures of MoS_2 as well as Pt. (3nm) coated on Si substrate to calculate C_{dl} and further analyze the ECSA.

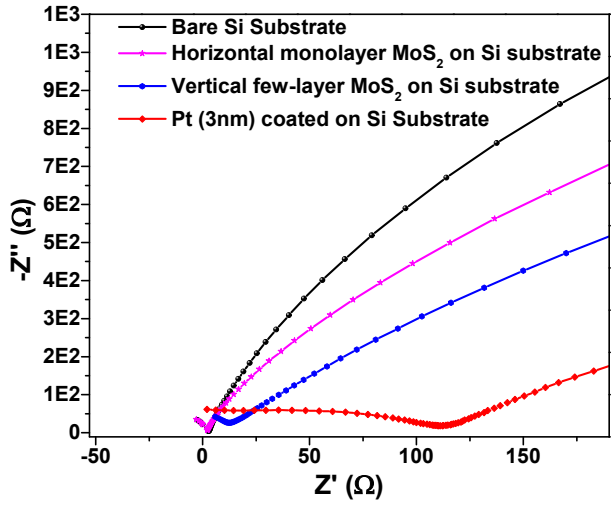


Figure S10: Zoomed region of impedance analysis for different aligned MoS_2 nanostructures with standard Pt. (3 nm).

Table ST1: Controlled growth conditions to achieve horizontal and vertical MoS_2 nanostructures.

Substrate	Growth Parameters	Horizontal MoS_2	Vertical MoS_2
Si SiO_2/Si Si_3N_4/Si	Temperature Zone 1 (MoO_3) : Zone 2 (S)	650°C : (180°C - 220°C)	700°C : (400°C - 450°C)
	Ar flow	~ 5 sccm	~ 5 sccm
	S - MoO_3 ratio	~18	~22
	S - MoO_3 distance	~15 cm	~12 cm
	Growth Time	~ 3 to 5 min.	~ 10 min.