Electronic Supplementary Material (ESI) for Journal of Materials Chemistry C.

Supporting Information

Controllable p-type doping of 2D MoS_2 via Sodium intercalation for optoelectronics

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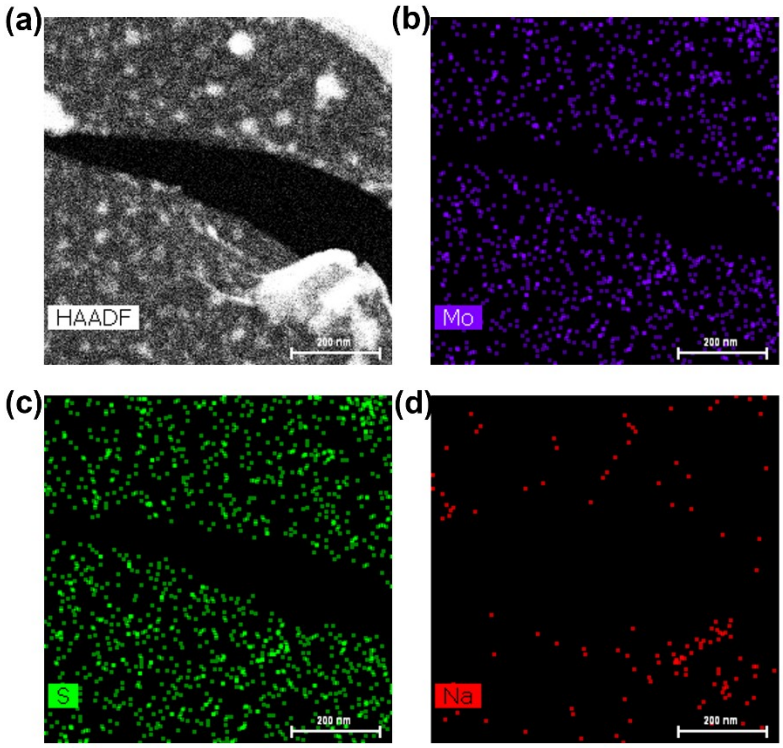

Figure S1. STEM EDS mapping of thin MoS_2 with NaOH grown on SiO_2/Si (a) High-angle-annular-dark-field (HAADF) image of the MoS_2 with NaOH on SiO_2/Si substrate. (b), (c), and are the elemental maps of MoS_2 on SiO_2/Si, showing the location of Mo, S, and Na respectively.

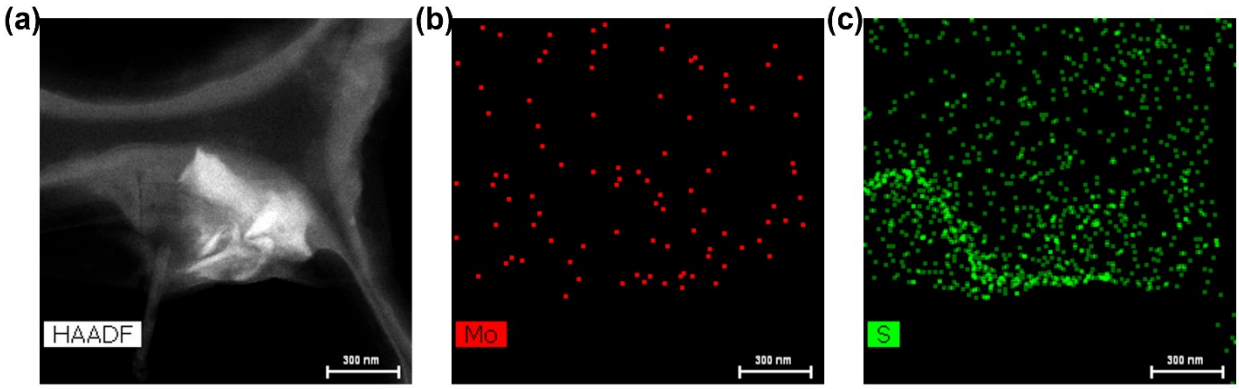

Figure S2. STEM EDS mapping of thin MoS_2 without NaOH grown on SiO_2/Si (a) High-angle-annular-dark-field (HAADF) image of the MoS_2 without NaOH on SiO_2/Si substrate. (b) and (c) are the elemental maps of MoS_2 on SiO_2/Si, showing the location of Mo and S respectively.

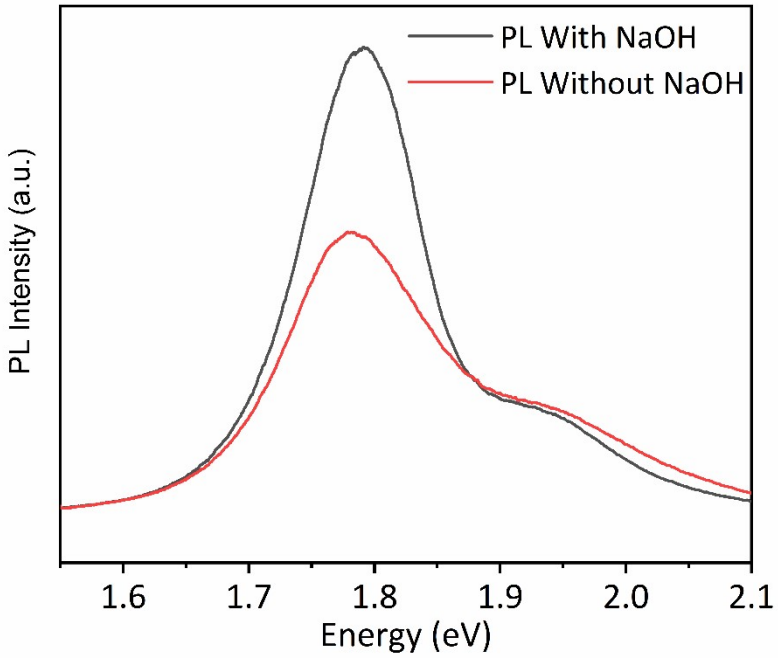

Figure S3. PL spectra of MoS_2 with and without NaOH

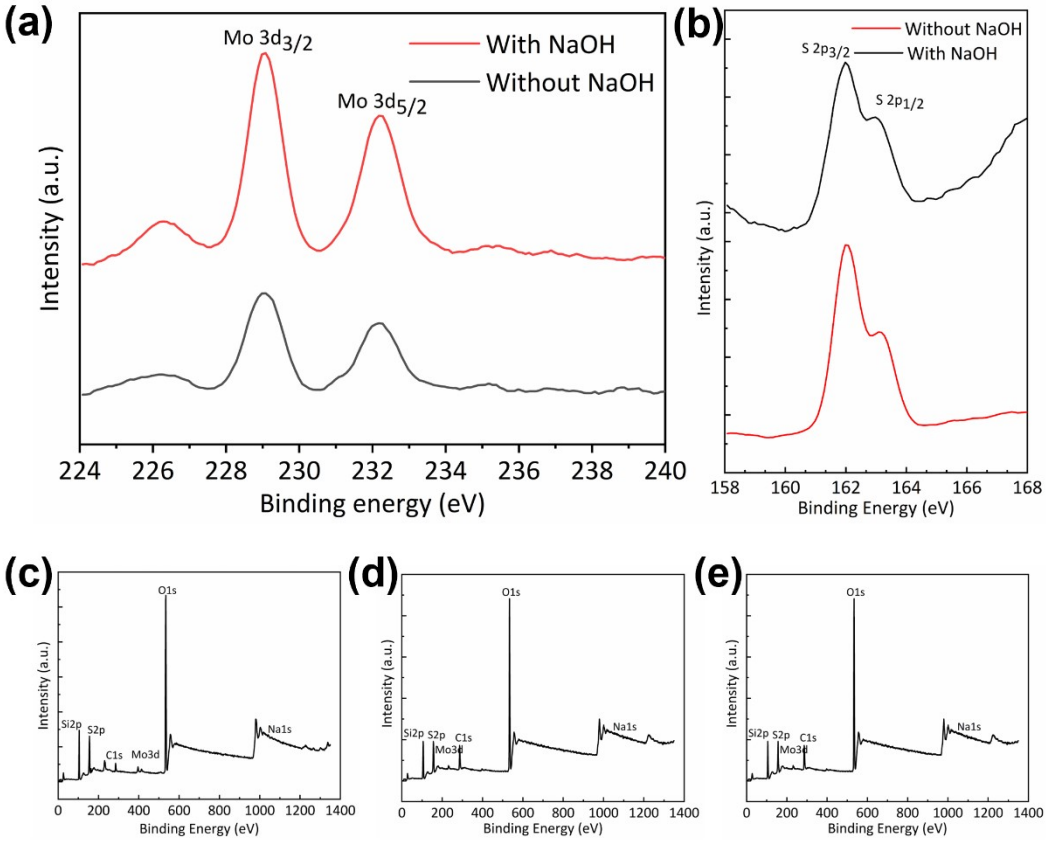

Figure S4. XPS spectra of (a) Mo 3d and (b) S 2p of the sample with and without NaOH. Survey spectrum of Na-doped MoS_2 (c) Low doped concentration (d) medium concentration (e) High concentration

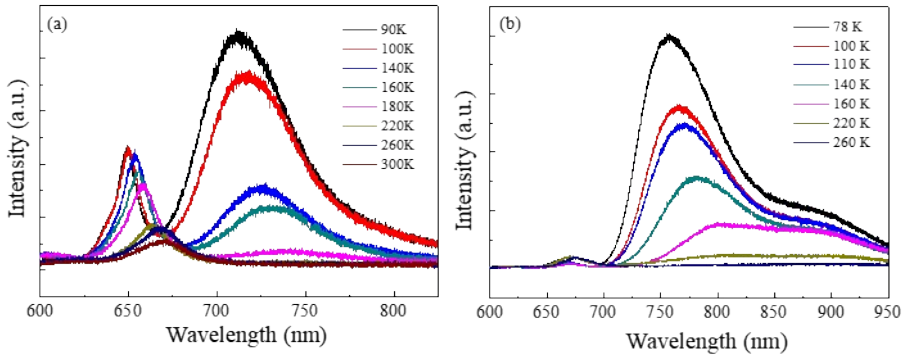

Figure S5. PL spectra of MoS_2 with (a) and without (b) NaOH

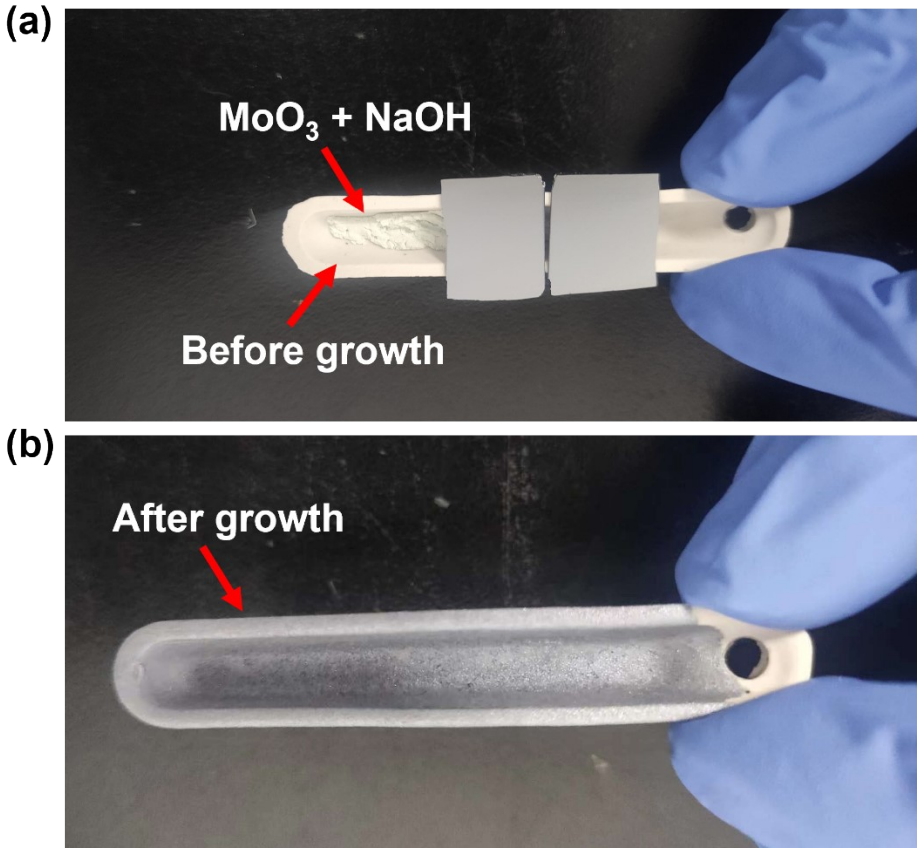

Figure S6. Influences of NaOH precursor during CVD synthesis of MoS_2 flakes, sodium clusters were observed on the alumina boat.

A TEM grid is placed on the targeted MoS_2 flakes grown on the SiO_2/Si substrate is shown in figure **S7** (a). As displayed in figure **S7** (b) a drop of isopropyl alcohol (IPA) is placed next to the

TEM grid. After the IPA evaporates completely, a drop of potassium hydroxide (KOH) placed next to the TEM grid is shown in fidure **S7** (c). After etching away, the SiO_2, the TEM grid with MoS_2 flakes is detached from the Si substrate. The TEM grid is then rinsed in de-ionized (DI) water several times is shown in figure **S7** (d).

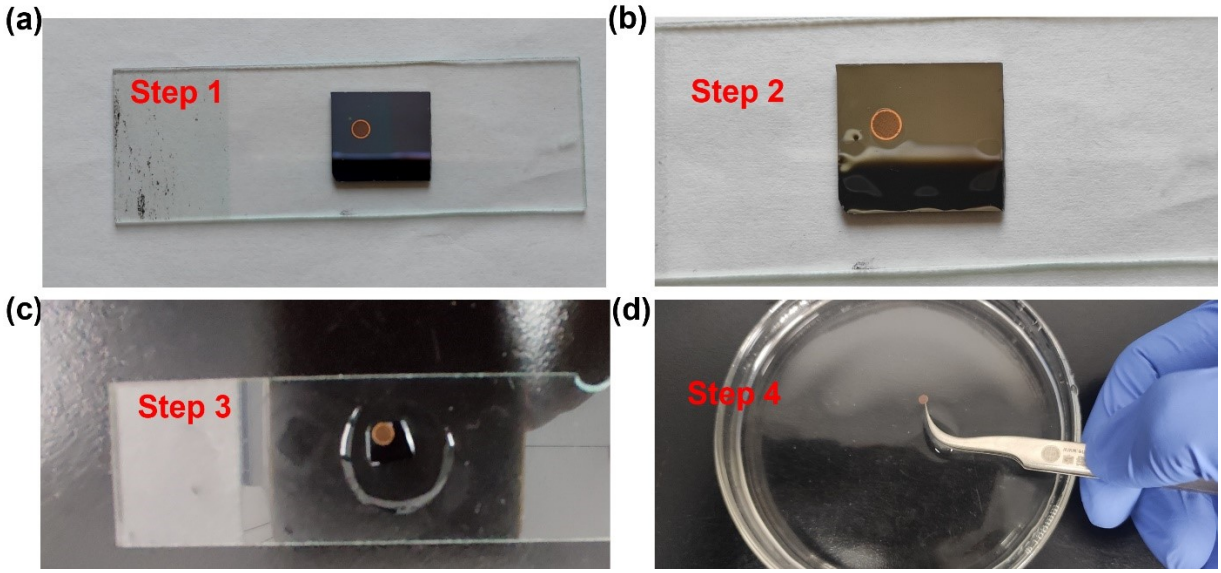

Figure S7. Transfer of CVD synthesis MoS_2 flakes to the TEM grid.

we observed the from the SEM result, when the growth temperature reduce from 800 °C to 700 °C the morphology of MoS_2 flakes changes from equillateral trinagle to three-point star is shown in **Figure S8**. This is possibly due to lowering the temperature the evaporation of MoO_3 reduces, resulting in a Mo:S ratio lower than the higher growth temperature under 800 °C, which makes the difference in the growth between Mo-zz terminations and S-zz terminations larger.

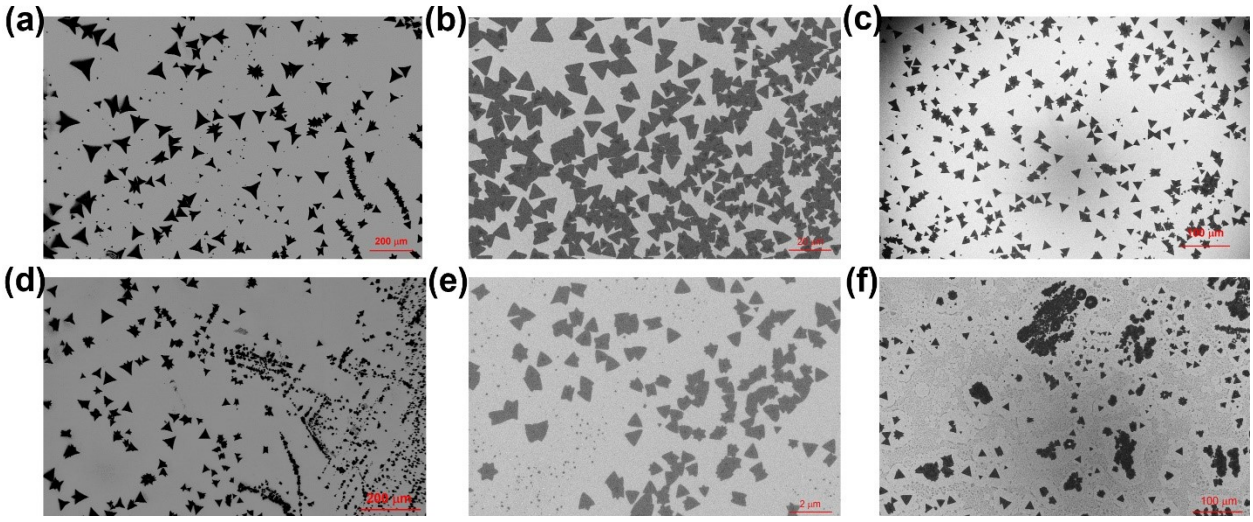

Figure S8. Scanning electron microscopy (SEM) images of MoS_2 flakes: With NaOH Chemical vapor deposition (CVD) of MoS_2 grown on SiO_2/Si at different growth condition is displayed in figure **S8.** (a-c) i.e., 700 °C, 750 °C and 800 °C respectively. Without NaOH CVD of MoS_2 flakes synthesis on SiO_2/Si as shown in figure **S8.** (d-f) at different growth temperature i.e., 700 °C, 750 °C and 800 °C respectively.

We used different amount of NaOH as shown in Table **S1.** The relative composition NaOH i.e., 8 mg, 12mg, 15 mg, was used with a fixed amount of MoO_3 and Sulfur (S). The details parameter is given below.

Growth parameter of MoS_2	NaOH	MoO_3	Sulfur	Temperature	Sccm
Low doping	8 mg	50 mg	500 mg	700-800 °C	20
Moderate doping	10 mg	50 mg	500 mg	700-800 °C	20
High doping	15 mg	50 mg	500 mg	700-800 °C	30

Table S1