Electronic Supplementary Information

Laminar MoS_2 membrane for molecule separation

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Experimental Section

The experiment was carried out in a N_2-filled glove box. 300 mg MoS_2 powder (Alfa Aesar) was dispersed in 3 ml of 1.6 M *n*-butyl lithium in hexane (Acros) under stirring for 48 hours. The obtained black product was filtered through 0.45 μm PTFE (polytetrafluoroethylene) filter membrane and washed repeatedly by copious hexane. The purified powder was dispersed in *ca.* 100 ml ultrapure water (Millipore) under the mild ultrasonication for ~60 min. Excess lithium hydroxyl was removed by centrifuging. MoS_2 membranes were prepared by vacuum filtrating diluted MoS_2 (20-50 mg/L) solution on a polycarbonate (PC) membrane with 200 nm pores (Millipore).

Water permeance and purification were tested in through a dead-end filter holder (Millipore P158, 25 mm) for pressure testing with effective area of 2.83 cm^2 at room temperature. 20 ml volume 15 μM Evans blue and Cyt. C (0.125 mg/ml) solutions were filtered through the MoS_2 membrane, respectively. The permeate was collected

by a plastic tube after certain time intervals. The rejection was calculated by the corresponding intensity of the characteristic absorbance peaks of feed and permeates solution.

Atom force microscope (AFM) image was obtained on a MultiMode (Veeco Inc.) test system under tapping mode. Zeta potential was measured on Zetasizer 3000 HAS (Malvern). Scanning electron microscopy (SEM) examination was performed by a Hitachi S-4800 at an acceleration voltage of 5 kV. The X-ray photoelectron spectroscopy (XPS) was carried out by Thermo ESCALAB 250 with an Al *Ka* radiation source (*hv* = 1486.6 eV). UV-*vis* spectra were acquired on an Agilent 3600 UV-*vis*-IR spectroscopy. Raman spectra were recorded by a HR800 Jobin Yvon Raman spectrometer with a 514 nm excitation laser under ambient condition.

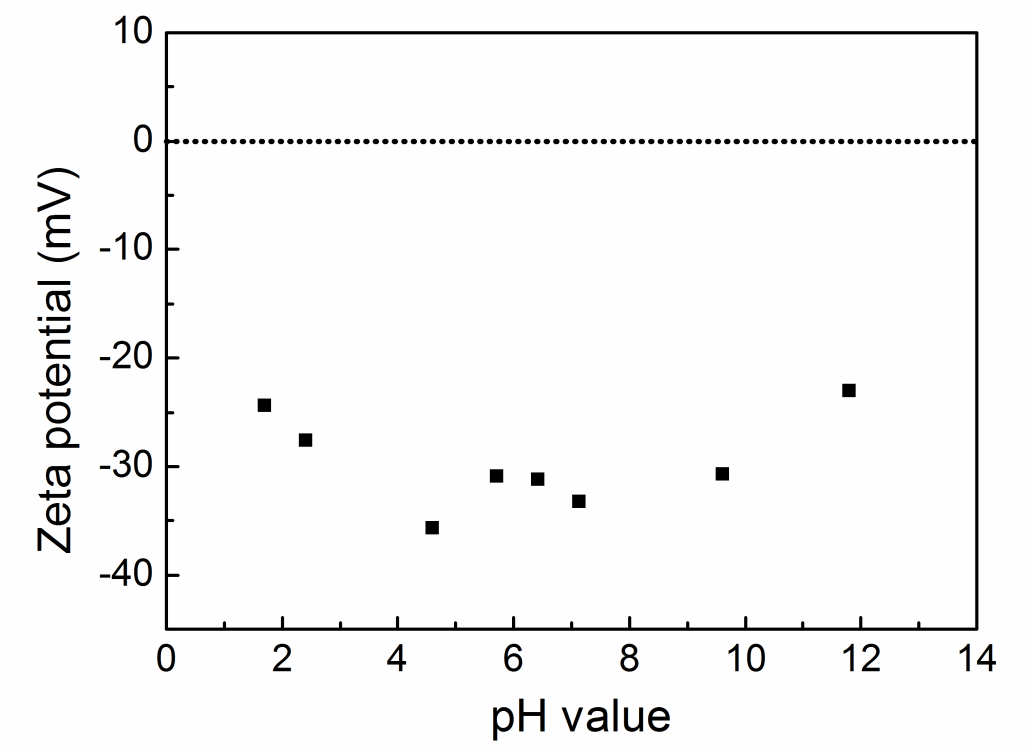

Figure S1. Zeta potential of the MoS_2 sheets dispersion solution at different pH value.

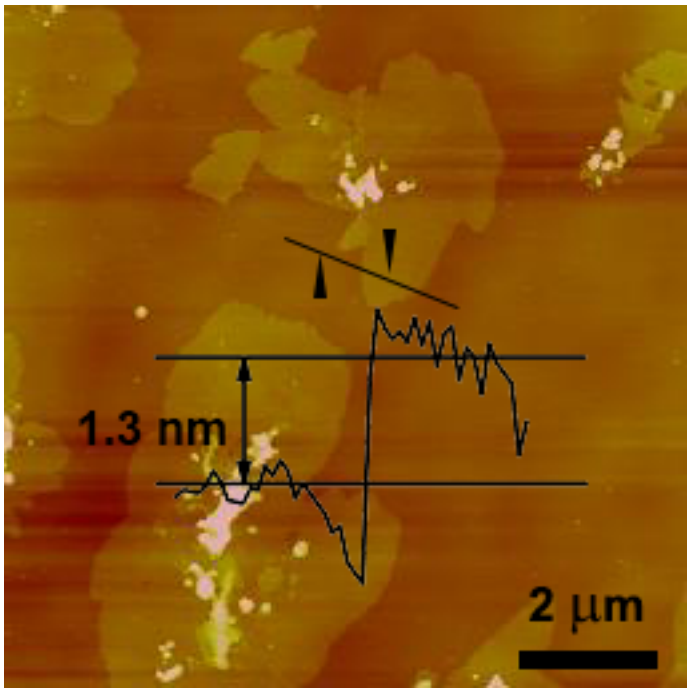

Figure S2. AFM image of MoS_2 sheet. Lateral dimension is scaled between two black arrows, as shown in inset. The MoS_2 sheet is 1.3 nm in thickness. The sharply drop in the height profile is due to silicon substrate.

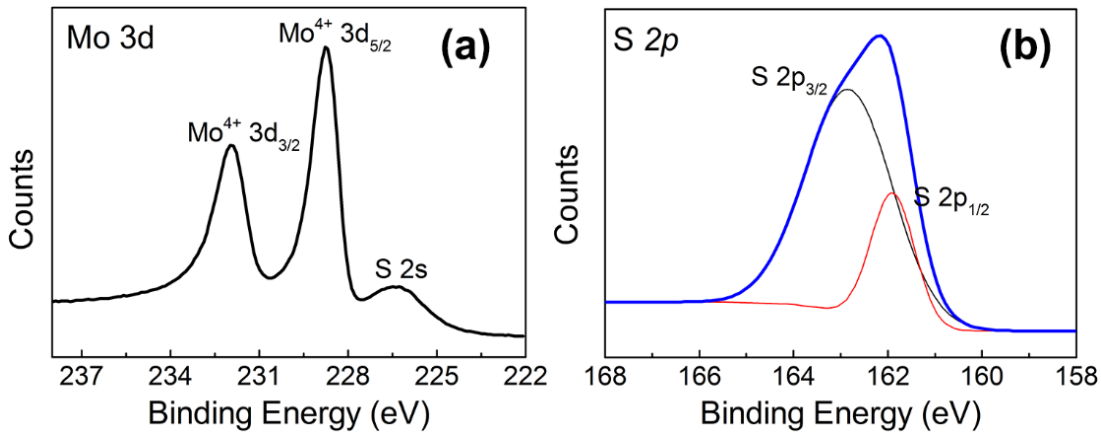

Figure S3. (a) and (b) are Mo 3*d* and S 2*p* XPS spectra, respectively. Mo^{4+} exhibits two peaks of $3d_{2/3}$ and $3d_{5/2}$. A broad peak centered at 226 eV is S 2*s* band. S 2*p* band is deconvoluted two peaks corresponding to S $2p_{1/2}$ and $2p_{3/2}$.

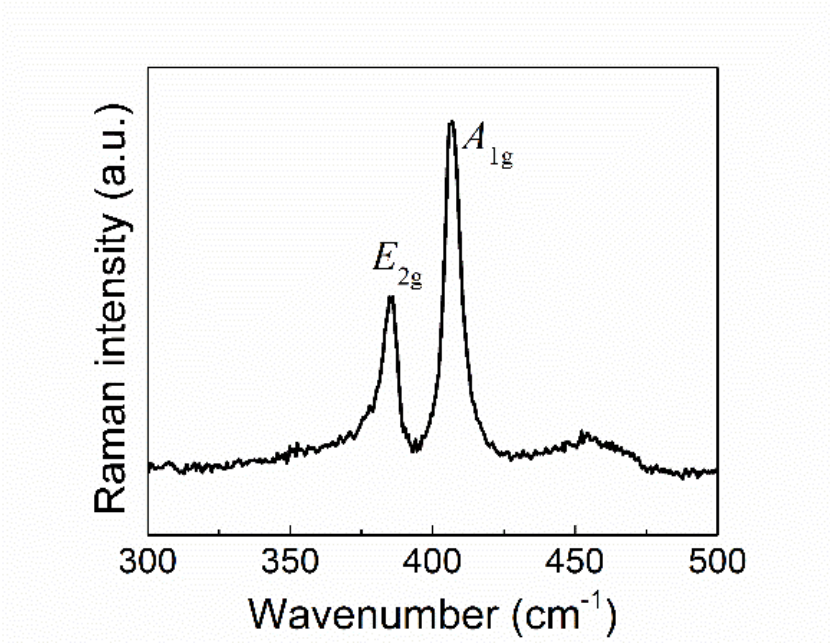

Figure S4. Raman spectrum of MoS_2 membrane

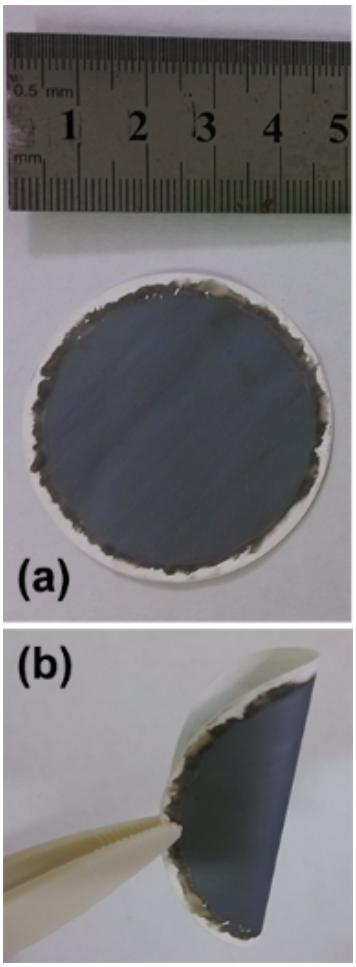

Figure S5 Photo of (a) a MoS_2 membrane with a diameter of 45 mm; and (b) its bending state.

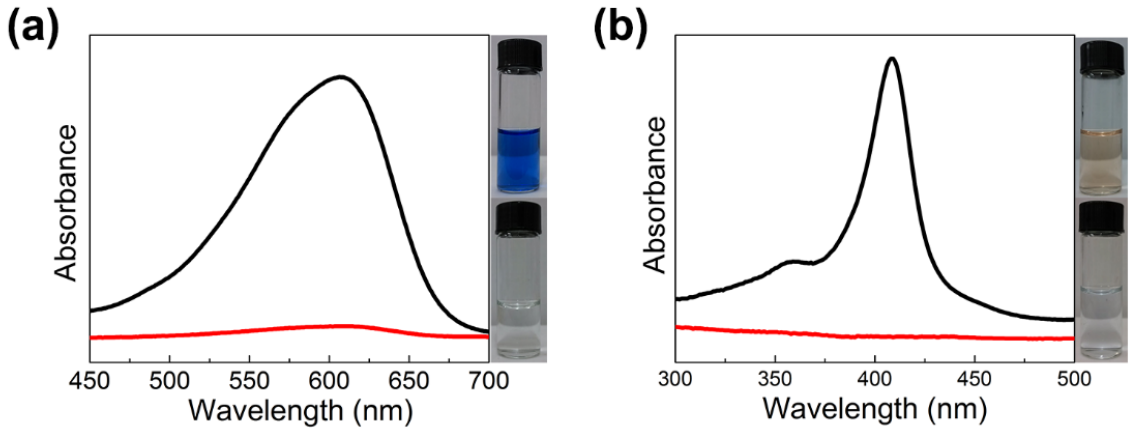

Figure S6. Photos and UV-*vis* absorbance spectra of feed (black line) and permeate (red line) solutions of (a) evans blue and (b) cytochrome C respectively through a 1.7 μm ± 60 nm thick MoS_2 membrane.

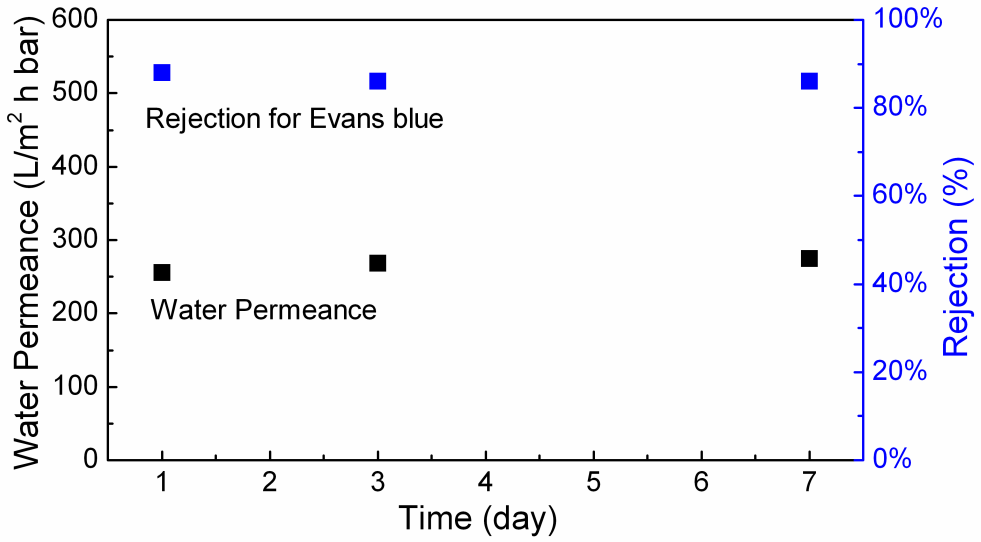

Figure S7. Water permeance (black squares) and rejection of EB (blue squares) are tested continuously through a 1.7 μm thick MoS_2 membrane after the 1, 3 and 7 days.