Supporting Information

Homogeneous P-N Junction Diode by Selective Doping Few layer $MoSe_2$ Using Ultraviolet Ozone for High- Performance Photovoltaic Devices

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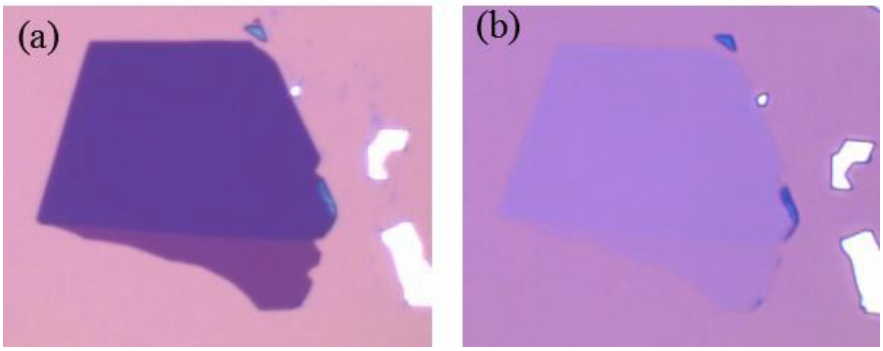

Figure S1 Optical images of different layer $MoSe_2$ flakes of before (a) and after(b) UVO treatment for 20 min.

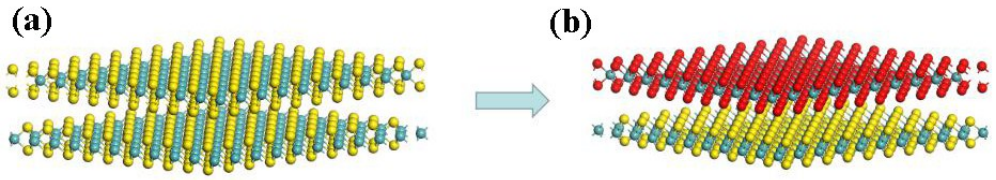

Figure S2 Schematic of atomically thinning $MoSe_2$ flakes.

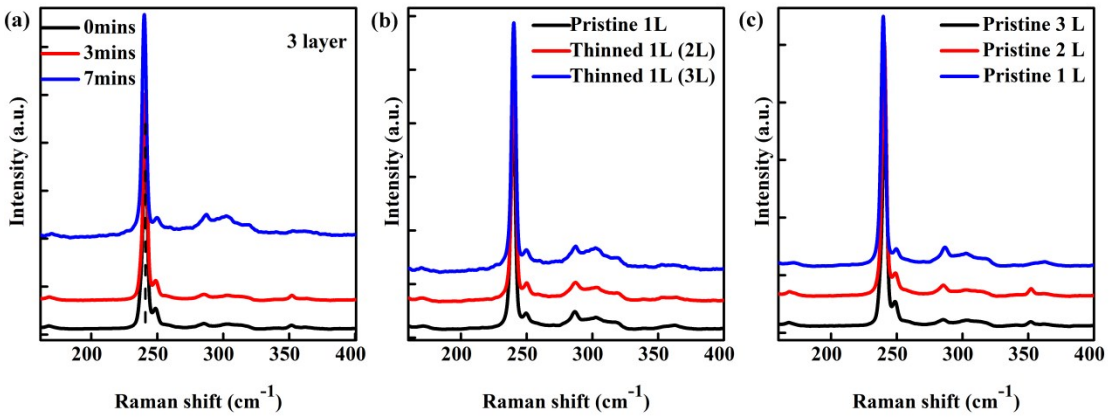

Figure S3 Raman spectra of trilayer $MoSe_2$ before and after UVO treatment for 3 and 7 mins (a), exfoliated pristine monolayer $MoSe_2$ and the thinned monolayer by oxidized bilayer and trilayer (b) $MoSe_2$, pristine $MoSe_2$ in different layers.

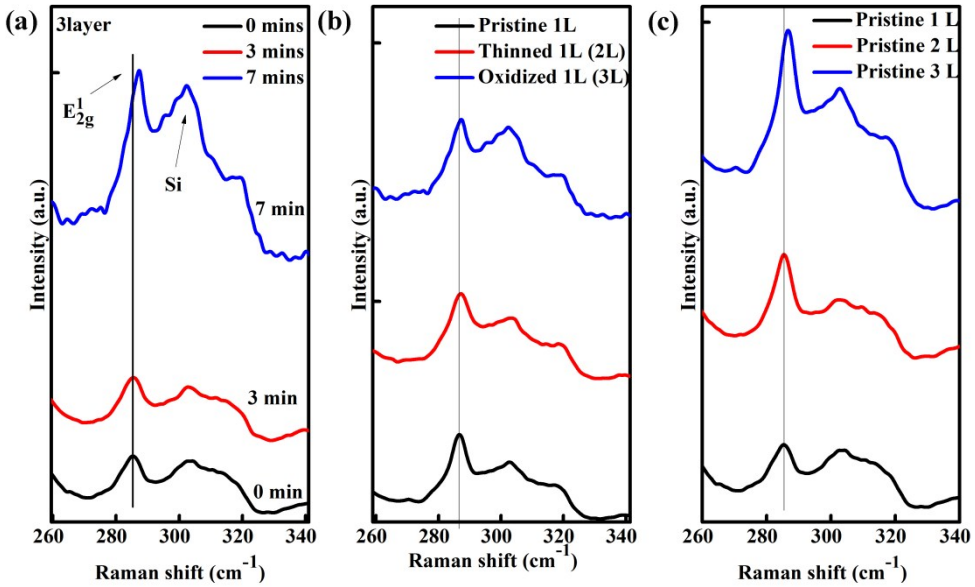

Figure S 4 Raman spectra centered at $MoSe_2$ E^1_{2g} peak from samples as in Figure S3.

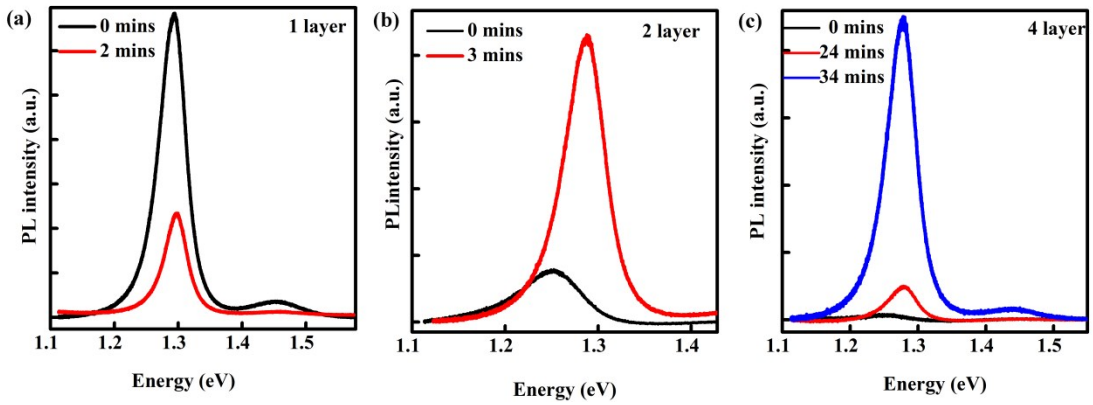

Figure S5 the evolution of Photoluminescence spectra of $MoSe_2$ before and after UVO treatment: (a) monolayer, (b) bilayer, (c) four layer

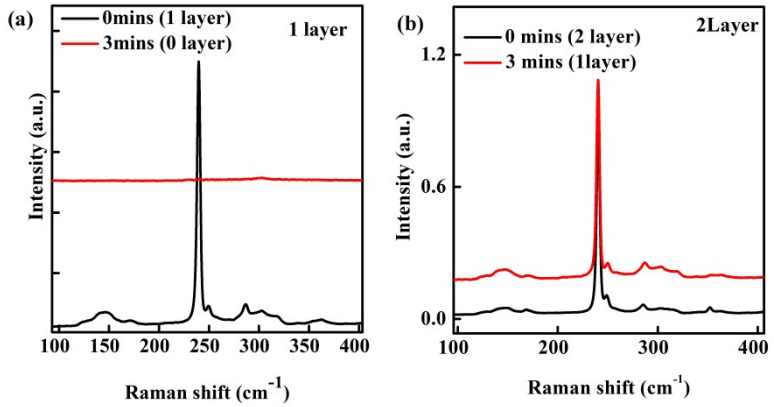

Figure S6 the evolution of Raman spectra of $MoSe_2$ before and after UVO treatment: (a) monolayer, (b) bilayer

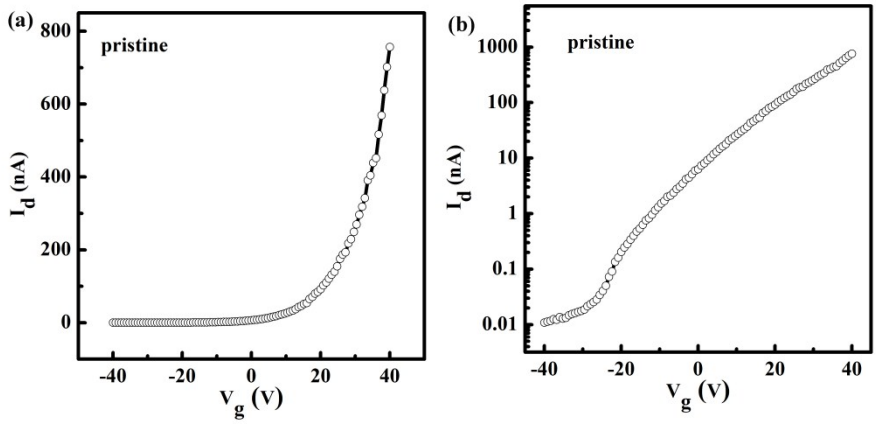

Figure S7. I_d–V_g characteristics of the $MoSe_2$ FET with V_d = 1 V for the thick $MoSe_2$ in linear (a) and log (b) scale, showing the intrinsic n-type nature.

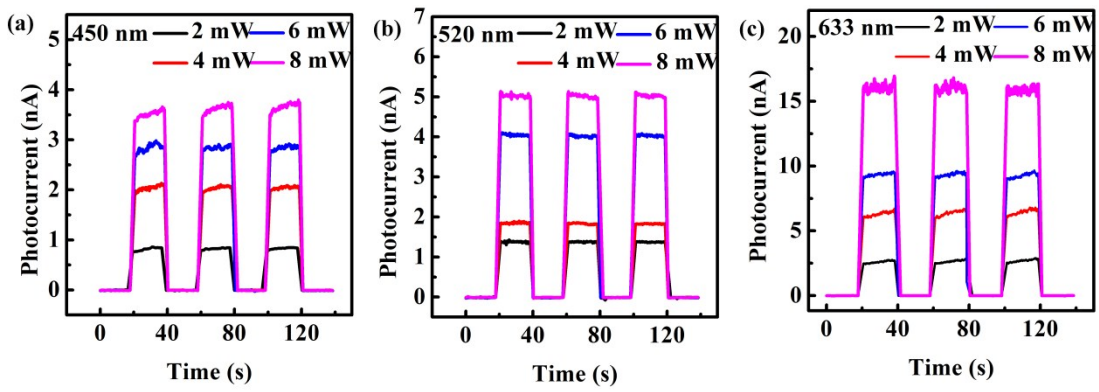

Figure S8. Dynamic optical response of the device (V_d =0 V, V_g= 0 V) under illumination of light with 450 nm, 520 nm and 633 nm, as function of different power (2, 4, 6, 8 mW)

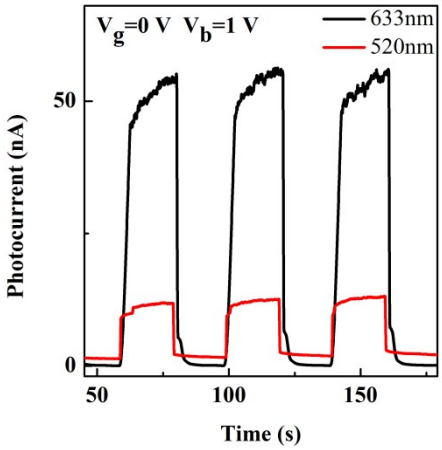

Figure S9 Dynamic optical response of the device (V_d=1V, V_g=0V) under illumination of light with 520 nm and 633 nm with 8 mW

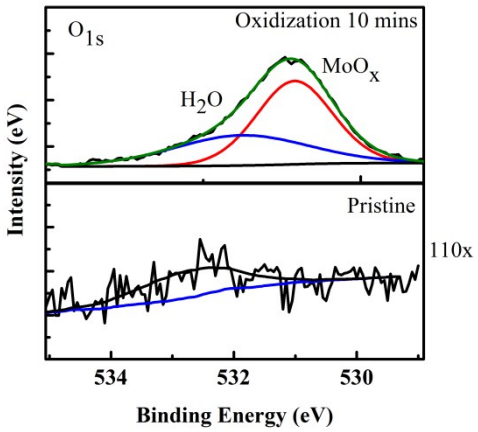

Figure S10 the O 1score level of XPS spectra for bulk $MoSe_2$ before and after UVO treatment for 10 mins For the pristine$MoSe_2$, there is almost no O. After oxidation treatment, there is an

obvious peak of oxygen, which is correspond absorbed H_2O and the MoOx.

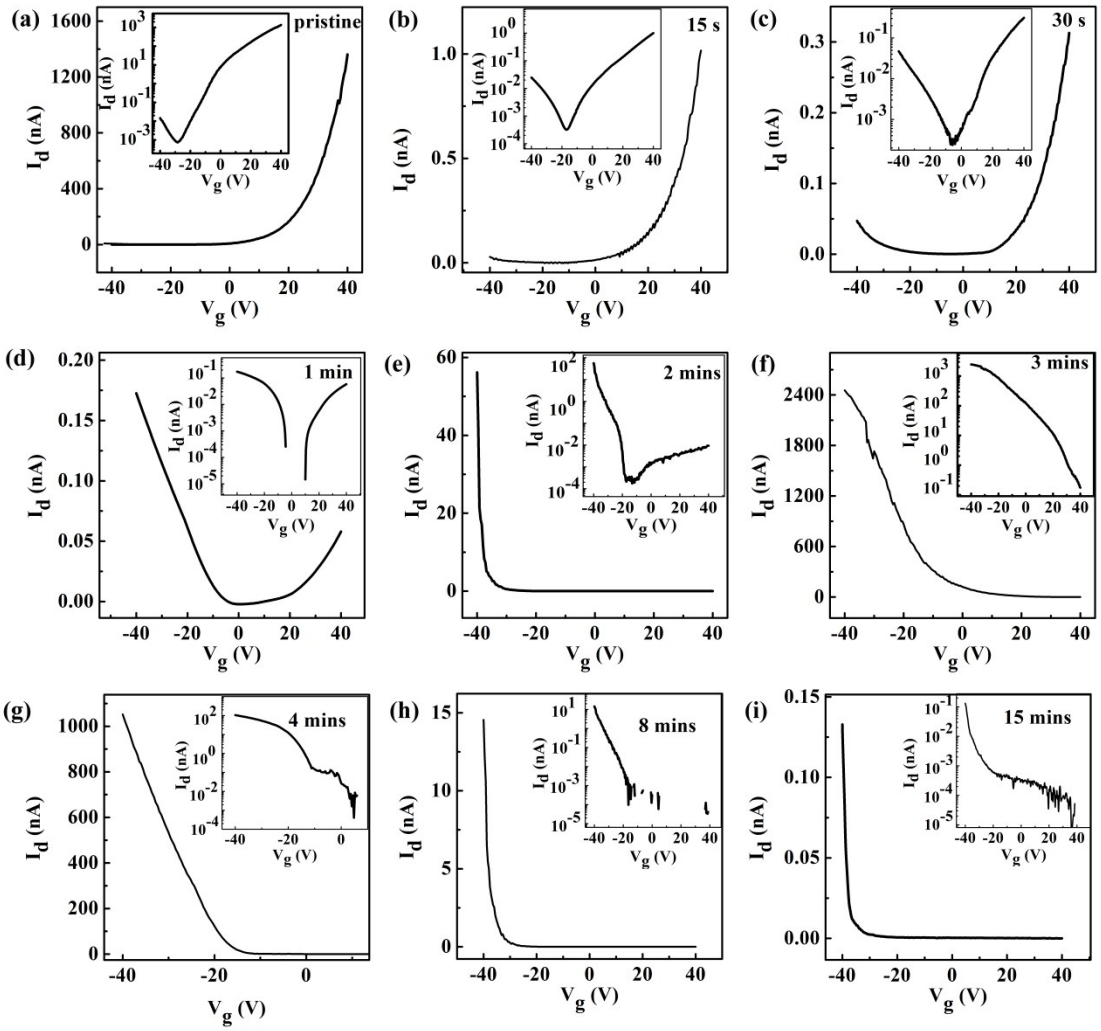

Figure S11 The transfer characteristic of $MoSe_2$ before (a) and after UVO treatment for 15 s (b), 30s (c), 1min (d), 2mins (e), 3mins (f), 4 mins (g), 8mins (h), 15 mins (i).

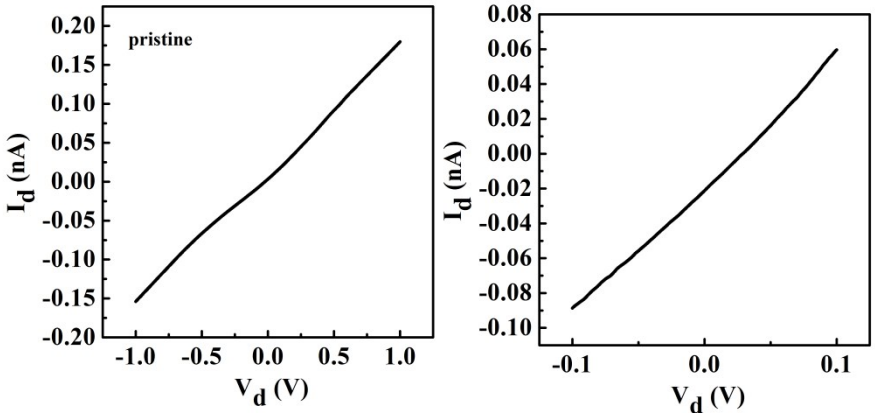

Figure S12 The I-V curves of pristine $MoSe_2$ with partial PMMA protect.

	R(A/W)	EQE(%)	D(Jones)
633nm	0.226	44.3%	$1.74x10^{10}$
520nm	0.071	16.5%	$0.548x10^{10}$
450nm	0.042	11.6%	$0.324x10^{10}$

TABLE 1.Performance of $MoSe_2$ p-n Diode