

## Directly hydrothermal growth of ultrathin MoS<sub>2</sub> nanostructured films as high performance counter electrodes for dye-sensitised solar cells

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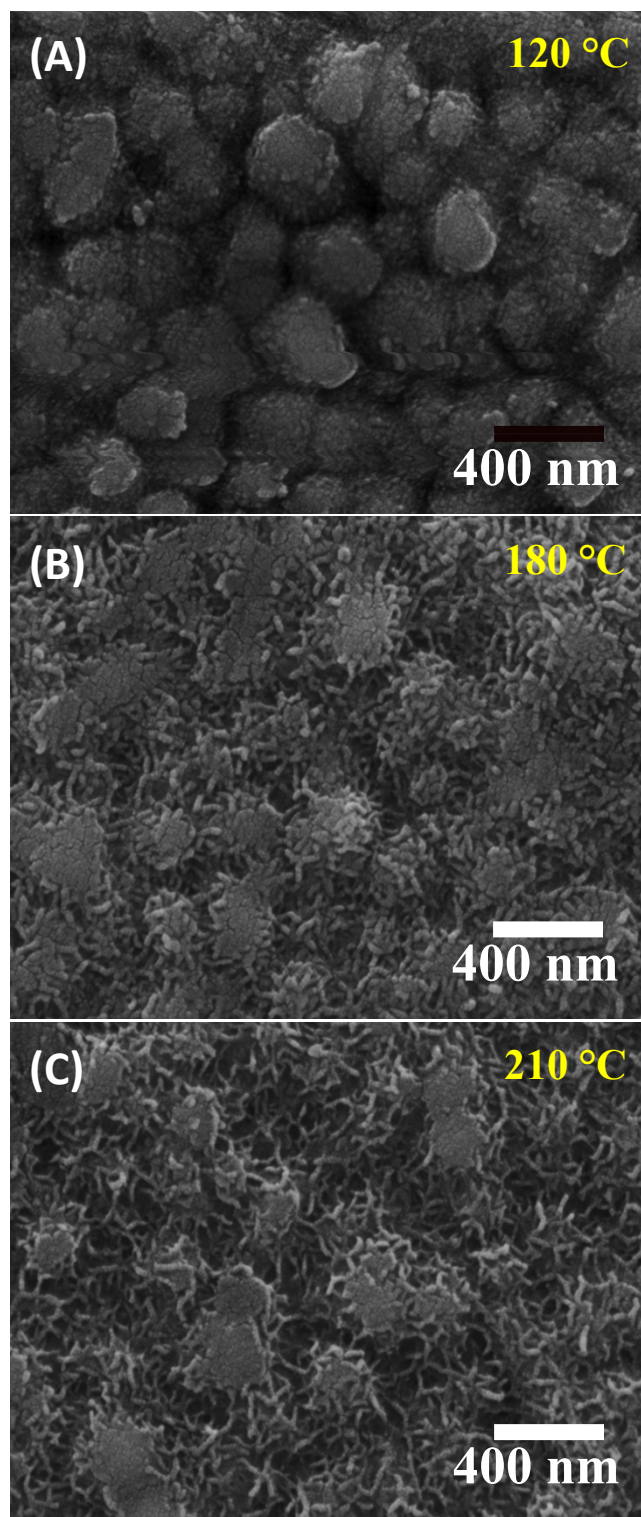
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**Table S1** A partial literature review of the DSSCs performance assembled with MoS<sub>2</sub> based counter electrodes.

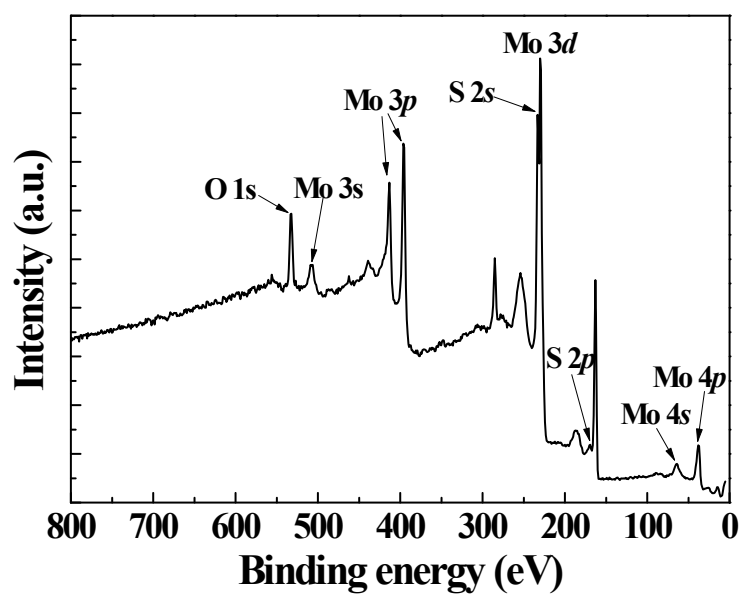
Counter Electrodes	PCEs (%) composite	PCEs (%) Pure MoS <sub>2</sub>	PCEs (%) Pt	Thickness (μm)	T (%)	Refs.
MoS <sub>2</sub>	—	7.59	7.64	20	Opaque	1
MoS <sub>2</sub> /graphene	5.98	—	6.23	6	Opaque	2
MoS <sub>2</sub> /graphene	6.04	5.09	6.38	4	Opaque	3
MWCNT/MoS <sub>2</sub>	6.45	4.99	6.41	20	Opaque	4
MoS <sub>2</sub> -C	7.69	5.36	6.74	12	Opaque	5
MoS <sub>2</sub> -GNS	5.81	4.15	6.24	0.25-3.0	0-70	6
MoS <sub>2</sub>	—	7.01	7.31	0.1	—	7
MoS <sub>2</sub> /GF	6.07	4.10	6.41	6	Opaque	8
MoS <sub>2</sub>	—	5.41	6.58	0.4	>80	9
MoS <sub>2</sub>	—	7.41	7.13	0.49	56	Present study

**Table S2** Photovoltaic parameters of three parallel DSSCs prepared by various MoS<sub>2</sub>-based counter electrodes showing the average values with standard deviation.

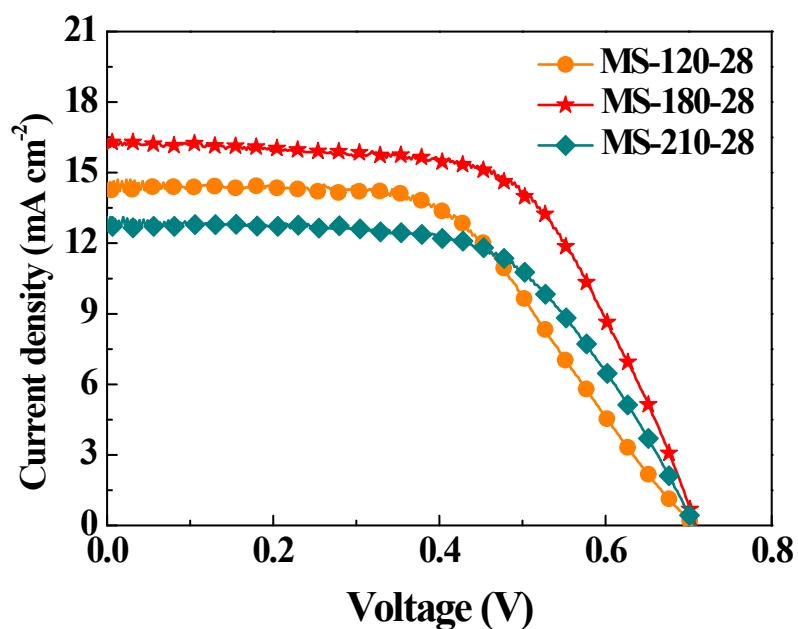
CEs	$V_{oc}$ (mV)	$J_{sc}$ (mA cm <sup>-2</sup> )	$\eta$ (%)	$FF$ (%)				
MS-150-7	691		13.92	3.70				
	689	690±1.52	13.82	13.89±0.07	3.60	3.67±0.06	37.9	38.5±0.65
	692		13.95		3.71		39.2	
MS-150-14	702		15.17		4.97		46.7	
	703	702±0.58	15.21	15.18±0.02	4.99	4.97±0.02	46.9	46.5±0.59
	702		15.16		4.95		45.8	
MS-150-28	698		18.37		7.41		57.8	
	690	696±5.69	18.40	18.24±0.24	7.40	7.40±0.02	57.2	57.2±0.65
	701		17.97		7.38		56.5	
MS-150-42	673		13.44		4.96		54.9	
	679	674±4.58	13.45	13.41±0.06	4.95	4.94±0.03	54.2	54.3±0.58
	670		13.35		4.90		53.8	
MS-120-28	708		14.25		5.52		54.8	
	709	709±0.58	14.30	14.18±0.16	5.54	5.52±0.03	55.1	54.6±0.57
	709		14.00		5.49		54.0	
MS-180-28	709		16.33		7.15		61.7	
	708	709±1.00	16.10	16.13±0.19	7.10	7.12±0.03	60.2	61.0±0.75
	710		15.95		7.12		61.1	
MS-210-28	709		12.76		5.47		60.5	
	709	709±0.58	12.05	12.59±0.47	5.42	5.45±0.03	58.2	59.8±1.39
	708		12.95		5.48		60.7	
Pt	722		16.78		7.13		58.8	
	729	723±5.57	15.90	16.55±0.57	7.09	7.13±0.05	57.2	57.6±1.02
	718		16.98		7.19		56.9	



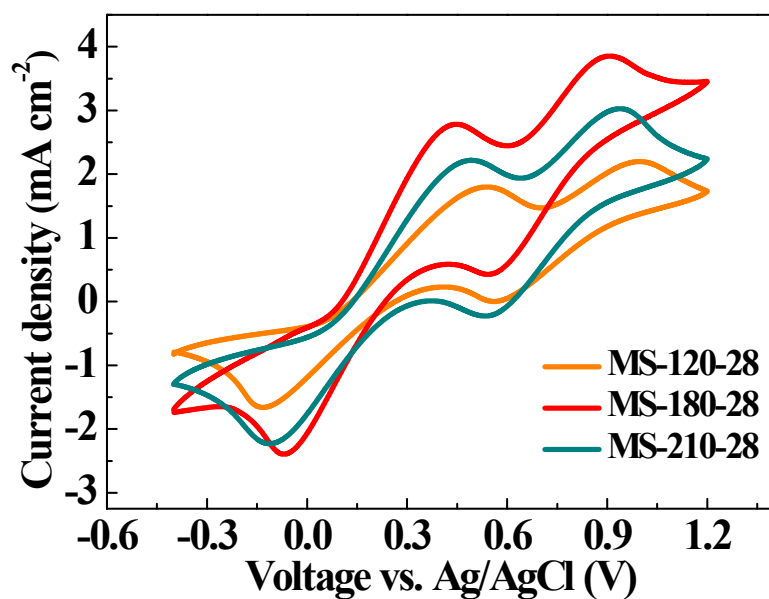
**Fig. S1** Surface SEM images of MoS<sub>2</sub> samples prepared with fixed precursor molar ratio of 1:28 at different reaction temperatures. (A) 120 °C, (B) 180 °C and (C) 210 °C.



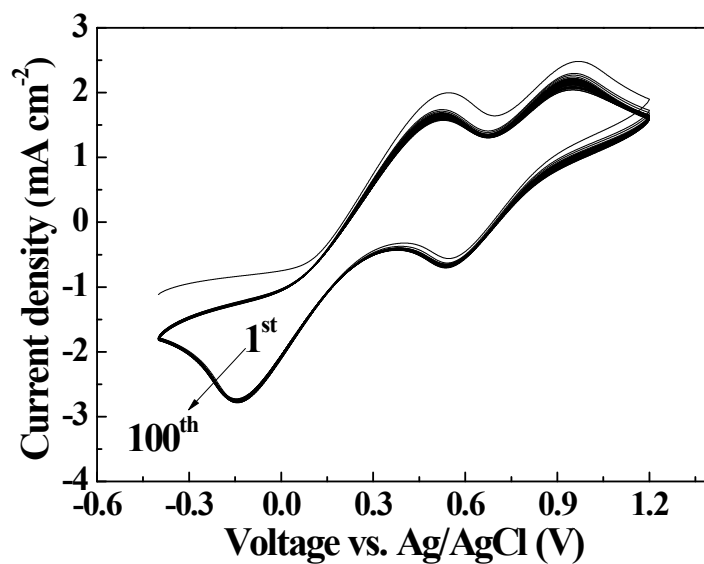
**Fig. S2** Survey XPS spectra of MoS<sub>2</sub> film prepared at 150 °C under the reaction precursor molar ratio of 1:28.



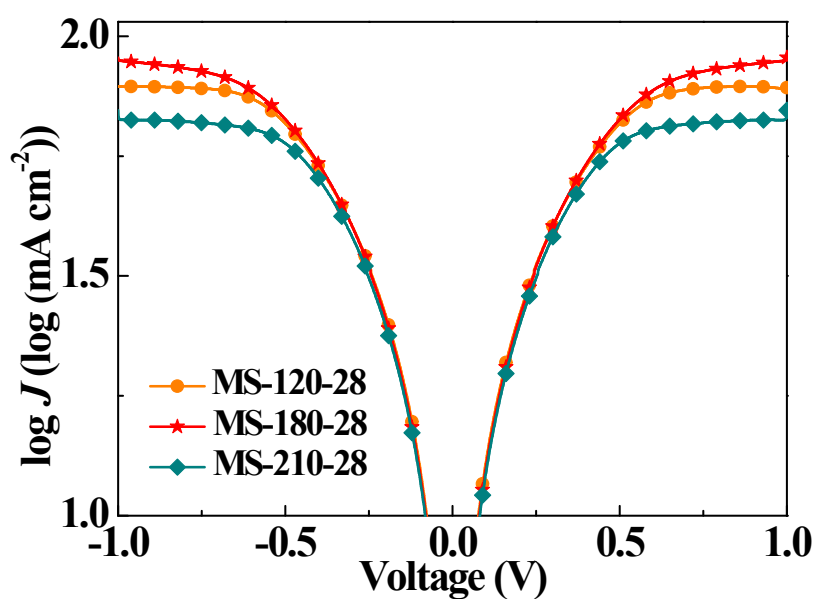
**Fig. S3** Photocurrent-voltage curves of DSSCs assembled with different MoS<sub>2</sub> counter electrodes prepared under different hydrothermal reaction temperatures at fixed precursor molar ratio of 1:28.



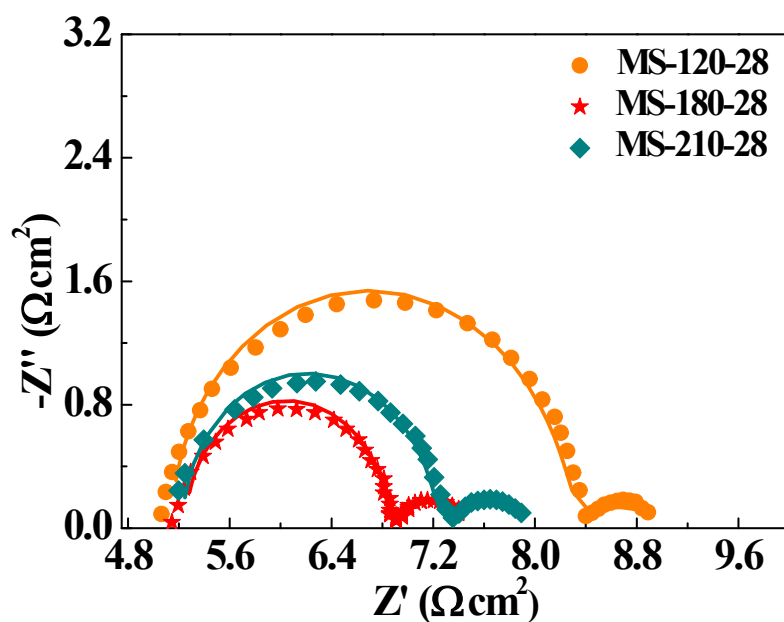
**Fig. S4** Cyclic voltammograms (CVs) of MoS<sub>2</sub> electrodes prepared at different hydrothermal reaction temperatures with fixed precursor molar ratio of 1:28.



**Fig. S5** A consecutive 100 cyclic voltammograms (CVs) for I<sub>3</sub><sup>-</sup>/I<sup>-</sup> redox system using MS-150-28 electrode at a scan rate of 100 mV s<sup>-1</sup>.



**Fig. S6** Tafel polarisation curves of MoS<sub>2</sub> electrodes prepared at different hydrothermal reaction temperatures with fixed precursor molar ratio of 1:28.



**Fig. S7** Nyquist plots of the dummy cells fabricated with two identical MoS<sub>2</sub> electrodes prepared at different hydrothermal reaction temperatures with fixed precursor molar ratio of 1:28. Symbols represent the experimental data and solid lines represent the model fitting.

## References

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