Supplementary Material (ESI) for Chemical Communications
This journal is (c) The Royal Society of Chemistry 2012

# $SnSe_2$ quantum dot sensitized solar cells prepared employing molecular metal chalcogenide as precursors

**Xuechao Yu, Jun Zhu,* Yaohong Zhang, Jian Weng, Linhua Hu and Songyuan Dai***
*Key Laboratory of Novel Thin Film Solar Cells, Institute of Plasma Physics, Chinese Academy of Sciences, P.O. Box 1126, Hefei, Anhui 230031, China. E-mail: zhujzhu@gmail.com, sydai@ipp.ac.cn; Fax: +86-551-5591377; Tel: +86-551-5591377*

## Experimental details

$(N_2H_4)_3(N_2H_5)_4Sn_2Se_6$ complex was synthesized using a literature method[1]. In detail, elemental tin (10 mmol) is dissolved in a mixture of 1M $Se/N_2H_4$ and $N_2H_4$ (10ml) and after stirring for 3h, a clear yellow solution of the complex is formed. Alternatively, it can be synthesized from $SnSe_2$ and Se by dissolving them in $N_2H_4$ solution. **Note that hydrazine is a highly toxic chemical and must be handled with great care.**

The colloidal $TiO_2$ nanoparticles were prepared by hydrolysis of titanium tetraisopropoxide as described elsewhere by our group[2] and were anatase phase. The $TiO_2$ paste was printed on transparent conducting glass sheets (TEC-8, LOF) by using a screen-printing technique, and sintered in air at 510 °C for 30 min to form a nanostructured $TiO_2$ electrode. The film thickness was about 10 μm, which was determined by a profilometer (XP-2, AMBIOS Technology Inc., USA).

The $TiO_2$ films were not rinsed after MCC adsorption, and dried with air. To prepare $SnSe_2$ sensitized photoanodes, the MCC deposited $TiO_2$ films were annealed at 250 °C under Ar atmosphere for 60 min, and then cooled to room temperature.

The electrolyte for the sensitized solar cells consists of anhydrous lithium iodide, iodine, 3-methoxypropionitrile (MePN) purchased from Fluka, and 1,2-dimethyl-3-propylimidazolium iodide (DMPII), methylbenzimidazole (MBI) obtained from Aldrich. The counter electrode was platinized by spraying $H_2PtCl_6$ solution to FTO glass and fired in air at 420 °C for 20 min. Then, it was placed directly on the top of the quantum dot-sensitized $TiO_2$ film. The gap between the two electrodes was sealed by thermal adhesive films (Surlyn, Dupont). The electrolyte was filled from a hole made on the counter electrode, which was later sealed by a cover glass and thermal adhesive films. The total active electrode area of the solar cells was 0.25 $cm^2$.

Thermogravimetric analysis data were acquired using Shimadzu DTG-60H/DSC-60 thermal analyzer at a heating rate of 10°C/min under slow nitrogen flow. Powder X-ray diffraction patterns were collected using a MXPAHF diffractometer with Cu $K_\alpha$ X-ray source operating at 40 kV and 40 mA and Vantec 2000 area detector. High Resolution Transmission Electron Microscopy imaging was carried out using JEM-2010 with a carbon-coated copper grid (Ted Pella).

Incident photon-to-electron conversion efficiency of $SnSe_2$ quantum dots sensitized solar cell was recorded under monochromatic irradiation by the use of a setup for the IPCE measurement (PEC-S2012, Peccell), which consisted of a 150 W Xe lamp and a monochromator (Instruments S. A. Triax 180). The photovoltaic performance, including short-circuit current ($J_{sc}$), open-circuit voltage ($V_{oc}$), fill factor ($FF$), and energy conversion efficiency ($\eta$) of the quantum dots sensitized solar cell

**Supplementary Material (ESI) for Chemical Communications**
**This journal is (c) The Royal Society of Chemistry 2012**

was measured with a Keithley model 2420 digital source meter controlled by test point software under a xenon lamp (Oriel, USA) with an AM 1.5 filter.

**Supplementary Material (ESI) for Chemical Communications**
**This journal is (c) The Royal Society of Chemistry 2012**

The amount of $SnSe_2$ on the $TiO_2$ photoanodes can be increased by repeating the MCC adsorption and annealing procedures for more times and the corresponding XRD patterns were shown in Figure S1.

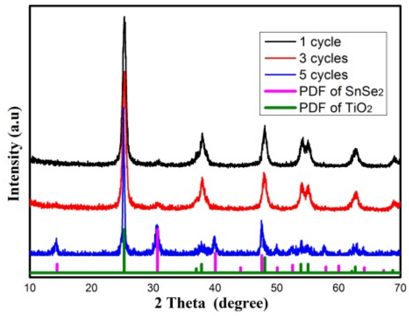


Figure S1. XRD of $SnSe_2$ sensitized $TiO_2$ powders with different deposition cycles

**Supplementary Material (ESI) for Chemical Communications**
**This journal is (c) The Royal Society of Chemistry 2012**

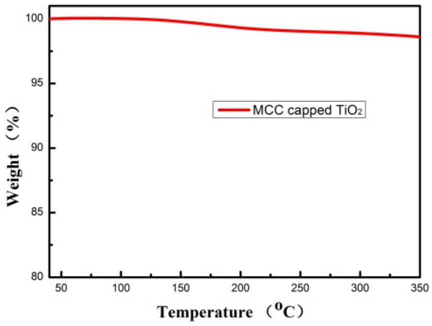


Figure S2. TG of $(N_2H_4)_3(N_2H_5)_4Sn_2Se_6$ complex capped $TiO_2$ film

**Supplementary Material (ESI) for Chemical Communications**
**This journal is (c) The Royal Society of Chemistry 2012**

Table S1 Photovoltaic data sets of $SnSe_2$ quantum dots sensitized $TiO_2$ solar cells with room temperature aging in dark

| | $J_{sc}$(mA cm$^{-2}$) | $V_{oc}$(V) | *FF* | $\eta$(%) |
|---|---|---|---|---|
| as prepared | 0.77 | 0.37 | 0.43 | 0.12 |
| 15 days aging | 0.67 | 0.33 | 0.39 | 0.089 |

## References

1. D. B. Mitzi, *Inorg.Chem.*, 2005, **44**, 3755-3761.
2. H. Tian, L. Hu, C. Zhang, W. Liu, Y. Huang, L. Mo, L. Guo, J. Sheng and S. Dai, *The Journal of Physical Chemistry C*, 2010, **114**, 1627-1632.