Electronic Supplementary Material (ESI) for Chemical Communications

Mesoporous SnO_2 agglomerates with hierarchical structures as an efficient dual-functional material for dye-sensitized solar cells

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Supporting Information (SI) 1

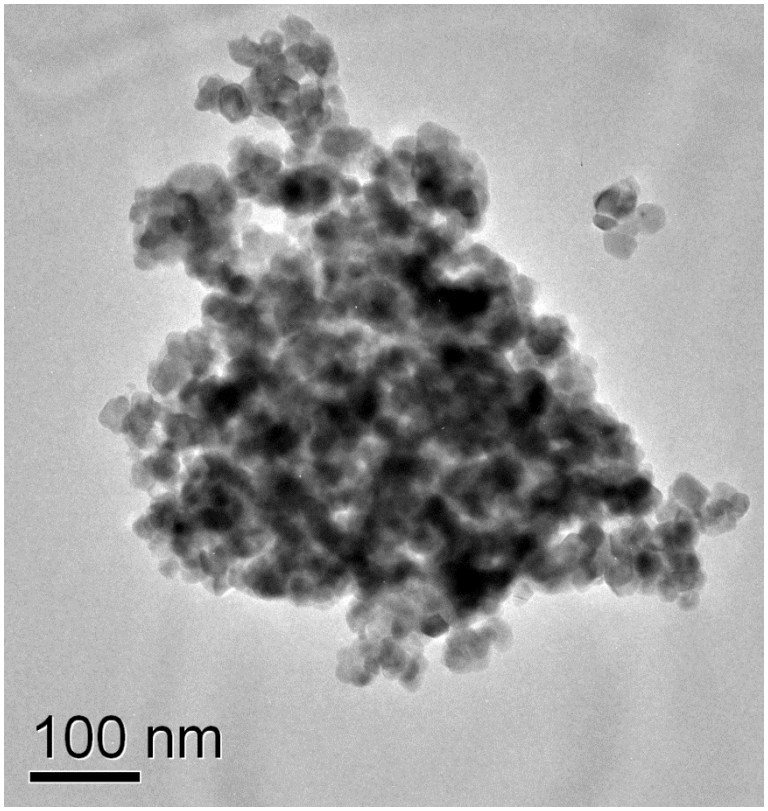
Experimental Details:

(a) Fabrication of SnO_2 by molten salt method: Tin oxide, (SnO_2) mesoporous aggregates were prepared by a Molten Salt Method (MSM) through reacting one mole Tin chloride Tetrahydrate ($SnCl_4 \cdot 4H_2O$, Merck, purity 99%) and 8.8 moles of Lithium Nitrate ($LiNO_3$, Alfa aesar) and 1.2 moles Lithium Chloride (LiCl, Merck) in a Alumina crucible. The mixture was heated in a box furnace (Carbolyte box furnace) at 280˚C for 2 hours in air and then washed with water to remove excess Li-salts. Finally, the powder was dried in vacuum oven.

(b) Fabrication of Dye-Sensitized Solar Cells: Dye-Sensitized Solar Cells (DSCs) were fabricated by a method of screen-printing. First, FTO plates were cleaned with actone, ethanol and water, respectively and treated with 50 mM $TiCl_4$ aqueous solution at 70 ^oC for 30 min. The as-obtained MSM SnO_2 aggregates and commercial SnO_2 nanoparticles were made into paste with ethyl cellulose and terpinol under certain ratio, and fabricated on FTO substrate FTO by screen-printing on an area of ~ 0.25 cm^2. The films were then heated at 450 ^oC in air for 30 min. The obtained electrodes were immersed into a 1:1 volume mixture of acetonitrile and tert-butanol solution of Ru dye ($(Bu_4N)_2[Ru(Hdcbpy)_2(NCS)_2]$ 0.3mM, N719, Solaronix) for 24h to get dye attached. The counter electrodes were prepared by spin-coating H_2PtCl_6 (50 mM in isopropyl alcohol) on the FTO substrates with following sintering process at 390 °C in air for 30 min. Acetonitrile containing 0.1 M lithium iodide, 0.03 M iodine, 0.5 M 4-tert-butylpyridine, and 0.6 M 1-propyl 2,3- dimethyl imidazolium iodide was used as the electrolyte.

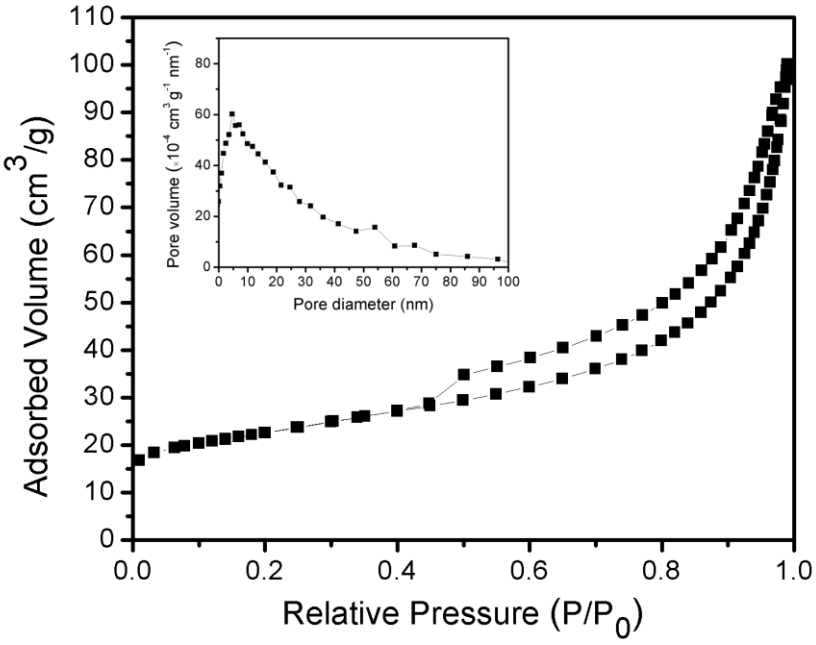
(C) Characterization: The as-prepared MSM SnO_2 aggregates were characterized by scanning electron microscopy (SEM, JEOL JSM-6701F microscope operated at 10 kV), high-resolution transmission electron microscopy (HRTEM, JEOL 3010 operated at 300 kV), BET surface area (NOVA 4200E Surface Area and Pore Size Analyzer, Quantachrome, USA), powder X-ray diffraction (XRD, Bruker-AXS D8 ADVANCE). And the UV-Vis diffuse reflectance spectra of electrodes were measured with UV-visible spectroscopy (Schimadzu UV-3600 UV-VIS-NIR spectrophotometer). Photocurrent measurements were carried out using a XES-151 S solar simulator (San-Ei, Japan) under AM1.5 G condition.

Supporting Information (SI) 2



TEM image of commercial SnO_2 nanoparticles

Supporting Information 3



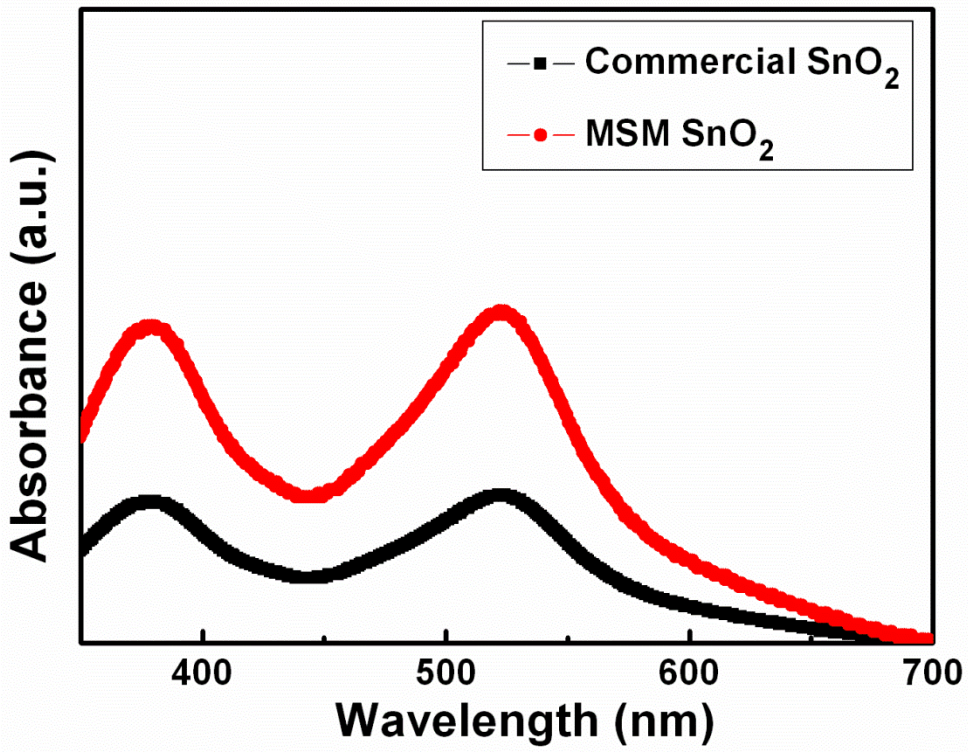
Nitrogen sorption isotherms and pore size distribution of MSM SnO_2 agglomerates

Supporting Information 4

Electrodes	Thickness of the electrode	J_{sc} (mA/cm^2)	V_{oc} (V)	FF(%)	η (%)
MSM SnO_2	6 µm	7.55±0.1	0.562±0.01	57±0.5	2.41±0.1
MSM SnO_2	8 µm	9.53±0.1	0.562±0.01	57±0.5	3.05 ±0.1
MSM SnO_2	10 µm	8.22±0.1	0.505±0.015	51±0.5	2.12±0.1
Commercial SnO_2	8 µm	5.23±0.1	0.55±0.015	56±0.5	1.61±0.1
MSM SnO_2+$TiCl_4$	8 µm	13.18±0.1	0.723±0.005	65±0.5	6.23±0.1

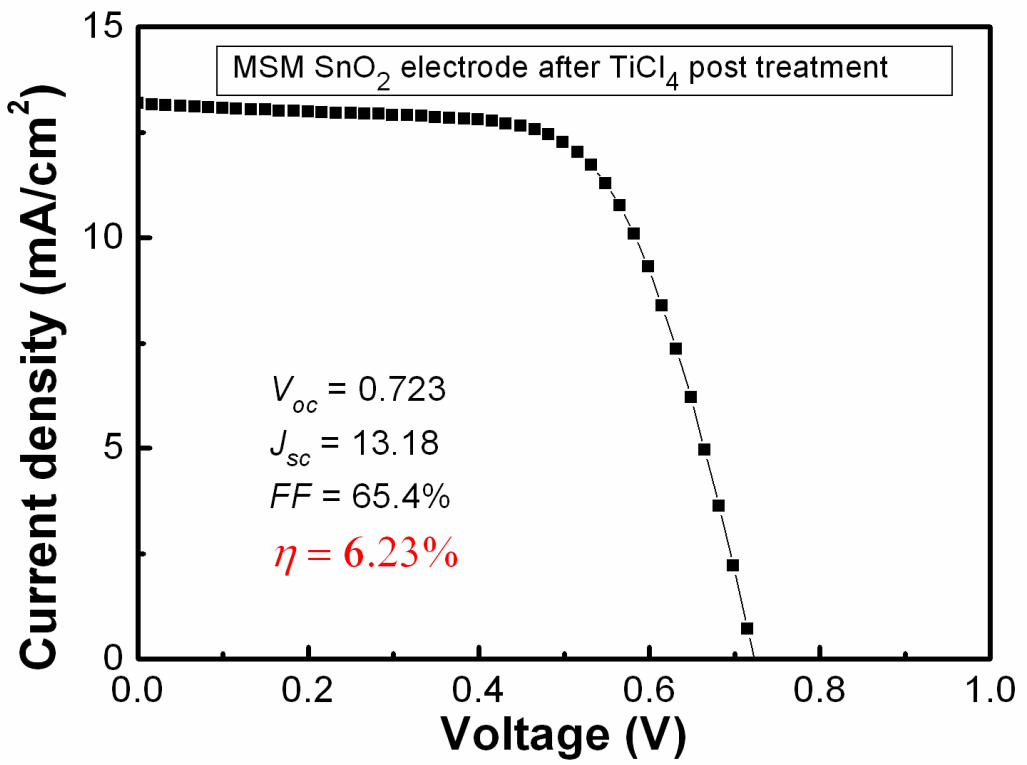
I-V parameters of solar cells with different electrodes

Supporting Information 5



UV-vis spectra of dye solutions detached from and SnO_2 electrodes

Supporting Information 6



I-V curve of the MSM SnO_2 electrode after the $TiCl_4$ post treatment