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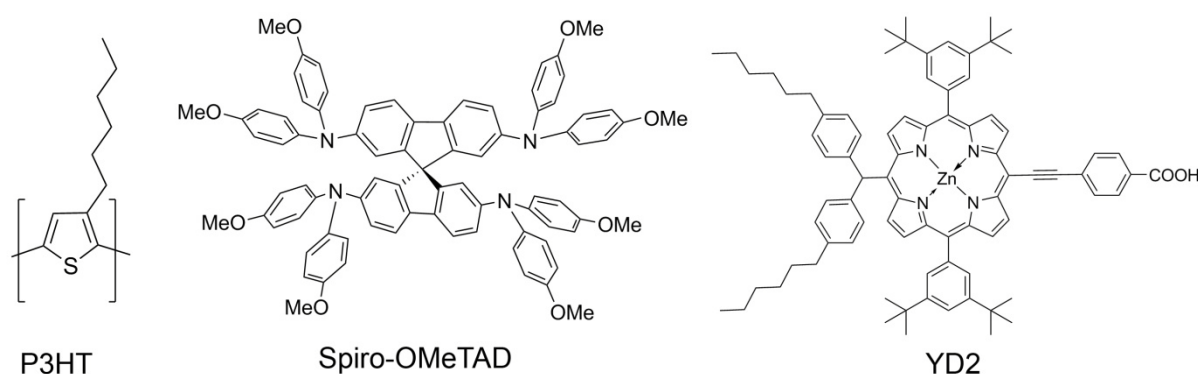
Enhanced light harvesting in mesoporous TiO<sub>2</sub>/P3HT hybrid solar cells using a porphyrin dye

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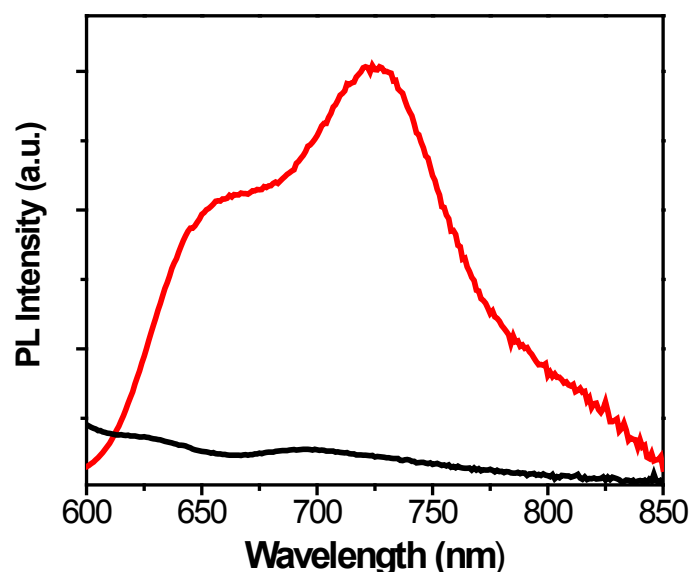
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**Fig. S1.** The molecular structures of the P3HT, Spiro-OMeTAD and YD2 are shown.

**Table S1.** Photovoltaic performance of YD2 sensitized cells with Spiro-OMeTAD and P3HT. Measured under AM1.5 conditions, 100 mW/cm<sup>2</sup>. (0.20 cm<sup>2</sup> of masked active area)

Device	$J_{sc}$ (mA/cm <sup>2</sup> )	$V_{oc}$ (mV)	<i>F.F.</i>	$\eta$ (%)
TiO <sub>2</sub> /P3HT	2.12	425	0.53	0.49
TiO <sub>2</sub> /YD2/P3HT	12.1	510	0.50	3.13
TiO <sub>2</sub> /YD2/P3HT (duplicate)	10.62	534	0.53	3.03
TiO <sub>2</sub> /YD2/Spiro-OMeTAD	2.56	827	0.77	1.64



**Fig. S2.** Photoluminescence spectra of the pristine P3HT film (red) and P3HT/YD2 mixture (black).

#### Device fabrication details:

The fabrication of our hybrid solar cells employed a F-doped SnO<sub>2</sub> glass substrate (15Ω/□, Pilkington) onto which a ~100 nm compact TiO<sub>2</sub> layer was deposited by spray pyrolysis.<sup>1</sup> Since P3HT is known to have difficulties infiltrating the 20 nm pores traditionally used in TiO<sub>2</sub>-based solar cells,<sup>2</sup> we prepared our mesoporous TiO<sub>2</sub> layer with larger particles and larger pores. A layer about 1 μm thick with 75 nm TiO<sub>2</sub> particles was coated onto the FTO/compact TiO<sub>2</sub> substrate using the spin coater. The 75 nm powder was received from Showa Titanium Co., and the TiO<sub>2</sub> paste was prepared using a previously reported procedure.<sup>3</sup> The electrode was then annealed at 500 °C for 30 min under oxygen flow, followed by treatment with a 0.02 M TiCl<sub>4</sub> aqueous solution for 6 hours at room temperature. It was re-annealed at 450 °C in air for 30 min and cooled before immersing it into a YD2 dye solution (0.2 mM in ethanol with 0.4 mM chenodeoxycholic acid to prevent aggregation<sup>4</sup>) for 18 hours. The dye coated TiO<sub>2</sub> electrodes were spin-coated at 250 rpm for 500 sec with a regioregular-P3HT solution (Reike Metals Co. 30 mg/ml in chlorobenzene). A poly(3,4-ethylenedioxythiophene):poly(styrenesulfonate) (PEDOT:PSS) solution (2.8 wt% dispersion in water, Baytron P) diluted with two volumes of MeOH was spin-coated onto the TiO<sub>2</sub>/YD2/P3HT films at 2000 rpm for 30 sec. As a counter electrode, Au was deposited on top of the samples using thermal resistance evaporation to define an active device area of 0.20 cm<sup>2</sup>. To compare the TiO<sub>2</sub>/YD2/P3HT based devices to devices without the benefit of the panchromatic light absorption, two types of control devices were prepared. First TiO<sub>2</sub>/P3HT devices were prepared as above, but without the YD2 dye. Also, a YD2 sensitized TiO<sub>2</sub> device with the transparent HTM, Spiro-OMeTAD, was assembled under optimized conditions as previously described.<sup>5</sup> In this case the mesoporous TiO<sub>2</sub> layer had a thickness of 2 μm

with 20 nm particles as this morphology has been found to give the highest performance in Spiro-OMeTAD based devices.

Additional experimental details:

*Device characterization:* The incident photon-to-current conversion efficiency (IPCE) was created by using the incident light from a 300 W xenon lamp (ILC Technology, U.S.A.), which had been focused through a Gemini-180 double monochromator (Jobin Yvon Ltd.). The irradiation source employed for the *J-V* measurements was a filtered (Schott 113) 450 W xenon light source (Osram XBO 450, USA) whose power was adjusted using a reference Si photodiode equipped with a color-matched filter (KG-3, Schott), thus reducing the spectral mismatch between the simulated light and AM 1.5G irradiation in the region of 350–750 nm to less than 4%.

*PL Measurements:* To probe efficient electron transfer from P3HT to YD2, photoluminescence (PL) measurements were performed using a time-correlated single photon counting (TCSPC) system from PicoQuant. Films were excited with a pulsed laser diode, (model LDH 485: 481nm, 70ps FWHM, 5MHz) detected with a single photon avalanche diode (PDM 100CT SPAD) attached to a monochromator and processed by a PicoHarp 300 correlating system. For the PL measurements we deposited the pristine P3HT and the P3HT/YD2 (P3HT:YD2=20:1 concentration ratio) in an inert poly(methyl methacrylate) (PMMA) matrix on a glass substrate using a spin coater.

References:

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