### Electronic Supporting information (ESI)

# Asymmetrical Squaraines for High-Performance Small-Molecule Organic Solar Cells with Short Circuit Current of over 12 mA cm<sup>-2</sup>

Yao Chen,<sup>\*</sup><sup>a</sup> Youqin Zhu,<sup>\*</sup><sup>b</sup> Daobin Yang,<sup>a</sup> Qian Luo,<sup>a</sup> Lin Yang,<sup>a</sup> Yan Huang,<sup>\*</sup><sup>a</sup> Suling Zhao<sup>\*<sup>b</sup></sup> and Zhiyun Lu<sup>\*a</sup>

<sup>a</sup>Key Laboratory of Green Chemistry and Technology (Ministry of Education), College of Chemistry, Sichuan University, Chengdu 610064, P. R. China. E-mail: huangyan@scu.edu.cn; luzhiyun@scu. edu.cn;
<sup>b</sup>Key Laboratory of Luminescence and Optical Information (Ministry of Education), Institute of Optoelectronics Technology, Beijing Jiaotong University, Beijing 100044, P. R. China. E-mail: slzhao@bjtu.edu.cn
<sup>‡</sup> The first two authors contributed equally to this work

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### **Experimental details**

Instruments and characterization: <sup>1</sup>H NMR and <sup>13</sup>C NMR were recorded on a Bruker Avance AV II-400 MHz spectrometer and the chemical shifts were recorded in units of ppm with TMS as the internal standard. High resolution MS spectra were recorded on a Shimadzu LCMS-IT-TOF instrument. UV-Vis absorption spectra were measured by a Perkin Elmer Lamdba 950 UV-Vis scanning spectrophotometer. For solution samples, the concentration is 2.00  $\times 10^{-6}$  mol L<sup>-1</sup> (in chloroform); for thin solid film samples, they were obtained by spin-coating from chloroform solution (5 mg mL<sup>-1</sup>, 1500 rpm/ 30 s) on quartz substrates. Cyclic voltammetry (CV) measurements were carried out in 5.0  $\times$  10<sup>-4</sup> mol L<sup>-1</sup> anhydrous CH<sub>2</sub>Cl<sub>2</sub> with tetrabutylammonium perchlorate as the supporting electrolyte under an Argon atmosphere at a scan rate of 50 mV s<sup>-1</sup> using a LK 2010 electrochemical workstation. The CV system was constructed using a Pt disk working electrode, a Pt wire counter electrode, and an Ag/AgNO<sub>3</sub> (0.1 mol L<sup>-1</sup> in acetonitrile) reference electrode. The potential of the Ag/AgNO<sub>3</sub> reference electrode was internally calibrated using the ferrocene/ferrocenium redox couple (Fc/ Fc<sup>+</sup>), which has a known reduction potential of -4.80 eV relative to the vacuum level.<sup>1</sup> The morphologies of the blend film were analyzed through atomic force microscopy (AFM) in tapping mode under ambient conditions (MFP 3D Asylum Research instrument).

*Device Preparation:* Small-molecule bulk-heterojunction photovoltaic devices were fabricated using indium-tin-oxide (ITO) coated glass as the substrate (sheet resistance

=15  $\Omega/sq$ ). Before device fabrication, the substrates were cleaned and ultrasonicated in detergent, deionized water, acetone and ethanol for 10 min in sequence, and finally blow-dried by high purity nitrogen. The substrates were treated by UV-ozone for 5 min, then immediately transferred into a high vacuum chamber for deposition of 80 Å  $MoO_3$  at a pressure of less than 3  $\,\times\,10^{-4}$  Pa with a deposition rate of 0.5 Å s^-1. Subsequently, photoactive layers were fabricated by spin-coating a blend of the target molecules and  $PC_{71}BM$  in chloroform with total concentration of 20 mg mL<sup>-1</sup> (1500 rpm, 30 s) in a N<sub>2</sub>-filling glove box at 25  $\,$ °C. Then the substrates were loaded into a vacuum chamber to finish the deposition of LiF (8 Å) and Al (1000 Å) at pressure of less than 3  $\times 10^{-4}$  Pa with a rate of 0.05 Å s<sup>-1</sup> and 1.5 Å s<sup>-1</sup>, respectively. Deposition rate and film thickness were in situ monitored using a quartz crystal oscillator mounted on the substrate holder. The active area of the OPV cells is 6 mm<sup>2</sup>. The current-voltage curves under illumination were measured using an Abet solar simulator with a Keithley 4200 source measurement unit under AM 1.5G illumination (100 mW/cm<sup>2</sup>, after spectral mismatch correction under an ambient atmosphere at 25  $^{\circ}$ C). The average data related to device performance was obtained from several batches of devices (8 cells per batch). The external quantum efficiency (EQE) of the solar cell was obtained using a QE/IPCE Measurements Solar Cell Scan 100 (ZOLIX) system in air.

### Synthesis

Compound 1, 2 and 3 were prepared according to the procedures described in the

literatures.<sup>2-4</sup> n-Butanol and toluene were distilled freshly from sodium prior to use. All the other chemicals were obtained from commercial sources and used as-received without further purification.



Scheme S1. Synthetic routes to compounds Py-1, Py-2 and Py-3.

## **3-Chloro-4-(1-(hex-5-en-1-yl)-5-diphenylhydrazone-1***H***-pyrrol-2-yl)cyclobut-3-en e-1,2-dione** (4)<sup>5</sup>: To a solution of compound **3** (0.60 g, 1.83 mmol) in dry Et<sub>2</sub>O (25

re-1,2-dione (4) : 16 a solution of compound 3 (0.60 g, 1.83 minor) in dry Et<sub>2</sub>O (25 mL) was added squaryl chloride (0.28 g, 1.87 mmol). After being stirred at r.t. for 1 h, the color of the reactants turned from colorless to deep yellow, and red precipitate could be observed. The solvent was removed under vacuum, and the residue was purified by column chromatography (silica gel, CH<sub>2</sub>Cl<sub>2</sub>) to afford a deep red viscous oil (0.76 g, 93%). <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>, ppm)  $\delta$ :7.52 (d, 1H, *J* = 4.0 Hz, ArH), 7.49-7.45 (m, 4H, ArH), 7.27 (t, 2H, *J* = 8.0 Hz, ArH), 7.19 (d, 4H, *J* = 8.0 Hz, ArH), 7.08 (s, 1H, -CH=), 6.75 (d, 1H, *J* = 4.0 Hz, ArH), 5.78-5.68 (m, 1H, -CH=),

4.98-4.93 (m, 2H, =CH<sub>2</sub>), 4.63 (t, 2H, *J* = 8.0 Hz, -CH<sub>2</sub>-), 2.05-1.97 (m, 2H, -CH<sub>2</sub>-), 1.69-1.60 (m, 2H, -CH<sub>2</sub>-), 1.43-1.35 (m, 2H, -CH<sub>2</sub>-).

## $\label{eq:2.1} \textbf{3-Hydroxy-4-(1-(hex-5-en-1-yl)-5-diphenylhydrazone-1\textit{H-pyrrol-2-yl})cyclobut-3-pyrrol-2-yl)cyclobut-3-pyrrol-3-py$

ene-1,2-dione (5)<sup>5</sup>: Compound 4 (0.70 g, 1.58 mmol) was dissolved in 20 ml of acetone, then 3 mL of triethylamine was added. After stirring at room temperature for 4 h, 50 mL H<sub>2</sub>O was added to quench the reaction. The yellow solution was filtered, then 2 M aqueous hydrochloric acid was added dropwise to adjust the pH = 2. The aqueous phase was extracted with CH<sub>2</sub>Cl<sub>2</sub> (50 mL × 3), then the solvent was removed under vacuum, and the residue was purified by column chromatography (silica gel, CH<sub>2</sub>Cl<sub>2</sub>) to afford deep red viscous oil (0.56 g, 75%). <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>, ppm)  $\delta$ :7.53 (d, 1H, *J* = 4.0 Hz, ArH), 7.48 (t, 4H, *J*=8.0 Hz, ArH), 7.25-7.13 (m, 6H, ArH), 7.08 (s, 1H, -CH=), 6.97 (d, 1H, *J* = 4.0 Hz, ArH), 6.78-5.68 (m, 1H, =CH-), 5.00-4.83 (m, 2H, -CH<sub>2</sub>-), 4.57-4.48 (m, 2H, -CH<sub>2</sub>-), 2.01-1.97 (m, 2H, -CH<sub>2</sub>-), 1.69-1.61 (m, 2H, -CH<sub>2</sub>-), 1.43-1.23 (m, 2H, -CH<sub>2</sub>-).

**7,8,9,10-Tetrahydrobenzo**[*e*]**cyclopenta**[*b*]**indole** (6): To a mixture of  $\beta$ -naphthylhydrazine (4.50 g, 28.5 mmol) and cyclopentanone (3.59 g, 42.7 mmol) in alcohol (80 mL) was added dropwise 3 M sulfuric acid (20 mL). Then the resulting reaction mixture was stirred and reflux for 4 h. After being cooled to room temperature, the mixture was decanted into to ice water (100 mL), and the aqueous phase was extracted with CH<sub>2</sub>Cl<sub>2</sub> (50 mL × 3). The organic phase was dried over anhydrous sodium sulfate, then the solvent was removed under vacuum, and the residue was purified by column chromatography (silica gel, hexane/CH<sub>2</sub>Cl<sub>2</sub>= 4:1, v/v)

to give brown solid (2.2 g, 37%). <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>, ppm) δ: 8.18 (d, 2H, J = 8.0 Hz, ArH), 8.16 (br, 1H, -NH-), 7.88 (d, 1H, J = 8.0 Hz, ArH), 7.52-7.45 (m, 3H, ArH), 7.40-7.36 (m, 1H), 3.21 (t, 2H, J = 8.0 Hz, -CH<sub>2</sub>-), 2.95 (t, 2H, J = 8.0 Hz, -CH<sub>2</sub>-), 2.71 (m, 2H, -CH<sub>2</sub>-).

**7,7a,8,9,10,10a-Hexahydrobenzo**[*e*]**cyclopenta**[*b*]**indole** (**7**): To an acetic acid suspension (35 mL) of **6** (2.20 g, 10.6 mmol) was added dropwise NaBH<sub>3</sub>CN (1.34 g, 21.20 mmol), and the reaction temperature was controlled to be below 35 °C. After the addition, the mixture was stirred at room temperature for 24 h, then 50 mL water was added. The product was extracted with CH<sub>2</sub>Cl<sub>2</sub>, and the organic phase was dried over anhydrous MgSO<sub>4</sub>, followed by the removal of solvents under vacuum. The crude product was purified by silica gel column chromatography (hexane/CH<sub>2</sub>Cl<sub>2</sub> = 1:1, v/v) to afford gray viscous oil (1.46 g, 66%). <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>, ppm)  $\delta$ :7.74 (d, 1H, *J* = 8.0 Hz, ArH), 7.65 (d, 1H, *J* = 8.0 Hz, ArH), 7.58 (d, 1H, *J* = 8.0 Hz, ArH), 4.59-4.55 (m, 1H, -CH-), 4.19-4.13 (m, 1H, -CH-), 3.46 (br, 1H, -NH-), 2.18-1.59 (m, 6H, -CH<sub>2</sub>-).

*N*-(3,5-Dimethoxyphenyl)-hexahydrobenzo[*e*]cyclopenta[*b*]indole (8): 7 (1.43 g, 6.84 mmol), 1-bromo-3,5-dimethoxybenzene (1.56 g, 7.18 mmol), NaOBu-*t*[sodium *t*-butoxide] (1.31 g, 13.68 mmol), Pd(OAc)<sub>2</sub>[palladium(II) acetate] (23.1 mg, 1.5%), and P(*t*-Bu)<sub>3</sub>HBF<sub>4</sub> [tri-*t*-butylphosphine tetrafluoroborate] (79.3 mg, 4%) were dissolved in 30 mL of toluene and refluxed under Ar for 10 h. The reaction mixture was cooled down, then filtered. The solvent in the filtrate was removed under reduced

pressure to afford the crude product, which was further purified by column chromatography (silica gel, hexane/ethyl acetate = 15:1, v/v) to yield compound **8** as a colorless oil (2.15 g, 91%). <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>, ppm)  $\delta$ : 7.75 (d, 1H, J = 8.0 Hz, ArH), 7.69 (d, 1H, J = 8.0 Hz, ArH), 7.62 (d, 1H, J = 8.0 Hz, ArH), 7.45-7.39 (m, 2H, ArH), 7.24-7.22 (m, 1H, ArH), 6.52 (s, 2H, ArH), 6.18 (s, 1H, ArH), 4.90-4.86 (m, 1H, -CH-), 4.25-4.20 (m, 1H, -CH-), 3.80 (s, 6H, -OCH<sub>3</sub>), 2.08-1.50 (m, 6H, -CH<sub>2</sub>-).

#### 5-*N*-5-(8,9,10,10a-tetrahydrobenzo[*e*]cyclopenta[*b*]indol-1,3-dihydroxybenzene

(9): To a solution of compound **8** (2.15 g, 6.23 mmol) dissolved in 90 mL of anhydrous CH<sub>2</sub>Cl<sub>2</sub> was added dropwise into boron tribromide (63 mL of 1 M solution in CH<sub>2</sub>Cl<sub>2</sub>, 62.3 mmol) in an ice bath. After the addition was finished, the mixture was stirred at room temperature for 24 h, then decanted to 100 mL of ice water to remove any excess of BBr<sub>3</sub>. The organic phase was separated, and the aqueous phase was extracted with CH<sub>2</sub>Cl<sub>2</sub> (50 mL × 3). The combined organic phase was washed with saturation aqueous NaHCO<sub>3</sub> solution and water in sequence, then dried over anhydrous Na<sub>2</sub>SO<sub>4</sub>. After removal of the solvent under vacuum, a viscous compound **9** (1.50 g, 76%) was obtained. <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>, ppm)  $\delta$ :7.68 (d, 1H, *J*=8.0 Hz, ArH), 7.62 (d, 1H, *J* = 8.0 Hz, ArH), 7.51 (d, 1H, *J* = 8.0 Hz, ArH), 7.42-7.35 (m, 2H, ArH), 7.20 (t, 1H, *J* = 8.0 Hz, ArH), 6.42 (s, 2H, ArH), 6.10 (s, 1H, ArH), 4.69 (br, 1H, -CH-), 4.06 (br, 1H, -CH-), 2.25-2.12 (m, 2H, -CH<sub>2</sub>-), 1.89-1.77 (m, 2H, -CH<sub>2</sub>-), 1.57-1.46 (m, 2H, -CH<sub>2</sub>-).

### 2-(2,6-Dihydroxy-4-(indolin-1-yl)phenyl)-4-(5-((2,2-diphenylhydrazono)methyl)-1

-(hex-5-en-1-yl)-2H-pyrrol-1-ium-2-ylidene)-3-oxocyclobut-1-en-1-olate (Py-1): A mixture of compound 5 (0.35 g, 0.59 mmol) and 1 (0.19 g, 0.57 mmol) in *n*-butanol (10 mL) and toluene (10 mL) was refluxed for 2 h (equipped with a Dean-Stark apparatus). Then the reactant mixture was cooled down, followed by the removal of the solvents under reduced pressure. The crude product was purified by column chromatography (silica gel, hexane/ $CH_2Cl_2 = 1:5$ , v/v) to afford a brown solid. The solid was recrystallized from a mixture of CH<sub>2</sub>Cl<sub>2</sub> and methanol (1:4, v/v) to afford **Py-1** with yellow metallic lustr (0.18 g, 35%). M.p. 232-234 °C. <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>, ppm)  $\delta$ : 7.60-7.59 (d, 1H, J = 4.4 Hz, ArH), 7.49-7.44 (m, 5H, ArH), 7.30-7.18 (m, 8H, ArH), 7.06 (s, 1H, -CH=), 6.99-6.96 (t, 1H, J = 7.6 Hz, ArH), 6.79 (d, 1H, J = 4.4Hz, ArH), 6.26 (s, 2H, ArH), 5.75-5.73 (m, 1H, -CH=), 4.99-4.93 (m, 2H, =CH<sub>2</sub>), 4.67 (t, 2H, J = 7.2 Hz, -CH<sub>2</sub>-), 4.09 (t, 2H, J = 8.0 Hz, -CH<sub>2</sub>-), 3.16 (t, 2H, J = 8.0 Hz, -CH<sub>2</sub>-), 2.01-1.99 (m, 2H, -CH<sub>2</sub>-), 1.71-1.79(m, 2H, -CH<sub>2</sub>-), 1.42-1.39(m, 2H, -CH<sub>2</sub>-). <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>, ppm) δ:173.5, 164.2, 155.2, 154.7, 143.3, 143.1, 142.3, 138.3, 133.8, 130.1, 129.3, 127.6, 125.9, 125.5, 124.9, 124.0, 123.1, 122.5, 117.0, 114.8, 114.3, 107.6, 96.5, 52.3, 47.4, 33.4, 31.4, 28.0, 25.6 HR-MS (ESI): m/z [M+H]<sup>+</sup> calcd for C<sub>41</sub>H<sub>37</sub>N<sub>4</sub>O<sub>4</sub> 649.2809; found, 649.2803.

2-(2,6-Dihydroxy-4-(1,3,3a,8b-tetrahydrocyclopenta[b]indol-4(2H)-yl)phenyl)-4-(
5-((2,2-diphenylhydrazono)methyl)-1-(hex-5-en-1-yl)-2H-pyrrol-1-ium-2-ylidene)
-3-oxocyclobut-1-enolate (Py-2): Py-2 was synthesized with the similar procedure of
Py-1, using compounds 5 (0.30 g, 0.70 mmol) and 2 (0.19 g, 0.71 mmol) as reactants.
Py-2 is a yellow crystal with metallic lustre (0.13 g, 27%), m.p.251-252 °C. <sup>1</sup>H NMR

(400 MHz, CDCl<sub>3</sub>, ppm)  $\delta$ :12.51 (s, 2H, -OH), 7.59 (d, 1H, *J* = 4.0 Hz, ArH), 7.47 (t, 4H, *J* = 5.2 Hz, ArH), 7.40 (d, 1H, *J* = 8.0 Hz, ArH), 7.28 (t, 3H, *J* = 4.0 Hz, ArH), 7.19 (d, 5H, *J* = 8.0 Hz, ArH), 7.06 (s, 1H, -CH=), 7.01 (t, 1H, *J* = 8.0 Hz, ArH), 6.78 (d, 1H, *J* = 4.0 Hz, ArH), 6.32 (s, 2H, ArH), 5.79-5.69 (m, 1H, -CH=), 4.96(t, 2H, *J* = 7.2 Hz, =CH<sub>2</sub>), 4.68 (t, 3H, *J* = 8.0 Hz, -CH<sub>2</sub>-), 3.92 (t, 1H, *J* = 8.0 Hz, -CH-), 2.06-1.94 (m, 6H, -CH<sub>2</sub>-), 1.72 (m, 3H, -CH<sub>2</sub>-), 1.43-1.39 (m, 3H, -CH<sub>2</sub>-). <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>, ppm)  $\delta$ :173.4, 164.1, 155.0, 154.6, 143.2, 142.9, 142.4, 138.4, 137.5, 130.1, 129.3, 127. 6, 125.8, 125.0, 124.8, 123.8, 123.6, 122.5, 116.9, 114.8, 114.7, 107.7, 96.8, 68.9, 47.4, 45.6, 34.6, 33.5, 33.4, 31.4, 25.6, 24.3. HR-MS (ESI): m/z [M+H]<sup>+</sup> calcd for C<sub>44</sub>H<sub>41</sub>N<sub>4</sub>O<sub>4</sub> 689.3122; found, 689.3093.

2-(2,6-Dihydroxy-4-(8,9,10,10a-tetrahydrobenzo[*e*]cyclopenta[b]indol-7(7a*H*)-yl) phenyl)-4-(5-((2,2-diphenylhydrazono)methyl)-1-(hex-5-en-1-yl)-2*H*-pyrrol-1-iu m-2-ylidene)-3-oxocyclobut-1-enolate (Py-3): Py-3 was synthesized with the similar procedure of Py-1, using compounds 5 (0.30 g, 0.70 mmol) and 9 (0.23 g, 0.73 mmol) as reactants. Py-3 is a yellow crystal with metallic lustre (0.13 g, 25%), m.p. 243-244 °C. <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>, ppm)  $\delta$ :12.52 (s, 2H, -OH), 7.82 (d, 1H, *J* = 8.0 Hz, ArH), 7.77-7.71 (m, 2H, ArH), 7.66 (d, 1H, *J* = 8.0 Hz, ArH), 7.58 (d, 1H, *J* = 4.0 Hz, ArH), 7.50-7.44 (m, 5H, ArH), 7.36 (t, 1H, *J* = 6.0 Hz, ArH), 7.28 (t, 2H, *J* = 8.0 Hz, ArH), 7.19 (d, 4H, *J* = 8.0 Hz, ArH), 7.06 (s, 1H, -CH=), 6.78 (d, 1H, *J* = 4.0 Hz, ArH), 6.36 (s, 2H, ArH), 5.80-5.69 (m, 1H, -CH<sub>2</sub>=), 4.99-4.86(m, 3H, -CH<sub>2</sub>-), 4.66 (t, 2H, *J* = 8.0 Hz, -CH<sub>2</sub>-), 4.32-4.26 (m, 1H, -CH-), 2.32-2.20 (m, 2H, -CH<sub>2</sub>-), 2.05-1.98 (m, 4H, -CH-), 1.76-1.66 (m, 3H, -CH<sub>2</sub>-), 1.43-1.39 (m, 3H, -CH<sub>2</sub>-). <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>, ppm) δ:173.2, 163.9, 154.8, 154.3, 142.8, 142.4, 140.3, 138.4, 130.8, 130.5, 130.2, 130.1, 129.3, 128.8, 128.6, 126.8, 125.8, 125.0, 124.4, 123.8, 123.2, 122.5, 116.9, 115.7, 114.8, 107.9, 97.1, 69.7, 47.33, 44.7, 35.2, 33.4, 33.4, 31.4, 25.6, 24.8. HR-MS (ESI): *m*/*z* [M+H]<sup>+</sup> calcd for C<sub>48</sub>H<sub>43</sub>N<sub>4</sub>O<sub>4</sub> 739.3279; found, 739.3273.



Fig. S1 Cyclic voltammogram of the objective compounds ( $5.0 \times 10^{-4} \text{ mol } L^{-1} \text{ in } CH_2Cl_2 \text{ solution}$ ).



**Fig. S2**. Current density-voltage characteristics of hole-only single-carrier devices using neat ASQs or ASQ:PC<sub>71</sub>BM=1:5 blending films as active layer (device structure: ITO/MoO<sub>3</sub> (8 nm)/ASQ:PC<sub>71</sub>BM (80 nm)/Au(100 nm).



**Fig. S3** 3D AFM images (5  $\times$  5 µm, tapping-mode) of (a) **Py-2**:PC<sub>71</sub>BM (1:5) composite film (RMS calculated to be 0.25 nm); and (b) **Py-3**:PC<sub>71</sub>BM (1: 5) composite film (RMS calculated to be 0.23 nm).

## **Renferences:**

- J. Pommerehne, H. Vestweber, W. Guss, R. F. Mahrt, H. B ässler, M. Porsch and J. Daub, *Adv. Mater.*, 1995, 7, 551.
- D. Yang, Q. Yang, L. Yang, Q. Luo, Y. Chen, Y. Zhu, Y. Huang, Z. Lu and S. Zhao, *Chem. Commun.*, 2014, **50**, 9346.
- 3 L. Yang, Q. Yang, D. Yang, Q. Luo, Y. Zhu, Y. Huang, S. Zhao and Z. Lu, J. Mater. Chem. A, 2014, 2, 18313.
- D. Bagnis, L. Beverina, H. Huang, F. Silvestri, Y. Yao, H. Yan, G. A. Pagani, T. J.
  Marks and A. Facchetti, *J. Am. Chem. Soc.*, 2010, **132**, 4073.
- 5 L. Beverina, R. Ruffo, G. Patriarca, F. De Angelis,; D. Roberto, S. Righetto R.
  Ugo and G. A. Pagani, *J. Mater. Chem.*, 2009, 19, 8190.