Supporting information for Nanoscale

**Efficient p-Type Dye-Sensitized Solar Cells based on Disulfide/Thiolate Electrolytes**

*Xiaobao Xu, a, ‡Bingyan Zhang, a, ‡Jin Cui, a Dehua Xiong, a Yan Shen, *a Wei Chen, *a Licheng Sun, b,c Yibing Cheng a,d and Mingkui Wang *a*

**Experimental section**

*Counter electrode preparation:* The PEDOT counter electrode was obtained by electrochemical deposition on FTO glass (3 mm thickness, 7 Ω/square, Nippon Sheet Glass) with 0.1 M EDOT in acetonitrile solution with 0.1 M LiTFSI (lithium bis(trifluoro- methanesulfonyl)amide) as supporting electrolyte. A large area Pt foil was used as counter electrode and Ag/AgCl (3M in KCl) was used as reference electrode. The electrochemical deposition was achieved by multi-potential steps (first step, 0.8V for 20s, second step, 1.05 V for 60s).

The CoS loaded ITO/glass electrodes were prepared by using a one-step electrochemical deposition method. [1] The deposition bath was an alkaline (pH=10) aqueous solution (40 ml) containing 5 mM cobalt (II) chloride hexahydrate, CoCl$_2$·6H$_2$O (Sigma-Aldrich, 98%) and 150 mM thiourea, CH$_4$N$_2$S (Sigma-Aldrich). The depositions were performed at room temperature (22 °C) in a one-compartment glass cell using a three-electrode configuration. The substrate was a 4 cm$^2$ flexible ITO/glass film previously cleaned with acetone. A 1.5 cm$^2$ Pt foil served as the counter electrode and an Ag/AgCl in 3M KCl as reference electrode. The deposition potential was kept at -0.8 V vs. Ag/AgCl with a width of 5 s.
Figure S1. Optimization of electrolyte concentration and the solvent used in experiment.

Table S1 Photovoltaic parameters of various devices under AM 1.5G illumination.

<table>
<thead>
<tr>
<th>Thickness [μm]</th>
<th>Counter electrode</th>
<th>V&lt;sub&gt;OC&lt;/sub&gt; [V]</th>
<th>J&lt;sub&gt;sc&lt;/sub&gt; [mA cm&lt;sup&gt;-2&lt;/sup&gt;]</th>
<th>FF [%]</th>
<th>PCE [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device G &lt;sup&gt;[a]&lt;/sup&gt;</td>
<td>1.8</td>
<td>Pt</td>
<td>0.247</td>
<td>1.60</td>
<td>40</td>
</tr>
<tr>
<td>Device H &lt;sup&gt;[b]&lt;/sup&gt;</td>
<td>1.8</td>
<td>Pt</td>
<td>0.231</td>
<td>1.44</td>
<td>42</td>
</tr>
</tbody>
</table>

<sup>[a]</sup> 0.9M T<sub>2</sub>/0.3M T<sub>1</sub> and 0.1M LiTFSI in the mixture of CH<sub>3</sub>CN and PC (v:v, 7:3);

<sup>[b]</sup> 0.9M T<sub>2</sub>/0.3M T<sub>1</sub> and 0.1M LiTFSI in CH<sub>3</sub>CN.

Figure S2. The effect from different redox couples and counter electrode on the dark current.