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Efficient Dye-sensitized Solar Cells Employing Highly Environment-friendly Ubiquinone 10 based I_2-free Electrolyte Inspired From the Photosynthesis

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Preparation of electrolytes

To make certain the optimal concentration of ubiquinone 10（UQ_{10}）in electrolytes employed in dye-sensitized solar cells (DSSCs), a series of electrolytes were prepared with following compositions: 0.6 M 1-propyl-3-methylimidazolium iodide (PMII), 0.1 M lithium bis (trifluoromethane sulfonimide) (LiN(CF3S02)2), 0.4 M 4-*tert*-butylpyridine (TBP), n (UQ_{10}): 0, 0.01, 0.02, 0.03, 0.05, 0.10 M, and ethyl acetate (EA) and propylene carbonate (PC) (vol: vol= 1: 1) was used as the solvent.

In order to compare the performance of devices with electrolytes based on UQ_{10} with the traditional one, Electrolyte A and Electrolyte B were prepared respectively. Electrolyte A: 0.6 M PMII, 0.1M LiN(CF3S02)2, 0.4 M TBP, 0.01M UQ_{10} solved in EA and PC (vol: vol= 1: 1); Electrolyte B: 0.6 M PMII, 0.05M lithium iodide (LiI), 0.4 M TBP, 0.1 M Guandine thiocyanate (GITC), 0.03 M iodine (I_2) solved in Acetonitrile (ACN) and PC (vol: vol= 1: 1).

Fabrication of DSSCs

Photoelectrodes were prepared based on a traditional procedure[1]. Firstly, 20nm TiO_2 (paste A) was synthesized by a hydrothermal method and 500nm rutile TiO_2 was

mixed in to prepare the paste (paste B) used for light-scattering layer. Paste A was doctor-bladed on $TiCl_4$ pretreated FTO glass followed by sintering at 500 ℃ for 30min to be used as electrode A. To further optimize the performance of DSSCs, another light-scattering layer was doctor-bladed on electrode A to prepare the electrode B. When being assembled as devices, both electrode A and electrode B were post treated in TiCl4 solution for 30min at 70 ℃ again before sintered at 500 ℃ for 30min. Following, all these photoanodes were immersed in a 0.5 mM N719 ethanol solution and kept at 25 ℃ for 24 h, then rinsed with ethanol and dried. The DSSCs were fabricated by sandwiching such sensitized photoanodes with platinum-coated FTO counter electrode by introducing electrolytes which had been mentioned before between them[2].

Characterization of DSSCs

CHI 660C electrochemical workstation (Shanghai, China) was employed for all the electrochemical measurements. Photovoltaic characteristics were measured by applying external potential bias to the device under AM 1.5 simulated illumination (Newport, 91192) with a power density of 100 mW cm^{-2}. The irradiated area of each cell was kept at 0.25 cm^2 by a light-tight metal mask. The UV-vis spectra were recorded on UV-2550 spectrometer (Shimadzu, Japan), and both the electrolyte A and electrolyte B were 400 times diluted. Electrochemical impedance spectroscopy (EIS) was performed with the frequency ranging from 100 KHz to 0.1 Hz at open circuit conditions under 100 mW cm^{-2} irradiation (active area is 0.25 cm^2). The electron lifetime of the DSSCs were measured through open circuit voltage decay (OCVD) by using the same electrochemical workstation via recording the subsequent decay of photovoltage after turning off the illumination in a steady state.

References

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