Electronic Supplementary Material (ESI) for RSC Advances

Supporting Information

Effects of Cation Composition in the Electrolyte on the Performances of Black-dye-based Dye-sensitized Solar Cells

Hironobu Ozawa, Yu Okuyama and Hironori Arakawa*

Department of Industrial Chemistry, Faculty of Engineering, Tokyo University of Science, 12-1, Ichigaya-Funagawara, Shinjuku, Tokyo, 162-0826, JAPAN
E-mail: h.arakawa@ci.kagu.tus.ac.jp; Fax: (+08) 3 5261 4631; Tel: (+81) 3 5228 8311

Experimental Section

Materials and General Measurements

Black dye was prepared according to the literature.[1] Titanium isopropoxide and deoxycholic acid (DCA) were purchased from Tokyo Chemical Industry Co. 1,2-Dimethyl-3-propylimidazolium iodide (DMPImI) was purchased from Shikoku Kasei. All solvents and reagents were of the highest quality available and were used as received. The elemental analysis was carried out on a Perkin Elmer 2400II elemental analyzer using acetanilide as a standard material. ^{1}H NMR spectra were acquired on a Bruker BioSpin AVANCE 400M spectrometer, where chemical shifts in CD_3OD were referenced to internal standard tetramethylsilane.

Preparation of TiO_2 photoelectrodes and DSCs

TiO_2 pastes were prepared using titanium isopropoxide.[2] Nanocrystalline TiO_2 photoelectrodes were prepared by screen printing the TiO_2 paste on fluorine-doped SnO_2 conducting glasses (FTO, Nippon Sheet Glass Co., 10 Ω/square). TiO_2 thin films were single layer of 20 nm TiO_2 particles (film thickness: approximately 6 μm). TiO_2

thick films were composed of seven layers (from the bottom to the third layer: 20 nm TiO_2 particles, the fourth and fifth layers: a 8:2 mixture of 20 nm and 100 nm particles, the sixth layer: a 6:4 mixture of 20 nm and 100 nm particles, and the top layer: 400 nm TiO_2 particles; film thickness: approximately 45 μm).[3] TiO_2 photoelectrodes were calcinated at 520 °C after every layer was coated. The active areas of these TiO_2 films were determined using a KEYENCE VHX-200 digital microscope. The TiO_2 photoelectrodes were immersed in a 1-propanol solution of 0.2 mM black dye and 20 mM DCA, or 0.2 mM black dye, 0.14 mM D131 and 20 mM DCA for 20 h at room temperature to adsorb dyes onto the TiO_2 surface.[3,4]

Photoelectrochemical measurements were performed in a two-electrode sandwich cell configuration composed of the dye-adsorbed TiO_2 photoelectrode, a platinum-sputtering counter electrode, a spacer film (50 μm), and an electrolyte with various kinds of compositions.

Photovoltaic measurements

The photocurrent-voltage (*I-V*) characteristics of the DSCs were measured on a Keithley 2400 source meter under irradiation of AM 1.5, 100 mW/cm^2 (1 sun) supplied by a solar simulator (Yamashita Denso, YSS-150A). The incident light intensity was calibrated with a grating spectroradiometer LS-100 (EKO Instruments) and Si photodiode (Bunkoh Keiki). The incident monochromatic photon-to-current conversion efficiency (IPCE) was measured on a PEC-S10 (Peccell Technologies). Electrochemical impedance spectroscopic (EIS) studies were conducted using an electrochemical interface SI 1287 (Solartron) and a frequency response analyzer 1255B (Solartron).

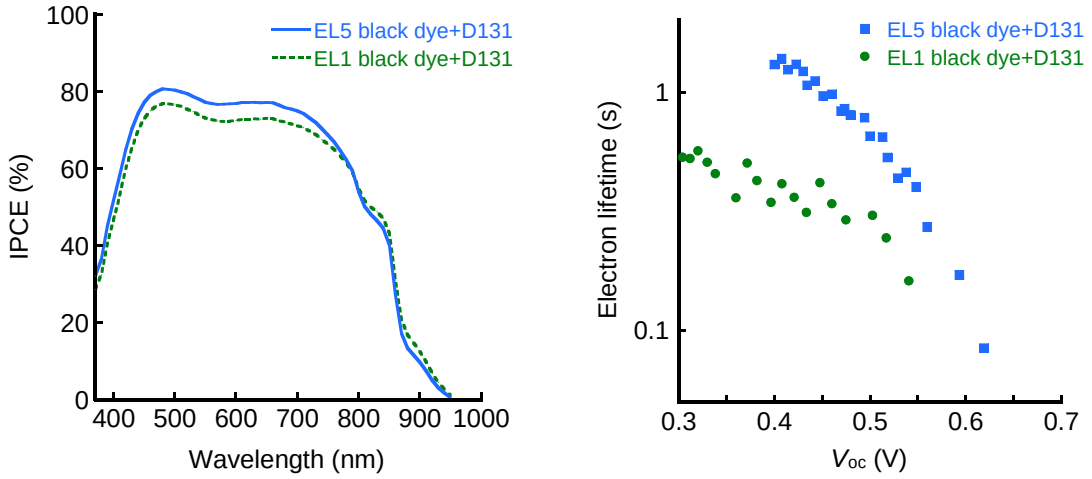

Figure S1. IPCE spectra and electron lifetimes as a function of V_{oc} of the cosensitized DSCs with black dye and D131 using EL1 or EL5 electrolyte with an anti-reflection film and a black mask (active area : 0.152 cm^2) under AM 1.5 (100 mW/cm^2) irradiation.

References

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