트리페닐아민을 이용한 염료감응형 태양전지 고효율 염료합성

*양 현식, 정 대영, 정 미란, **김 재홍

Highly Efficient and Stable Organic Photo-Sensitizers based on Triphenylamine with Multi-anchoring Chromophore for Dye-sensitized Solar Cells

*Hyunsik Yang, Daeyoung Jung, Miran Jung, **Jaehong Kim

Organic dyes, because of their many advantages, such as high molar extinction coefficients, convenience of customized molecular design for desired photophysical and photochemical properties, inexpensiveness with no transition metals contained, and environment-friendliness, are suitable as photosensitizers for the Dye-sensitized Solar Cell (DSSC). The efficiency of DSSC based on metal-free organic dyes is known to be much lower than that of Ru dyes generally, but a high solar energy-to-electricity conversion efficiency of up to 8% in full sunlight has been achieved by Ito et al. using an indoline dye. This result suggests that smartly designed and synthesized metal-free organic dyes are also highly competitive candidates for photosensitizers of DSSCs with their advantages mentioned above. Recently, the performance of DSSC based on metal-free organic dyes has been remarkably improved by several groups. We had reported the novel organic dye with double electron acceptor chromophore, which was a new strategy to design an efficient photosensitizer for DSSC. To verify the strategy, we synthesized organic dyes whose geometries, electronic structures and optical properties were derived from preceding density functional theory (DFT) and time-dependent density functional theory (TD-DFT) calculations. In this paper, we successfully synthesized the chromophore containing multi-acceptor push-pull system from triphenylamine with thiophene moieties as a bridge unit. Organic dyes with a single electron acceptor and double acceptor system were also synthesized for comparison purposes. The photovoltaic performances of these dyes were compared, and the recombination dark current curves and the incident photon-to-current (IPCE) efficiencies were also measured in order to characterize the effects of the multi-anchoring groups on the open-circuit voltage and the short-circuit current. In order to match specifications required for practical applications to be implemented outdoors, light soaking and thermal stability tests of these DSSCs, performed under 100mWcm^{-2} and 60℃ for 1000h.

Key words : DSSC, Chromophore, Organic photo-sensitizer

E-mail : * yanggoon@ynu.ac.kr, ** jaehkim@ynu.ac.kr

형광물질을 이용한 염료감응태양전지의 효율향상

*천 종훈, 이 정관, 정 미란, **김 재홍

Enhancement of Photovoltaic Performance of Fluorescence Materials added TiO2 electrode in Dye-sensitized Solar Cells

*JongHun Cheon, JeongGwan Lee, MiRan Jung, **JaeHong Kim

Dye-sensitized solar cells (DSSCs) have attracted considerable attention on account of their high solar energy-to-conversion efficiencies and low cost processes compared to conventional p-n junction solar cells. The mechanism of DSSC is based on the injection of electrons from the photo excited dyes into the conduction band of the semiconductor electrode. The oxidized dye is reduced by the hole injection into either the hole conductor or the electrolyte. Thus, the light harvesting effect of dye plays an important role in capturing the photons and generating the electron/hole pair, as well as transferring them to the interface of the semiconductor and the electrolyte, respectively. We used the organic fluorescence materials which can absorb short wavelength light and emit longer wavelength region where dye sensitize effectively. In this work, the DSSCs were fabricated with fluorescence materials added TiO_2 photo-electrode which were sensitized with metal-free organic dyes. The photovoltaic performances of fluorescence aided DSSCs were compared, and the recombination dark current curves and the incident photon-to-current (IPCE) efficiencies were measured in order to characterize the effects of the additional light harvesting effect in DSSC. Electro-optical measurements were also used to optimize the fluorescence material contents on TiO_2 photo-electrode surface for higher conversion efficiency (η), fill factor (FF), open-circuit voltage (VOC) and short-circuit current (ISC). The enhanced light harvesting effect by the judicious choice/design of the fluorescence materials and sensitizing dyes permits the enhancement of photovoltaic performance of DSSC.

Key words : TiO_2, Fluorescence(형광체), DSSC(염료감응태양전지)

E-mail : * jhcheon@ynu.ac.kr, ** jaehkim@ynu.ac.kr