카바졸과 페노시아진을 이용한 염료감응형 태양전지의 염료 합성과 광적특성

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Synthesis and Photovoltaic Properties of Dendritic Photosensitizers containing Carbazole and Phenothiazine for Dye-sensitized Solar Cells

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Since Gratzel and co-workers developed a new type of solar cell based on the nanocrystalline TiO_2 electrode, dye-sensitized solar cells (DSSCs) have attracted considerable attention on account of their high solar energy-to-conversion efficiencies (11%), their easy manufacturing process with low cost production compared to conventional p-n junction solar cells. The mechanism of DSSC is based on the injection of electrons from the photoexcited dye into the conduction band of nanocrystalline TiO_2. The oxidized dye is reduced by the hole injection process from either the hole counter or electrolyte. Thus, the electronic structures, such as HOMO, LUMO, and HOMO-LUMO gap, of dye molecule in DSSC are deeply related to the electron transfer by photoexcitation and redox potential. To date, high performance and good stability of DSSC based on Ru-dyes as a photosensitizer had been widely addressed in the literatures. DSSC with Ru-bipyridyl complexes (N3 and N719), and the black ruthenium dye have achieved power conversion efficiencies up to 11.2% and 10.4%, respectively. However, the Ru-dyes are facing the problem of manufacturing costs and environmental issues. In order to obtain even cheaper photosensitizers for DSSC, metal-free organic photosensitizers are strongly desired. Metal-free organic dyes offer superior molar extinction coefficients, low cost, and a diversity of molecular structures, compared to conventional Ru-dyes. Recently, novel photosensitizers such as coumarin, merocyanine, cyanine, indoline, hemicyanine, triphenylamine, dialkylaniline, bis(dimethylfluorenyl)-aminophenyl, phenothiazine, tetrahydroquinoline, and carbazole based dyes have achieved solar-to-electrical power conversion efficiencies up to 5-9%. On the other hand, organic dye molecules have large π-conjugated planner structures which would bring out strong molecular stacking in their solid-state and poor solubility in their media. It was well known that the molecular stacking of organic dyes could reduce the electron transfer pathway in opto-electronic devices, significantly. In this paper, we have studied on synthesis and characterization of dendritic organic dyes with different number of electron acceptor/anchoring moieties in the end of dendrimer. The photovoltaic performances and the incident photon-to-current (IPCE) of these dyes were measured to evaluate the effects of the dendritic strucuture on the open-circuit voltage and the short-circuit current.

Key words : Carbazole, Phenothiazine, DSSC, Dendritic, Photosensitizer

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장 파장 대 태양광을 흡수하는 염료감응형태양전지에 대한 염료와 합성

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Synthesis and Photovoltaic Performance of Long Wavelength Absorption Dyes for the Dye Sensitized Solar Cell

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The dye-sensitized solar cell (DSSC) is a device for the conversion of visible light into electricity, based on the sensitization of wide bandgap semiconductors. The performance of the cell mainly depends on a dye used as sensitizer. The absorption spectrum of the dye and the anchorage of the dye to the surface of TiO_2 are important parameters determining the efficiency of the cell. Generally, transition metal coordination compounds(ruthenium polypyridyl complexes) are used as the effective sensitizers, due to their intense charge-transfer absorption in the whole visible range and highly efficient metal-to ligand charge transfer. However, ruthenium polypyridyl complexes contain a heavy metal, which is undesirable from point of view of the environmental aspects. Moreover, the process to synthesize the complexes is complicated and costly. Alternatively, organic dyes can be used for the same purpose with an acceptable efficiency. The advantages of organic dyes include their availability and low cost. We designed and synthesized a series of organic sensitizers containing long wavelength absorption-chromophores for the dye sensitized solar cell. The DSSC composed of Blue-chromophores for the sensitization absorbed long wavelength region which is different also applied into the dye-cocktail (mixing) system. The photovoltaic property of DSSCs organic long wavelength absorption-chromophores were measured and evaluated by comparison with that of individual chromophores.

Key words : Dye sensitized solar cell(염료감응형태양전지), long wavelength(장 파장), Organic dye(유기염료)

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