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Organic semiconductor materials for high efficiency dye-sensitized solar cells

Hwan Kyu Kim, Yu Kyung Eom, Sung Ho Kang and **In Taek Choi**
Korea University, Korea

Dye-sensitized solar cells (DSSCs) have attracted much interest as a promising renewable energy supply device based on the merits of low-cost, flexibility and easy fabrication. Very recently, a variety of organic dyes using inexpensive metals has been prepared for DSSCs. A state of the art DSC based on porphyrin-baseed solar cells with cobalt-based electrolyte has exceeded the conversion efficiency of 13.1%. For the high PCE of D-π-A sensitizer-based DSSCs, the structural modifications of a π-bridge, including tuning the energy levels and the improvement of intramolecular charge transfer (ICT) from D to A of the sensitizer, are particularly essential. We demonstrate that new thieno[3,2-b][1]benzothiophene (TBT)-based D-π-A sensitizers and D–π–A structured Zn(II)–porphyrin sensitizers based on the structural modification of SM315 as a world champion dye for efficient retardation of charge recombination and fast dye regeneration were synthesized. The device with new porphyrin sensitizers exhibited the higher photovoltaic conversion efficiency (PCE) than those of the devices with SM315 as a world champion porphyrin dye. To further improve the maximum efficiency of the DSSCs, by replacing the TBT π-bridge with the alkylated thieno[3,2-b]indole (TI) moiety, the TI-based DSSC exhibits a highest PCE (12.45%) than does TBT-based DSSC (9.67%). Furthermore, the first parallel-connected (PC) tandem DSSCs in the top cell with a TI-based sensitizer and bottom cell with a porphyrin-based sensitizer were demonstrated and an extremely high efficiency of 14.64% was achieved. In this presentation, new strategy on materials paradigm for low-cost, long-term stable, highly efficient dye-sensitized solar cells will be described.

Biography

Hwan Kyu Kim received PhD from Carnegie Mellon University. After postdoctoral associate in Materials Science and Engineering at Cornell University, he joined ETRI as a project leader of polymeric photonic device group. After his career at Hannam University where he became Professor of Polymer Science and Engineering, he was invited as a distinguished professor to Korea University in 2007. He had executed the president-ship of both Korean Society of Photoscience and Korean Organic Photovoltaics Society. His current research focuses on developing advanced organic and polymeric semiconductors for dye-sensitized solar cells, perovskite solar cells as well as solar energy conversion.

hkk777@korea.ac.kr

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