Quasi-Solid-state dye-sensitized solar cells assembled with polymer electrolyte containing core-shell structured polymeric ionic liquid

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Dye-sensitized solar cells (DSSCs) are promising alternatives to silicon solar cells due to their low cost, easy fabrication, and relatively high conversion efficiency. Recently, impressive conversion efficiency of 12 % has been achieved in a DSSC with a liquid electrolyte [1]. However, leakage or evaporation of liquid electrolyte is a critical problem that limits the long-term operation and practical use of DSSCs. To overcome these problems, considerable efforts have been made to replace liquid electrolytes with gel polymer electrolytes that exhibit high ionic conductivity and improved stability. In these gel polymer electrolytes, both cations and anions are mobile, which polarizes the electrolyte and increases the resistance of I^-/I_3^- ions. The use of a single-ion conductive gel polymer electrolyte in which cations are immobilized while anions are highly mobile is therefore highly desirable. A polymeric ionic liquid (PIL) is a single-ion conductor in which cationic or anionic centers are constrained to the polymer backbone.

In this work, the core-shell structured SiO_2 particles with polymeric ionic liquid containing iodide ions in their shell were synthesized as a single-ion conductor and used as functional fillers in gel polymer electrolytes for DSSCs. These fillers have a very uniform spherical shape, and the SiO_2 core is covalently bonded to poly(1-methyl 3-(2-acryloyloxypropyl) imidazolium iodide) in the shell layer. Highly conductive single-ion conducting gel polymer electrolytes were prepared with core-shell structured SiO_2 particles. Additional iodide salts were not used for formation of the redox couple in the polymer electrolytes. The photovoltaic performance of DSSCs assembled with these polymer electrolytes was investigated and compared to that of liquid electrolyte-based DSSC. The results showed that the DSSC employing core-shell structured SiO_2 particles exhibited relatively high conversion efficiency and good long-term stability.

References

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