수소결합 고분자 전해질을 이용한 염료감응 태양전지

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Dye-sensitized Solar Cells Employing Hydrogen-bonded Polymer Electrolytes

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Abstract : Dye-sensitized solar cells (DSSCs) have generated considerable research interest because of high-energy conversion efficiency (~ 11 %) and low production cost. Among them, DSSCs employing solid polymer electrolytes have paid much attention because they exclude many problems such as leakage, evaporation of solvent, high-temperature instability and flammability. We report that a supramolecular electrolyte is designed for use in DSSCs by modifying low molecular weight polyethylene glycol (M_n=1,000 g/mol) at both chain ends with functional groups having quadruple hydrogen bonding sites. The coil size in dilute solutions of this electrolyte is small enough for the electrolyte to penetrate into the nanopores of the TiO_2 layer, resulting in improved interfacial contact between the dye-adsorbed TiO_2 nanoparticles and the electrolyte, but the electrolyte becomes non-fluidic and has the necessary mechanical strength in the solid state. The overall conversion efficiency of these DSSCs was 3.34% at 100 mW/cm^2 (4.59 % at 42.9 mW/cm^2). We also demonstrate that composite polymer electrolytes consisting of PEO, fumed nanosized silica, an iodide salt, and iodine provide improved DSSC performance and excellent mechanical properties. These DSSCs exhibited remarkably high conversion efficiencies, 4.5% at 100 mW/cm^2, which is one of the highest values ever reported for DSSCs employing solid polymer electrolytes. Hydroxyl groups attached to the surface of fumed silica nanoparticles make the surface hydrophilic and capable of hydrogen bonding. With these properties, fumed silica nanoparticles create a three-dimensional network that prevents the viscous flow of low molecular weight polymer, and thus providing the required mechanical strength of polymer electrolytes.

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