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PHOTOVOLTAIC PERFORMANCE OF DYE-SENSITIZED SOLAR CELLS FABRICATED WITH CELLULOSE ACETATE NANOFIBER-BASED GEL ELECTROLYTE

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Polymer nanofibers have emerged as scientifically intriguing novel materials where that can perform extraordinarily well with their unique chemical and physical properties. Electrospinning has become one of the simple and versatile methods to produce nanofibers, and electrospun polymer nanofibers can be applied in dye-sensitized solar cells (DSSCs). In contrast to conventional liquid electrolytes, which inherently lack long-term stability and suffer from electrolyte evaporation and liquid leakage, electrospun polymer nanofiber membrane-based quasi-solid-state gel electrolytes have offered a promising alternative. The quasi-solid-state gel electrolyte, made by trapping an electrolyte solution within a three-dimensional polymer nanofiber matrix, exhibits almost liquid-like ionic conductivities while offering better mechanical strength by a non-flowing electrolyte medium. In the present study, cellulose acetate (CA) nanofiber gel electrolyte-based DSSCs were fabricated. Their photovoltaic performance was investigated as a comparative study with conventional liquid and gel electrolyte-based DSSCs. Scanning electron microscopic images showed a porous membrane containing ultra-thin polymer nanofibers with an average diameter of 180 nm. In order to prepare quasi solid-state gel electrolyte, the CA nanofiber membrane was soaked with the liquid electrolyte prepared by dissolving iodine (I_2), tetrapropylammonium iodide (Pr_4NI), potassium iodide (KI) in ethylene carbonate (EC) and propylene carbonate (PC) co-solvent system. The photovoltaic parameters of DSSCs with nanofiber gel electrolyte show an efficiency of 6.06%, a short circuit current density (J_{sc}) of 13.9 mA cm^{-2} under the simulated sunlight of 100 mW cm^{-2} (1.5 AM). This efficiency value lies in between those of conventional liquid and gel electrolyte-based DSSCs exhibiting efficiencies of 6.53% and 5.50%, respectively. This study suggests that CA electrospun nanofiber gel electrolyte-based DSSC offers a possible alternative to obtain higher efficiencies than those of conventional gel electrolyte-based DSSCs while providing sufficient stability compared to the liquid electrolyte-based solar cells.

Keywords: Cellulose acetate, Dye-sensitized solar cells, Electrospinning, Nanofiber gel electrolyte