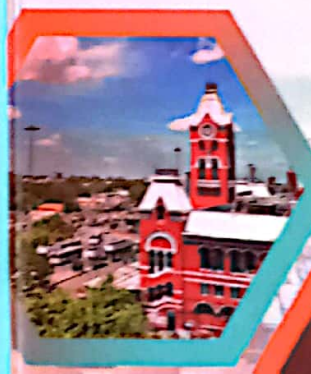

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Enhancing Efficiency in Poly(Ethylene Oxide) Solid Polymer Electrolyte -based Dye-Sensitized Solar Cells: The Synergistic Effect of Plasticizers, Mixed Cations, and Nanofillers

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Abstract

N719 ruthenium dye-based dye-sensitized solar cells (DSSCs) were fabricated using solid polymeric electrolytes based on poly(ethylene oxide) (PEO) by incorporating a plasticizer, mixed cations (tetrapropyl ammonium iodide, $Pr_4N^+I^-$ and KI), and TiO_2 nanofiller. The starting electrolyte composition with PEO:15 wt.% $Pr_4N^+I^-$:I_2 showed the highest conductivity of 3.97×10^{-5} S m^{-1} at 30 °C, and the DSSCs employing this electrolyte exhibited an efficiency of 1.08%. The addition of plasticizer ethylene carbonate (EC) to the electrolyte at the optimum composition of 42.5 wt.% PEO: 42.5 wt.% EC: 15 wt.% $Pr_4N^+I^-$: I_2 enhanced the efficiency to 1.46%, evidently due to the increased amorphous nature of the PEO polymer. When Pr_4N^+I was added to the electrolyte as the second iodide salt, corresponding to the optimized composition of 42.5 wt.% PEO: 42.5 wt.% EC: 3.75 wt.% $Pr_4N^+I^-$: 11.25 wt.% KI: I_2, the efficiency was further increased to 1.81%, which is very likely due to the mixed cation effect. The incorporation of 2.5 wt.% TiO_2 nanofiller into the above electrolyte further enhanced the efficiency up to 3.02%, evidently due to the higher ionic mobility caused by the increased amorphous phase content of the polymer electrolyte. TiO_2 photoanodes were subjected to $TiCl_4$ treatment to increase their effective specific surface area and hence to increase the short-circuit photocurrent and the overall efficiency of the DSSCs. The DSSCs optimized by the synergistic effect of the above-stated strategies exhibited an overall efficiency of 3.41%, which is among the highest for a solid polymer electrolyte-based DSSC.