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FABRICATION OF QUASI-SOLID-STATE ELECTROLYTE FOR DYE-SENSITIZED SOLAR CELLS USING FUMED SILICA AS THE GELLING AGENT

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Dye-sensitized solar cells (DSCs) have attracted worldwide attention, due to their low-cost and easy fabrication procedures, when compared to conventional silicon photovoltaic devices. However, the use of organic solvent-based liquid electrolytes cause many problems, such as, solvent evaporation, electrolyte leakage, corrosion of the Pt counter electrode and photodegradation, which affect the long-term applications of them in solar panels. To overcome these problems, many attempts have been made to replace the liquid electrolytes with solids or quasi-solids. The use of p-type semiconductor organic and inorganic hole-transport materials in solid-state solar cells and the use of polymer electrolytes and gelling agents in quasi-solid-state solar cells are viable alternatives to liquid electrolytes. This is due to their good stability and better sealing ability, though with less efficiencies, owing to low mobility of ions through the solid or quasi-solid medium and also due to imperfect filling of pores with the electrolyte. Compared to solid-type hole-transport materials, gel electrolytes have certain advantages, due to high ionic conductivity owing to their diffusive nature of liquids and good stability due to cohesive nature of solids. Hence, this study is focused on a gel electrolyte system with added inert filler, fumed silica, to ethylene carbonate (EC) and propylene carbonate (PC) plasticizers, along with dissolved tetrapropylammonium iodide ($Pr_4N^+I^-$) and iodine as redox species. DSCs were assembled, according to the configuration of FTO/TiO_2 working electrode/dye (N719)/corresponding gel electrolyte/lightly-platinized FTO. The cell performance has been studied, by varying the amounts of tetrapropylammonium iodide ($Pr_4N^+I^-$) salt and plasticizers in the gel electrolyte, in order to get the optimum conditions. The gel electrolyte containing 50:1 molar ratio of total moles of oxygen atoms in EC and PC to iodide gave the best light-to-electricity conversion efficiency of 6.29%, under simulated AM 1.5 irradiation with 100 mW cm^{-2}. EC and PC were kept at 1:1 mass ratio and total I^-:I_2 molar ratio was kept at 10:1 in the optimized gel system. A room temperature conductivity of 6.92×10^{-3} S cm^{-1} was exhibited for the optimized composition which consists of EC (41.157%): PC (41.157%): $Pr_4N^+I^-$ (16.36%): I_2 (1.325%): fumed silica (10% of the total mass) by weight.

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