ABSTRACT

In this work, plasticized poly (vinylidene fluoride-co-hexafluoropropylene) or PVDF-HFP polymer electrolytes have been prepared by solution casting and optimized for the fabrication of dye sensitized solar cells (DSSCs). Potassium iodide (KI) and sodium iodide (NaI) salts have been chosen as the ion sources. A mixture of 1:1 weight ratio of ethylene carbonate (EC) and propylene carbonate (PC) forms the plasticizing agent. The complexation between polymer and salt and interaction between salt and the plasticizer have been verified using Fourier transform infrared (FTIR) spectroscopy. The structural characterization was performed using X-ray diffraction (XRD) and electrical and transport properties by electrochemical impedance spectroscopy (EIS). The highest conducting electrolytes have compositions of 40 wt.% (PVDF-HFP)-10 wt.% KI-50 wt.% (EC/PC) with room temperature (RT) ionic conductivity of 1.10×10^{-3} S cm^{-1} and 48 wt.% (PVDF-HFP)–32 wt.% NaI–20 wt.% (EC/PC), which exhibits the highest conductivity of 1.53×10^{-4} S cm^{-1} at RT. These electrolytes have been used in the fabrication of DSSCs with configuration FTO/TiO_2/dye/electrolyte/Pt/FTO. Synthetic Ruthenizer 535 (N3) dye, anthocyanin and chlorophyll pigments solvent extracted from black-rice and *Pandanus amaryllifolius* leaves have been used as light absorbers. UV-vis absorption spectra of N3 dye, anthocyanin, chlorophyll and the equal volume mixture of anthocyanin and chlorophyll were recorded. The N3 dye exhibits maximum absorption at 535 nm. The spectrum of the anthocyanin dye peaks at 532 nm and that of chlorophyll shows peaks at 536 nm and 665 nm under white light illumination of 100 mW cm^{-2}. The DSSC fabricated with 47 wt.% (PVDF-HFP)–31 wt.% NaI-19 wt.% -3 wt.% I_2 electrolyte and the dye mixture shows short-circuit current density (J_{SC}) of 2.63 mA cm^{-2}, open-circuit voltage (V_{OC}) of 0.47 V, fill factor (FF) of 0.58 and photo-conversion efficiency of 0.72%

while the DSSC fabricated with 40 wt.% (PVDF-HFP)-10 wt.% KI-50 wt.% (EC/PC)-1 wt.% I_2 and the dye mixture shows J_{SC} of 2.62 mA cm^{-2}, V_{OC} of 0.67 V, *FF* of 0.47 and photo-conversion efficiency of 0.83%. The DSSC with 47 wt.% (PVDF-HFP)–31 wt.% NaI–19 wt.% (EC/PC)-3 wt.% I_2 electrolyte and N3 dye shows J_{SC} of 6.40 mA cm^{-2}, V_{OC} of 0.58 V, *FF* of 0.48 and photo-conversion efficiency of 1.78%. The DSSC fabricated with the highest conducting 40 wt.% (PVDF-HFP)-10 wt.% KI-50 wt.% (EC/PC) 1 wt.% I_2 electrolyte shows good performance with both synthetic and natural dyes. However, the DSSC fabricated with the same KI based electrolyte and N3 dye show better performance with J_{SC} of 7.54 mA cm^{-2}, V_{OC} of 0.65 V, *FF* of 0.51 and photo-conversion efficiency of 2.49% under the illumination of 100 mW cm^{-2} white light. The same DSSC under low intensity light of 30 mW cm^{-2} and 60 mW cm^{-2} shows better efficiencies of 4.13 % and 3.68 % respectively. The DSSC with double salt electrolyte, 40 wt.% (PVDF-HFP)-2 wt.% KI-10 wt.% TBAI-50 wt.% (EC/PC)-1 wt.% I_2 exhibited J_{SC} of 7.98 mA cm^{-2}, V_{OC} of 0.66 V, *FF* of 0.51 and photo-conversion efficiency of 2.69 %. The mixed-cation iodide salts (KI+TBAI) in the electrolyte give better efficiency than the single-cation iodide salt (KI) system. This is because the TBA^+ cation is bulky and therefore is less mobile. Hence the addition of TBAI helps to increase the iodide ion contribution to the conductivity and good DSSC performance.