

Non-edible oil based polyurethane acrylate with tetrabutylammonium iodide gel polymer electrolytes for dye-sensitized solar cells

ABSTRACT

Polyurethane acrylate (PUA) gel polymer electrolytes were prepared with tetrabutylammonium iodide (TBAI) as the complex salt. Fourier transform infrared spectroscopy results confirmed that the Nsingle bondH, Cdouble bondO, Csingle bondN and Csingle bondOsingle bondC polar functional groups formed the coordination with TBA⁺ cations of salt observed from the bands shift. The maximum ionic conductivity of $(1.88 \pm 0.02) \times 10^{-4} \text{ S cm}^{-1}$ was obtained for the electrolyte with composition of 67.94 wt% PUA–30.00 wt% TBAI–2.06 wt% I₂ (S3 electrolyte) which influenced by the highest charge mobility of $(6.24 \pm 0.12) \times 10^{-7} \text{ cm}^2 \text{ V}^{-1} \text{ s}^{-1}$ and number density of $(1.93 \pm 0.04) \times 10^{21} \text{ cm}^{-3}$ estimated from fitting the Nyquist plots. The S3 electrolyte was electrochemically stable up to 1.64 V and capable of performing up to 2000 cycles steadily. Triiodide ion diffusivity obtained was $1.70 \times 10^{-8} \text{ cm}^2 \text{ s}^{-1}$. The electrolyte performance in dye-sensitized solar cells (DSSCs) was tested and cell with S3 electrolyte showed the highest solar conversion efficiency of $(1.97 \pm 0.21)\%$ with short-circuit current density (J_{sc}) of $(7.15 \pm 0.74) \text{ mA cm}^{-2}$ and open-circuit voltage (V_{oc}) of $(0.55 \pm 0.01) \text{ V}$ when exposed under 1000 W m^{-2} light illumination. The highest efficiency obtained was influenced by the high electrons driving force in DSSCs. Low reduction resistance (R_{red}) of $(2.46 \pm 0.08) \Omega$ at the electrolyte/counter electrode interface along with low charge transfer resistance (R_{ct}) of $(24.97 \pm 0.14) \Omega$ at TiO₂/dye/electrolyte interface and charge diffusion resistance (R_{diff}) of $(34.14 \pm 0.11) \Omega$ in redox electrolyte increase the electrons dynamic, thus resulting high J_{sc} and hence high DSSC efficiency. This work shows that PUA-based electrolytes have potential for DSSC applications.

Keyword: Polyurethane acrylate; FTIR; DSSCs; EIS; Charge transport properties