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RESEARCH

Iodine-free acetonitrile-modified BmimI ionic liquid electrolyte with in-situ triiodide formation for efficient dye-sensitized solar cells

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Abstract

In this study, an iodine-free 1-butyl-3-methylimidazolium iodide (BmimI) ionic liquid, modified with acetonitrile (AN), was employed as a redox mediator using a facile approach to enhance DSSC performance. The optical properties of BmimI-AN(1:2) electrolyte (BmimI: AN = 1:2 w/w) indicate low absorption and high transmittance in the visible region. In addition to the UV-Vis spectra, Raman spectra also confirm the presence of the in-situ generated I_3^- ions, which are sufficient to complete the reaction mechanism in DSSCs. Conductivity measurements revealed that the BmimI-AN(1:2) electrolyte possesses excellent ionic conductivity compared to BmimI and standard commercial I^-/I_3^- electrolytes. The photovoltaic performances of the fabricated devices were analysed under simulated irradiation at an intensity of 100 mWcm^{-2} using a Xe lamp with an AM 1.5 filter. The BmimI-AN(1:2) electrolyte led to a higher power conversion efficiency (PCE) in DSSC, reaching up to 6.26 ± 0.21%, primarily due to improvements in V_{OC} and J_{SC}. Apart from the transparent nature of the BmimI-AN(1:2) electrolyte, it suppresses charge recombination, resulting in a higher electron lifetime in DSSCs. Moreover, DSSCs with the BmimI-AN(1:2) electrolyte exhibited short-term stability comparable to that of standard commercial electrolytes under ambient conditions, with the potential for further improvement through future optimization.

Keywords DSSCs · Ionic liquids · Iodine-Free electrolyte · BmimI · Conductivity