

THE EFFECT OF GEL POLYMER ELECTROLYTES CONTAINING CsI AND LiI BINARY IODIDE SYSTEM ON THE EFFICIENCY OF DYE SENSITIZED SOLAR CELLS

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Several natural energy sources are used to produce electricity. Among them solar radiation is the most abundant and freely available energy source. Limitlessness of solar energy, made solar cells the best candidate to fulfill future energy requirement. Among the different categories, Dye Sensitized Solar Cells (DSSC) acquired the attraction of scientists due to their low production cost, easy fabrication and relatively high conversion efficiency¹. DSSC consists of a dye-adsorbed porous TiO₂ layer on conducting tin oxide (CTO) glass as a working electrode, a Pt coated counter electrode and an electrolyte normally containing I⁻/I₃⁻ redox couple^{2,3} or recently reported Co⁺²/Co⁺³⁴. The electrolyte, as one of the key ingredients, provides internal electrical conductivity by diffusing within the mesoporous TiO₂ layer^{1,2} and is an important factor in determining the cell performance. Although liquid electrolyte based dye-sensitized solar cells reach power conversion efficiencies of about 11%^{3,5} with I⁻/I₃⁻ redox couple and about 12% Co⁺²/Co⁺³ redox couple. There are durability issues in conventional DSSCs due to usage of liquid type electrolytes. Solid state and Quasi solid state electrolytes are being devolved to produce more durable DSSCs. Although the conducting anions play a key role in performance of DSSCs, cations in electrolytes also seem to function in the light-to-electricity conversion process of DSSCs^{6,7}. Therefore, studying the effect of incorporating cations is also important. Polyacrylonitrile (PAN), CsI, LiI, iodine (I₂), Ethylene carbonate (EC) and Propylene carbonate (PC) all with purity greater than 98%, Conducting glass substrate and ruthenium 535-bis TBA (N719) were used as starting materials. In the preparation of two TiO₂ layers, the first TiO₂ layer was deposited using spin coating method and the second was coated on the first layer according to a published procedure⁸. PAN host polymer and different compositions of CsI and LiI salts were used to prepare gel-type electrolytes. EC and PC were used as incorporating plasticizers. In order to maximize performance, the added amount of iodine was fixed to 0.1 times of the total moles of CsI + LiI. In the electrolytes PAN:EC:PC composition was kept as 0.10:0.40:0.40 g respectively. The TiO₂ nano-porous electrodes were coated with dye N 719. Selected salt compositions of electrolyte samples are shown in the Table 1.

Table 1: Salt composition of electrolytes

Electrolyte	x	y	z
CsI / g	0.00	0.03	0.06
LiI / g	0.06	0.03	0.00
I ₂ / g	0.0114	0.0086	0.0059

Three DSSCs were fabricated in each composition of electrolyte and performance of DSSCs was studied with the aim of understanding the effect of mixed salts. V-I characteristics of fabricated DSSCs were obtained while exposing them to one sun and using eDAQ Potentiostat and e-coder. The area of cell exposure to light was 11mm²

Among all the fabricated cells, the cells with only CsI or LiI gave an energy conversion efficiency of ~3.9% and ~3.6%, respectively, highlighting the influence of cation on the performance. The best solar cell performance or energy conversion efficiency of ~4.8% under the irradiation of one sun was experienced with electrolyte containing LiI : CsI of the mass ratio 1:1. The I-V characteristics of fabricated solar cells are shown in the Fig.1.

Dissociation of the iodide salt in the electrolyte increases with increasing the size of the cation. The ionic radii of the alkyl ions Li⁺ and Cs⁺ are 0.6 and 1.69⁹ respectively⁹. The size decrement of the cation makes positive influence on the electron injection and charge separation in the photo-electrode. It can be concluded that the electrolytes containing mixed cations give better DSSC performance compared to that of single cation systems.

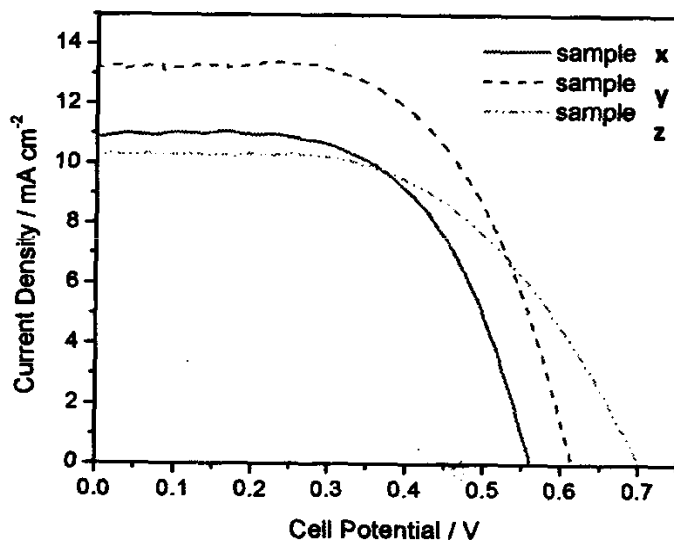


Figure 1: I-V characteristics of solar cells

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