Effect of 4-tertbutyl pyridine and guanidinium thiocyanate Co-Additives on Performance of Dye-Sensitized Solar Cells Fabricated with Non-Volatile Liquid Electrolyte

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Dye-sensitized solar cells (DSSCs) are emerging as potential candidates to substitute for expensive silicon solar cells because of reasonably high efficiency, easy fabrication method, lower production cost and transparency. Electrolyte modifications of DSSC are an easy way to enhance the photovoltaic performance. The conventional liquid electrolyte system is composed of iodide/triiodide single salt in the volatile, acetonitrile solvent. In this work, the non-volatile ethylene carbonate (EC) and propylene carbonate (PC) were used with tetrapropyl ammonium iodide (Pr_4NI) salt to prepare the reference electrolyte. The effect of the co- additives 4-tert butylpyridine (TBP) and Guanidinium thiocyanate (GuSCN) on the photovoltaic performance of DSSCs was also studied. The addition of TBP as an additive into the iodide electrolyte system increased the photovoltage (V_{OC}) by 13.8%, but it reduced the photocurrent density (J_{SC}) by 7.2%. However, the J_{SC} was increased by about 8.7% by the addition of GuSCN as the additive. The addition of the combination of TBP and GuSCN binary additives in the optimized ratio of 65:35 enhanced the cell efficiency from 5.63% to 6.83%. The overall efficiency enhancement has been explained by the shifting of the conduction energy band edge of TiO_2 due to the adsorption of species from the two co-additives by TiO_2 leading to the enhancement of both, the photocurrent density as well as the photovoltage. TBP improves the V_{OC} by a negative shift of the band-edge and also prevents the electron recombination to I_3^- due to the blocking effect on the dye-absent active site of the TiO_2 surface. The addition of GuSCN to TBP-added electrolyte restored the J_{SC} by the positive shift of the band-edge. The net effect is to increase the overall performance of DSSCs due to the synergistic effect of the two co-additives.

***Keywords*:** Photovoltaic effect; Co-additives; Band-edge shift; Non-volatile; V_{OC} improver