

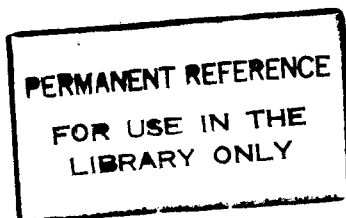
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**DEVELOPMENT OF SOLAR CELLS BASED ON DYE-SENSITIZED  
TITANIUM DIOXIDE WITH SOLID-STATE ELECTROLYTE**

A THESIS PRESENTED BY

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## ABSTRACT

Nano structural dye-sensitized solar cells based on titanium dioxide traditionally use a liquid electrolyte such as acetonitrile, which causes many difficulties. In this study, quasi-solid state dye-sensitized Photoelectrochemical cells of the type, FTO/TiO<sub>2</sub>/dye/(15%) Polyacrylonitrile, (35%) ethylene carbonate, (50%) propylene carbonate, tetrapropylammonium iodide, iodine/Pt/FTO have been fabricated and characterized using current-voltage measurements. The short-circuit current ( $I_{sc}$ ) obtained at 1000 Wm<sup>-2</sup> was 6 mA and efficiencies obtained for solid electrolyte solar cells with and without 4-tertiary butyl pyridine are 2.9 and 1.6% respectively. A mechanism involving "trapping" of the liquid electrolyte on the Polyacrylonitrile (PAN) structure is proposed for the efficiency of this solid electrolyte.

For comparative purposes *cis*-di(thiocyanate)bis(4,4'-dicarboxy-2,2'-bipyridyl)ruthenium(II) (RuL<sub>2</sub>(NCS)<sub>2</sub>) was investigated. Bis((4,4'-dimethoxy-2,2'-bipyridyl)-4,4'-dicarboxy-2,2'-bipyridyl)ruthenium(II) (RuL'<sub>2</sub>L) dye was also prepared as a possible sensitizer. The short-circuit current, open-circuit voltage and efficiencies of the latter dye were very low compared to (RuL<sub>2</sub>(NCS)<sub>2</sub>). From action spectra, the maximum incident photon conversion efficiencies of 5 and 0.5 % were obtained at 530 nm for RuL<sub>2</sub>(NCS)<sub>2</sub> and 470 nm for RuL'<sub>2</sub>L respectively.

Charge recombination between dye-sensitized nanocrystalline TiO<sub>2</sub> electrodes and I<sub>3</sub><sup>-</sup>/I<sup>-</sup> couple in nonaqueous and quasi-solid electrolyte is described. The sensitizer was RuL<sub>2</sub>(NCS)<sub>2</sub>. Treating the dye-coated TiO<sub>2</sub> electrodes with 4-tertiarybutylpyridine and 8-hydroxyquinoline improves significantly both the open-circuit voltage V<sub>oc</sub> (from 650 to 750 mV) and the efficiency (from 4 to 6 %) at 1000 Wm<sup>-2</sup> with respect to

untreated electrode. The use of 8-hydroxyquinoline for this purpose has been successfully demonstrated.

Double dye systems using  $\text{RuL}_2(\text{NCS})_2$  and methyl violet thiocyanate simultaneously adsorbed on titanium dioxide film give enhanced photocurrents and quantum efficiencies. The results show that this is not a simple additive effect. This can be explained by the interaction of the two dyes via chemical interactions where charge recombination is suppressed due to charge separation.