ENHANCEMENT OF THE EFFICIENCY BY INCREASING THE PORE VOLUME IN THE TiO_2 LAYER OF THE TRANSPARENT SOLID STATE DYE-SENSITIZED SOLAR CELL

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Introduction

Dye sensitized (DS) solar cells are gaining much attraction in production of electricity from solar power (Gratzel and O'regan, 1991). Among the two types of DS Photo Electro Chemical Cells and DS Solid State Cells, DS PECs have high performance. The quantum efficiency and power conversion efficiency are high in DS PECs while an unavoidable drawback is the difficulty in leak proof confinement. In this manner, DS solid state cells are advantageous since their chemical and physical durability is high(Thennakone, *et al.*,2002) Except above mentioned features, when bringing them to larger scale production and to domestic applications, low consumption of space, user-friendliness, exterior finishing of the cells stands out being in the forefront.

The uniformity and transparency of the TiO_2 layer as well as the CuI layer plays an enormous role for gaining above targets. Especially the transparency of the cell becomes a privilege when it is fixed to mobile equipments. Transparent solar cells can be utilized in windscreens of vehicles, walls of glass water bottles, windows of tall buildings, and especially where big solar panels cannot be fixed. A significant amount of electricity can be produced while they are in day-to-day domestic use. For domestic uses, what is more important is not the efficiency but the durability.

There are many methods available for preparing transparent electrodes. The method we demonstrate here is the simple atomized spray pyrolysis method for producing electrodes that are transparent. The method employed here is a moving nozzle above the substrate with a special atomizer system, which produces a thin beam of nanometer level particles, which avoid particle aggregation. In colloidal solutions particles tend to aggregate and settle at the bottom. But here an air suspension of nanometer sized particles is produced where at the same time a selection of light weight particles and small aggregates is done. Therefore only selected small sized aggregates or particles are injected through the nozzle. When the size of the particles becomes smaller and sprayed slowly for a long time as a thin beam, they are uniformly packed. This avoids the formation of imperfections in the layer also. The electrolyte system containing CuI and CuSCN can be sprayed on the TiO_2 layer in a highly uniform arrangement.

Materials and Methods

Acetyl acetone and Titanium tetraisopropoxide was sprayed on the FTO glass substrate at 450 ^{0}C by the spray pyrolysis system. The TiO_2 colloidal suspension was prepared by mixing of TOsol, 90% ethanol, acetic acid and polyethylene glycol. Then the solution was sprayed on the substrate which was kept on a hot plate at an experimentally found optimum temperature at 130 °C. After 60 min of spraying the glass plate was kept at the same temperature for 30 min on the hot plate. Then this was sintered at 500 °C for 30 min. Afterwards it was dipped in N719 (Ruthenium) dye solution for one night. This cell was again kept on the hot plate at 80 ^{0}C and CuI solution system which was added with Triethylhydrothiocyanate (THT) as a crystal growth inhibitor, (Kumara *et al.*, 2002) was sprayed on it for 3 min. Then I-V characteristics were measured using PEcell solar simulator. The composition of polyetheleneglycol was varied and the change of the efficiency was studied.

Results and Discussion

The transparency can be studied with UV-visible spectroscopy, but just by the view it is possible to identify the cells prepared by the automated spray pyrolysis system is very much transparent than the cells prepared by the solvent deposition system(Zhang *et al*,. 2007) (Fig 1, appendix). The transparent cell has low efficiency 1.07 % compared to the others where 3-4 % efficiencies have been obtained, since a portion of the incoming light travels through the cell without allowing to harvest solar energy. Another reason is that the CuI penetrates through the pores in TiO_2 layer to a lesser extent than that in the normal deposition method. Therefore, polyeheleneglycol was added to the solution before spraying and when it is sintered to 500 °C the polymer burns and the volume of pores becomes high. Therefore the efficiency has improved by 17.5 % (Fig 2, appendix). This reveals that the improvement of the pores and surface area for CuI adsorption to the TiO_2 layer. Then the charge transfer at the TiO_2/CuI interface is improved. Therefore, efficiency has been improved from 0.91 % to 1.07 %.

References

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Appendix

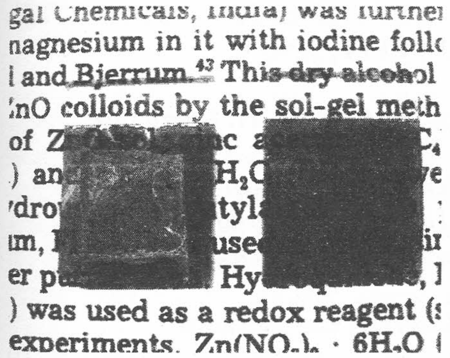

Fig. 1. Transparent Solid state cell sprayed by automated system (right), prepared by conventional deposition system (left)

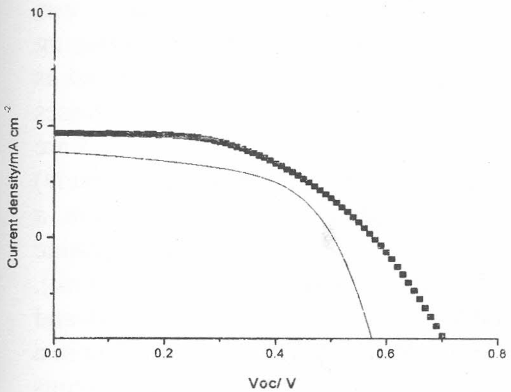

Fig. 2. I-V curves of transparent solid sate cell with (scattered line) and without (single line) introducing polyetheleneglycol