Effect of carrier collectors on the Efficiency of DSSCs

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Abstract: Transparent conducting glasses exhibit high ohmic losses that are apparent in the case of large size Dye Sensitized Solar Cells (DSSCs). In this study, we investigated the impact of current collectors over the efficiency of DSSCs. The Silver current collectors were prepared on both counter electrode and working electrode surface by screen printing method. For long term stability in electrolyte environment and also to avoid the charge recombination, current collectors are protected by sodium silicate overcoat layer. These current collectors were characterized for their microstructure parameters. Also current collector’s stability in electrolyte environment has been investigated.

Key Words: current collector, electrode, resistive loss, overcoat layer

1. INTRODUCTION

Dye sensitized solar cells (DSSCs) invented by Swiss scientist M. Graetzel has attracted an increasing number of academic and industrial researchers due to its high performance and low cost. Since Gratzel’s breakthrough report in Nature[1], high commercial expectation placed on DSSCs. We are from research institutes, have concentrated our efforts to scaling up the DSSCs from laboratory level to practical applications such as 10 x 10 cm² modules. Parallel grid modules, due to its maximum active area and simple manufacturing methods, are preferred rather then monolithic; series interconnect Z and W design modules for scaling up the DSSCs [2].

In large area cells the main problem arising from high resistance of transparent conducting glass substrates. In order to avoid resistive losses and collect the photo excited carriers more effectively; silver current collectors are screen printed on conducting glass surface in analogy with conventional photovoltaic cells. In DSSCs, these current collectors are easily attacked by electrolyte and also cause to charge recombination. So current collectors should protect from electrolyte through overcoat layer [3].

In this report, we have prepared the silver current collectors on FTO conducting glass surface by screen printing method. Following heat treatment, overcoat layer of sodium silicate was printed on Ag current collectors. Photo-current density of the DSSCs, which are made up of photo anode and counter electrode with silver current collectors, has been calculated and compared with normal DSSCs.

2. EXPERIMENTAL PROCEDURE

Silver current collectors are formed on FTO conducting glass surface by screen printing method and annealed at 180°C for 10 minutes in box furnace. Then glass overcoat layer was formed on silver current collectors using the specially designed screen that cover the whole surface of the current collectors except bus bar. Then, FTO substrates having current collectors with glass overcoat layer annealed at 180°C for 10 minutes.

TiO₂ colloidal paste (Deagussa, P25) was printed between the two conductive fingers. These layers kept in room temperature for 15 minutes for drying and then sintered at 500°C for 30 minutes. Sintered TiO₂ photo anodes (20μm thickness) are immersed in 0.15mM dye solution (cis-bis(isothiocyanato) bis(2,2’-bipyridyl-4,4’-dicarboxylato) ruthenium(II), generally known as N₃) in ethanol for 24 hours.

Thin layer of Platinum was deposited on FTO substrates with current collectors by means of electro deposition method. In counter electrode surface, two holes are made for electrolyte injection. In order to prepare DSSC, counter electrode was placed on sensitized TiO₂ layer, in between them Surlyn sheet was kept as a spacer (approximately 50μm) for avoid the direct contact between TiO₂ surface and counter electrode. Electrolyte was injected through counter electrode holes and then holes were sealed by Amosil. I-V characteristics of these cells were measured using Keithley instruments in Air Mass 1.5, simulated solar light (1000W/m²).
3. RESULTS AND DISCUSSION

Fig 1 shows DSSCs with and without silver current collectors having an active area 1.4 cm² (Dimension of TiO₂ layer 35mm x 4mm x 5um). The distance between TiO₂ layer and silver current collector was fixed to 2 mm. For comparison, the same size DSSC prepared without silver current collectors. Both cells are characterized for their I-V properties in simulated solar radiation under same parameters.

Table 1 show the photo current density of the cells with and without silver current collectors. Photo current density of DSSC with silver current collector was more then one order of normal DSSC which don't have silver current collectors.

![Fig 1 DSSCs with and without Silver current collectors.](image)

<table>
<thead>
<tr>
<th>Cell</th>
<th>Voc (V)</th>
<th>Jsc (mA/cm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DSSC without Ag current collector</td>
<td>0.699</td>
<td>2.571</td>
</tr>
<tr>
<td>DSSC with Ag current collector</td>
<td>0.650</td>
<td>5.253</td>
</tr>
</tbody>
</table>

4. CONCLUSION

Dye sensitized solar cells with screen printed silver current collector and without current collector were prepared. Its photo current density has been calculated and compared. Due to low resistance of FTO conducting glass surface with silver current collectors, the photo current density of this type solar cell was higher then normal DSSCs which dont have current collectors. Now optimizations of distance between current collectors and dimension of silver collectors for higher efficiency are underway.

REFERENCES