

A Review on Dye Sensitized Solar Cell

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ABSTRACT

The hunger of energy of such a vast population is leading us towards our end because its other aspect which is dark and ignored all the time. Till now we are mainly dependent on the fossil fuels like coal, petrol, diesel etc. These fuels generates energy along with byproducts like carbon CO₂ and many other which are very dangerous to us and our environment . These fuels has ruined our atmosphere to such a extent that the recovery is very difficult. If it takes more time than it would be very late to us. Due to the long time research and technology advancement we have a lot of alternate of fossil fuels in which the solar energy is at the top . Solar energy can provide us very cheap and more important clean energy because it has no byproducts. There are a lot of ways by which we can use solar energy according to our need. Apart from this solar energy has solved the first and the biggest problem in human approach to the space, yes these are the PV cells which are providing energy to all of our satellites and space station.

Keywords: *DSSC (Dye sensitized solar cell) ,Thin film solar cell*

I. INTRODUCTION

Due to the need of time and popularity of the PV cells at the present time there are a lot of type of PV cells has been developed and research work is still in progress to increase the efficiency and to decrease the installation cost.

PV cells work same as the p-n junction diode and has same basic construction. First of all by using the

photolithography and etching n and p regions are created. Change take place over the n region where a transparent and antireflection coating is performed so that maximum amount of the incident photon can be utilized. to decrease the refraction and reflection the upper surface of the n region is made uneven by texturing on it.

For flowing current in the cell it is important that an electric field is generated across it and this is done by the incident photon. When a photon collides with the electron-hole combination then electron get energized and thus it break the combination. As this process goes further an electric field is generated due to the separation of electron hole pair and a current starts to flow.

In this paper we will discuss on the most popular and advanced type of the solar cell which is Dye sensitized solar cell (DSSC). It is also called Gratzel cell which is a thin film solar cell. It is based on a semiconductor formed between a photo- sensitized anode and an electrolyte, a photoelectro-chemical system.

The DSSC has number of alternative feature like it is simple to make using conventional roll printing techniques, is semi flexible and semi transparent which offers a varieties of uses not applicable to glass based system, and most of the materials are low cost.

II. Methodologies

A. ZnO thin film solar cell

ZnO based DSSC are the one of the best materials which are used in making photo-anodes because of the available large surface area, effective light dispersing centers etc. ZnO nano tubes thin film are developed using seed mediated hydrothermal technique.

ZnO thin film can be made from 0.1 M of zinc acetate dehydrate from Aldrich as a starting material. This solution is dissolved in the solution of ethanol and acetylacetone in 1:1 mol ratio. This solution is called the precursor solution for this procedure. Now going further the achieved solution is then coated on the glass like soda glass. After the coating process it is treated with the acetone, ethanol, deionized water for 15 minutes and at last the to eliminate the harmful contaminants the drying procedure takes place using the nitrogen gas.

The procedure of coating includes the 0.2 ml precursor solution which is to be deposited on the glass is coated by using the spinner running at the speed of 2000rpm for 10 seconds. Thus the coated glass is then put for drying process for 3 minutes. this process is repeated for 5 times and the last process of annealing is started at 500 degree celsius under O₂ for 2 hours.

The most dense and compact structure is observed for the 0.010 M sample

The amount of the O₂ during annealing of ZnO is critical because it acts as the reagent to eliminating the organic compounds and impurities.[14]

B. TiO₂-based DSSC

As we know that the DSSC is one of the most developed technology in the field of solar energy and the TiO₂ nanoparticle based solar cell is one of the best. In order to develop tio₂ based solar cell first of all we have to prepare a dye solution which includes ethanol, acetic acid and distilled water in the ratio of 3:2:1. Now the resultant solution is stirred continuously at 50 degree celsius for about 30 minutes. After the previous step the solution is filtered out with the help of the filter paper and then 0.2 gm TiO₂ nanoparticles is mixed by using the agate mortar with 0.4 ml nitric acid (0.1 M), 0.8 gm polyethylen

glycol and one drop of nonionic surfactant to achieve porous TiO₂ film on FTO.

Now after making the tio₂ solution we have to coat it on the FTO plate and for this purpose the best method is spin coating method because it provides even and fast coating on a surface. Thickness of the coating can be changed by changing the speed of the spinning surface. When a coated plate of FTO is achieved then this plate is put in a oven at the 450°C for 2 hours.

For the analysis of the bandgap UV absorption spectrum method is used by using which we find the range of 2.41 to 2.59 eV. By the comparison among all the outputs we can see that the band gap decreases as the speed of the rotation increases.[15]

Table 1 Relation between bandgap and RPM [15]

Rotation per minute	Band gap ev	
	PL	UV
3000	2.57	2.59
4000	2.52	2.52
4000	2.47	2.46

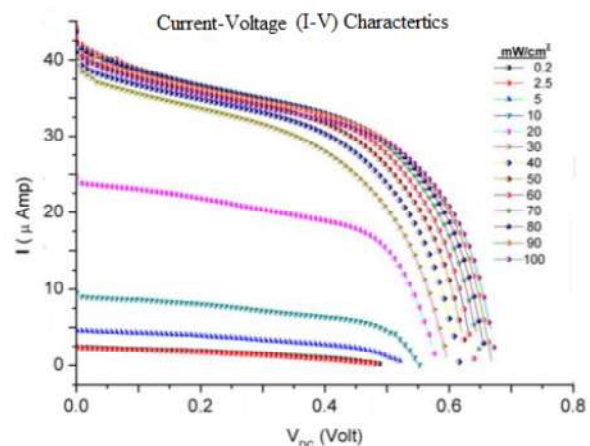


Fig.1: Current-voltage (I-V) characteristics of the studied solar cell [5]

C. Bi₂S₃ based DSSC

It is also one of the developing DSSC technology. In this idea the FTO glass is coated with the Bi₂S₃ thin films at the room temperature. In this procedure the solution containing (20ml) 0.003M Bi(NO₃)₃ solution, used as cationic precursors with pH~10 and (16ml) 0.1M of thioacetamide [CH₂-CS-NH₂] used as anionic precursor with pH~11 which was raised by

addition of hydra zine hydrate as demonstrated by Ahire and Sharma(2006).

The FTO glass is put in the prepared cationic precursor solution of $[\text{Bi}(\text{NO}_2)_3]$ for 30 seconds. In this solution the FTO glass plates absorb the Bi^{3+} ions and after this the plate is then put in the distilled water for a little while. this is done so that the unabsorbed ion can be removed from the surface of the glass.

Thereafter, the substrates were then immersed into the ionic precursor of $[\text{CH}_2\text{-CS-NH}_2]$ solution for another 30 seconds in which the S^{2-} ions from the thioacetamide solution reacted with Bi^{3+} ions already absorbed by the FTO glass substrates in the cationic precursor. After above processes a PEC configuration of Bi_2S_3 is formed and then the cell is ready to produce the dark voltage and dark current with the help of negative electrode.

When the junction of the cell encountered to the photon then the negative voltage on the Bi_2S_3 electrode increases and thus we can see that it starts to work as a cathode . [6]

D. Modified SILAR grown CdS quantum dot DSSC

CdS is well known properties specially in the field its electrical properties. By using the Cds an transparent solar cell can be manufactured which is very helpful in trapping the light in the cell and helps in increasing the efficiency.

In cds type of DSSC a three layer cell is made which includes active area of 0.283 cm^2 . The first layer is titanium isopropoxide , second one is TiO nanocrystalline paste and last one is titanium chloride . all the coating takes place with the help of spinners .

The quantum dots are prepared by SILAR technique. This film was dipped into a 0.5 M Cadmium Nitrate $[\text{Cd}(\text{NO}_3)_2]$ ethanol solution (Cadmium cationic precursor) for 2 min, rinsed with ethanol, heated for 10 min, cooled to room temperature and then dipped for another 2 min into a 0.5 M Sodium Sulfide $[\text{Na}_2\text{S}]$ water solution (Sulphur anionic precursor) and rinsed again with water, heated for 10 min, cooled to room temperature. The CdS adsorbed TiO_2 film is dried with N_2 air stream. The two-step dipping procedure is called 1 SILAR cycle and the process continued to 10 cycles. Counter electrodes are prepared with sputtering on FTO.

The surface is cleaned by dipping the prepared cell into the 0.3 M ionic solution of sodium sulfide nanohydrate to remove the all type of impurities and unabsorbed ions .[1]

E. Sb_2S_3 extremely thin absorber solar cell

This is one of the best technology available for the thin film solar cell. It provides most thinner coating which makes it flexible and light .first of all the Sb_2S_3 is absorbed by the TiO_2 using the chemical bath method. Chemical bath is a process in which a solution is made using 650 gm SbCl_3 in 2.5 ml of acetone, 12 ml of $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$ and distilled water. After preparing the solution the FTO or TiO_2 film is put into it. The film is remained in it for about 3 hours. To make the surface clean and remove unabsorbed ions from the surface of TiO_2 films an environment of N_2 is created for 20 minutes.

To make the solution saturated CuI is dissolved in it 6 mg of guanidinium thiocyanate was dissolved in 5.0 ml of this solution and the resulted solution was spread on the preheated FTO/ TiO_2 / Sb_2S_3 / N_719 electrode few times until CuI layer is appeared on electrode. At last to complete the construction of cell gold spotted glass electrode is used as the counter electrode and put into the sunlight then it will start producing current.

At the time of working it produces 0.512 V and a current density of 4.88 mA cm^{-2} . In this type of cell current produced is low because the working area of cell is quite low than the other type of cell.

0.512 V and lower short-circuits current density of 4.88 mA cm^{-2} . Here the J_{sc} value is comparatively low, due to low surface area in the TiO_2 film (screen printed TiO_2 film of 3 μm in thickness), when compared to our previous publication which has over 3% efficiency with the same solar cell having TiO_2 thickness is 15 μm [20]. That TiO_2 film, 15 μm thickness, made by dropping method, is not efficient for Sb_2S_3 - extremely thin absorber solar cell. [9]

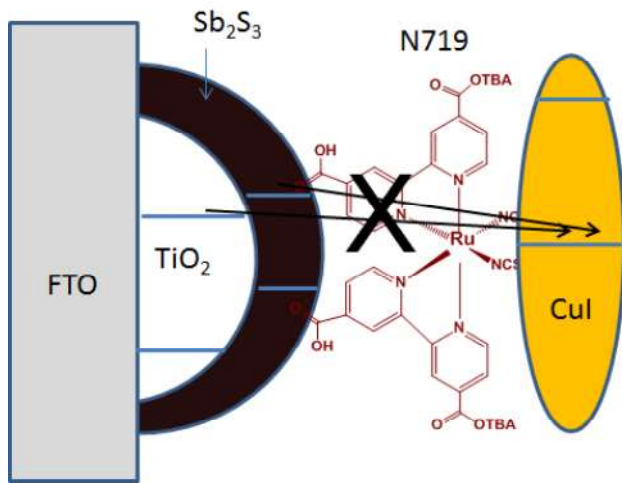


Fig 2. Illustration of the solar cell configuration of the FTO/TiO₂/Sb₂S₃/N719/CuI/Pt-FTO indicating relevant recombination paths. [9].

III Problems related with DSSC technology

There are a lot of problems which are to be solved which are as follows-

- The installation and manufacturing cost of the DSSC are very high because platinum, gold, titanium are used in formation a complete solar cell so an alternative of all these expensive metals should be find which should be cheap.
- The overall efficiency of the DSSC is less than the other type of solar cell so an effort on increasing the efficiency should be done.
- The DSSC do not work well towards the light with low intensity so this aspect of the solar cell should be developed.
- Transparent type DSSC are not well at their performance and a lot of effort is still needed in this field.
- These type of the solar has shorter life because of the leakage and vaporization of the electrolytes.

IV Future Scope

Our home is earth and by and by it is getting ill due to the unbalanced works of humans. Due to the unbounded use of the fossil fuel leads us to the many huge problems like air pollution, global warming, melting of the icebergs and many others. Solar energy is one of the cheap clean and effective way to overcome all of the problems.

DSSC is the latest technology which increase the area of the utilization of solar energy. DSSC are compact in size, light in weight and are flexible which makes

them able to use on the different portable and small devices. If we say that the all the DSSC will replace the all other poor sources in electronic and electrical devices in the future.

By using the DSSC on the clothes we will be the walking power sources who can fulfill all the need of the power of our devices and perhaps there will no time in which our smart phones are out of power.

Transparent solar cell can be the major power suppliers for skyscrapers because they are covered with the glass and the window.

Thus in our future DSSC is the key technology that can make all of the devices plug free and self dependant for the power needs

V CONCLUSION

Dye sensitized solar cell, based on the concept of photo sensitization of wide band gap mesoporous oxide semiconductors, are now in a state of advanced development.

DSSC have many advantages over their silicon based counterparts. They offer transparency, low cost and high power conversion efficiencies under cloudy and artificial light condition. However, till now their overall efficiency is quite low in comparison with their rival technologies. On the basis of the efficiency their primal competitor is the SI based solar cell.

The low efficiency is due to the inherent voltage loss at the time of the re generation of the sensitizing dyel at the present time in a nature publication, EPFL scientists have developed a state solid version of the DSSC that is fabricated by a new two step process raising their efficiency up to record 15% without sacrificing their stability. If we talk in short about the DSSC then in it a perovskite material to place directly onto a metal oxide film. The tough task is to put all of these material together causes the decrease in the efficiency and the performance which can more difficult in daily use. But after developing above written technology we are very close to the final result.

Due the research on the many DSSC technologies the efficiency of the many DSSC has reached to record 15% which is somewhat high to it's rival solar cells. the authers and researchers believe that the new era has started of DSSC development.

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