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EFFECT OF SINTERING TEMPERATURE ON PHOTOANODES FOR DYE-SENSITIZED SOLAR CELLS

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ABSTRACT

In the presented study effect of sintering temperature on photoanodes for dye-sensitized solar cells has been discussed. TiO_2 semiconducting layer coated on ITO has been used a photoanode in the synthesized cells. To construct TiO_2 layer on ITO, spin coating technique has been used. Structural analyses have been done with the help of x-ray diffraction and scanning electron microscopy. It has been found that all performance parameters of DSSC decrease with increase in temperature.

I. INTRODUCTION

Dye-sensitized solar cells are the cheap and best way to ward out energy crisis on commercial basis with a great deal of viability [1-5]. Our lives totally rely on energy processes but fossil fuels are moving ahead towards their end. So there is a high demand to look out for other renewable energy sources and sun can provide a huge amount of usable energy[6-10]. Other solar cell technologies are too costly to commercialize on a massive scale but dye-sensitized solar cells have potential applications because of their optimum cost to performance ratio [11-17].

Four major components of DDSCs are: A photoanode, dye adsorbed on to photoanodic layer, an electrolyte and a conducting counter electrode [18-22].In this paper, our focussed attention is on effect of temperature on electrode material performance.

II. EXPERIMENTAL

Electricity TiO_2 thin films have been synthesized via sol-gel spin coating technique. TBOT (tertiary butyl ortho titanate) was mixed with diethanolamine along with ethanol along the course of a continuous stirring with hot plate and magnetic stirrer. A vigorous stirring was done at room temperature for one hour and at $40^{O}C$ for one hour. Ethanol was added drop wise using burette during stirring process. Then the solution was kept for 4 hours for the formation of sol. Although a lot of methods have been quoted in literature, this is an easy and reliable technique to fabricate TiO_2 films on ITO [23-25].

Prepared sol was deposited onto ITO coated glass plates by spin coating. After the formation of layer different sintering temperatures were used for different cells and calculated the values of performance parameters

III. RESULTS AND DISCUSSIONS

Structural analysis was done with the help of XRD and SEM coated elsewhere[26]. Following plot shows the effect of temperature on Voc value of formed dye-sensitized solar cells.

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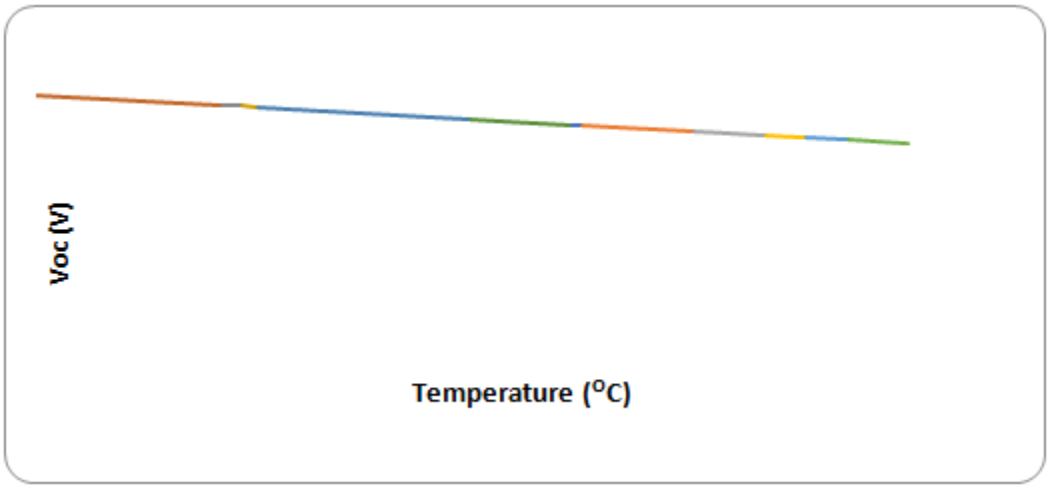

Figure 1. Effect of temperature on open-circuit voltage

Figure 1 clearly shows that with increase in temperature open-circuit voltage decreases. It might be due to the fact that increase in temperature may cause allotropic form of TiO_2 and that form might be less conducting.

Figure 2 represents the variation of short-circuit current with temperature. This diagram also depicts that short circuit current decays down with increase in temperature. This decrease may also be due to transition of allotropic form.

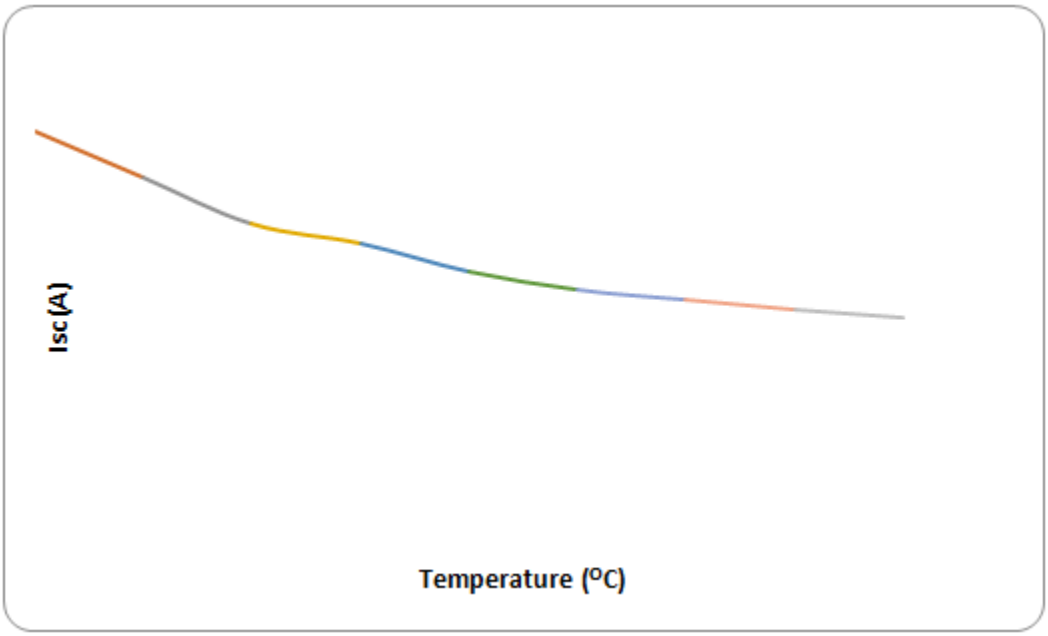

Figure 2. Change in I_{SC} value with change in temperature

Following picture shows the change in effective voltage with change in temperature during the process of sintering.

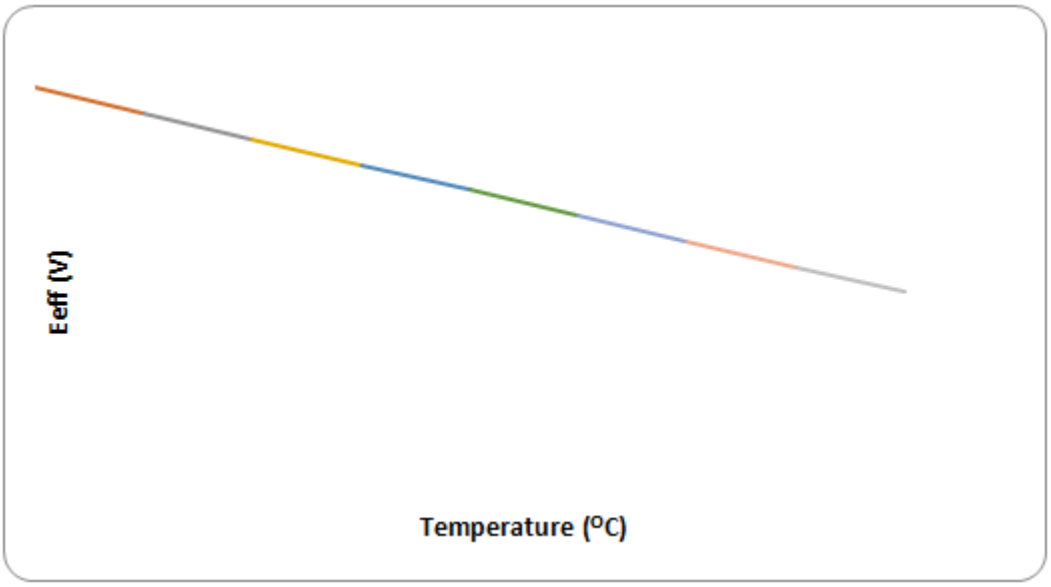

Figure 3. Variation of E_{eff} with change in temperature

E_{eff} is the maximum voltage responsible for efficiency of a dye-sensitized solar cell. The decrease in value of effective voltage with increase in temperature may be attributed due to loss of conducting channels at higher temperatures.

IV. CONCLUSIONS

Crackfree TiO_2 films have been synthesized via sol-gel spin coating method. The behavior of these films as photoanode have been studied by varying temperature during sintering process and it has been found that all the performance parameters decrease with increase in temperature. It has been concluded that during sol-gel spin coating technique, anatase TiO_2 is formed and with increase in temperature anatase form is converted into rutile form which is more brittle and less conducting. Therefore it can be said that rutile films are not suitable for usage in dye-sensitized solar cells.

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