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FABRICATION OF DYE SENSITIZED SOLAR CELL

ARUN KUMAR JOGI[1] & SREEDHAR D[2]

Sreenidhi Institute of Science and Technology, Hyderabad, Telangana, India

ABSTRACT

Dye-sensitized solar cells combine the unique properties of both inorganic and organic compounds. They are potential alternatives for present day p-n junction photovoltaic devices. In this work fabrication of a dye-sensitized solar cell using Black Berry fruit extract as a natural organic dye and TiO_2 semiconductor nanoparticles synthesized through sol-gel method has been reported. Graphite was used as a counter electrode and potassium iodide was used as a charge carrier in the cell. Light form the sun excites the electrons of the organic dye that is coordinated to TiO_2 and the electrons are then injected into TiO_2 nanocrystals. The electrons then flow from TiO_2 coated electrode, through the load and back to the Graphite counter electrode. The counter electrode then donates electrons to the dye completing the circuit. SEM images of synthesized TiO_2 nanoparticles had an average size of 65 nm. An efficiency of 33.45% has been achieved by using Black Berry fruit extract as the dye.

KEYWORDS: Solar Cell, DSSC, Sol Gel Method, Dye of Black Berry, Carbon Electrode, SEM, EDS, Solar Spectrum

INTRODUCTION

In a conventional semiconductor a solar cell is made from two doped crystals, one doped with p-type impurities and other doped with n-type crystals. Electron-hole pairs are generated when light hits the device. But such a cells require a relatively thick layer of doped silicon in order to achieve reasonable photon capture rates and processing silica is expensive. In such a solar cell silicon acts as both the source of photoelectrons and the charge carrying material for creating current. In the dye-sensitized solar cell the semiconductor is solely used for charge transport and the photoelectrons are generated form a separate photosensitive dye(1). Separation of charges occurs at the surfaces between the dye and the semiconductor. Using nanomaterials as the semiconductor increases the chances of capturing a reasonable amount of photoelectrons(2).

EXPERIMENTAL PROCESS

Synthesis of Nano Tio2

TiO_2 nano particles were prepared through sol–gel method using titanium tetraisopropoxide (TTIP), distilled water, and ethyl alcohol. The sol-gel synthesized TiO_2 was obtained from Titanium tetraisopropoxide was dissolved in absolute ethanol and distilled water was added to the solution in terms of a molar ratio of TTIP: H_2O=1:4. Nitric acid (HNO_3) was used to adjust the pH and for restrain the hydrolysis process of the solution. Kept the solution on a magnetic stirrer for 45 min at room temperature. In order to obtain nanoparticles, the gels were dried under 50 ºC for 1.5 hr to evaporate water and organic material to the maximum extent [3]. After ball milling [4] the dried powders obtained were calcinated at 400ºC for 2 h to carry out to obtain desired TiO2 nanocrystalline.

Fabrication of Dye Sensitized Solar Cell

- Take 2 gm of Titanium Dioxide nano powder in a clean mortar and pestle. Add nitric acid using a dropper. Grind well for 15 minutes.
- Clean the conductive glass slide with ethyl alcohol. The resistance of the glass slide was measured using multimeter and it showed to be zero ohms.
- Conductive side o of the glass slide was taped to a tissue on all four sides about a 2mm gap.
- Take TiO_2 paste on conductive glass slide taped to the tissue. Spread the titanium dioxide paste on the slide to form a thin uniform layer.
- Let theTiO_2 paste dry off. Remove the tape carefully.
- Place the glass slide in a Hot plate and heated at 80^oC for 20 minutes.
- After that glass slide was allowed to cool in free air. After cooling it was gently washed with distilled water and ethyl alcohol.
- Blackberry seeds were crushed in a clean mortar and pestle to extract the juice.
- The TiO2 coated glass slide was allowed to soak in the extracted blackberry dye for twenty minutes.
- The other glass slide was coated with graphite.
- Three drops of potassium iodide solution was put on the TiO_2 coated glass slide.
- Combine both glass slides in a particular manner and use 2 binder clips were used to keep the glass slides in place.
- Required DSSC is fabricated. A multimeter is used to take the readings at direct sun light.

RESULTS AND DISCUSSIONS

Structural Study Using XRD

The XRD patterns of the Tio2 nanoparticles obtained by sol gel route are shown in Fig.1. The size of the TiO_2 nanocrystals calculated using the Scherrer's formula is 65 nm.

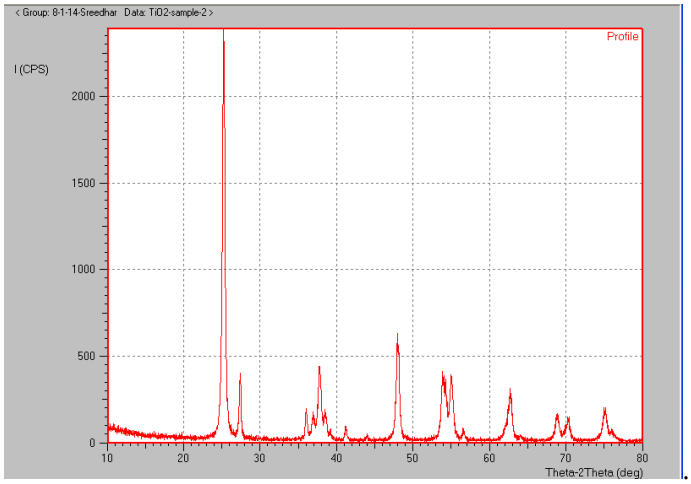

Figure 1: XRD Patterns of TiO_2 Nanoparticles

SEM Morphology of TiO_2

The SEM morphology of calcinated TiO_2 nanopowder at 400 ºC is shown in fig..2. The pure TiO_2 particles obtained with irregular morphology due to the agglomeration of primary particles and with an average diameter of ~65nm.

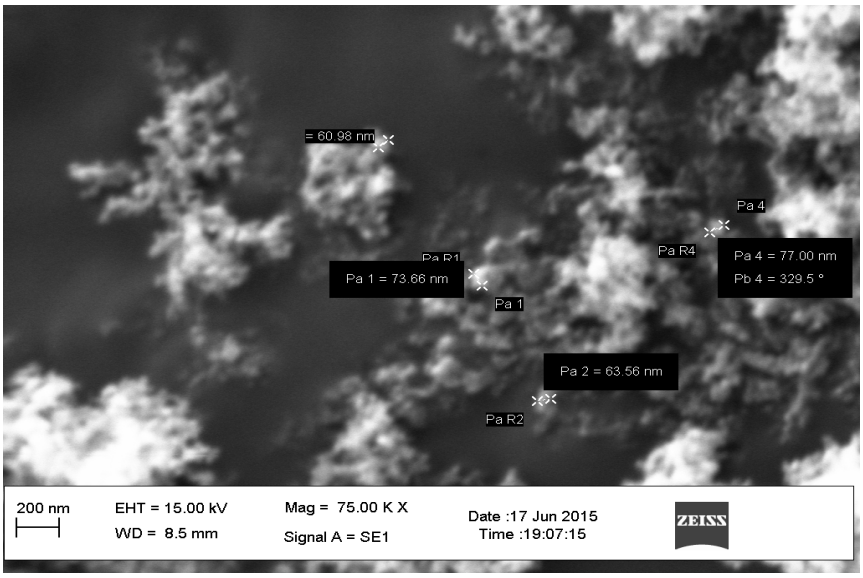

Figure 2: SEM Morphology of Calcinated Titania Powder at 400 ºC

EDAX Result of TiO_2 Nanoparticles

EDAX spectrum of TiO2 nanoparticles is shown figure 3. Peaks regarding Titanium and Oxygen are seen in the spectrum which indicates their presence.

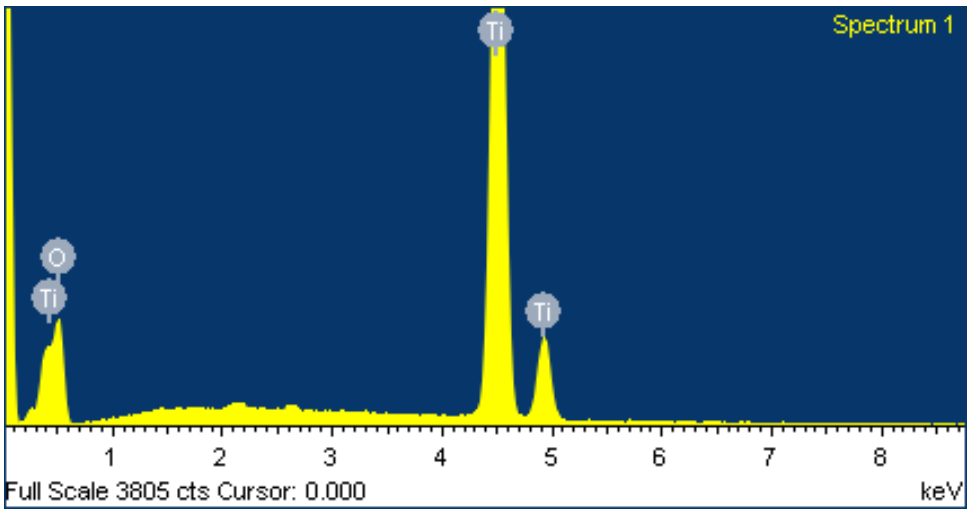

Figure 3: EDAX image of TiO_2 Nanoparticles

Table 1: Weight and Molecular percentages of Titanium and Oxygen in the Sample

Eelment	Weight %	Atomic %
O	30.24	56.48
Ti	69.76	43.52

Dye Sensitized Solar Cell Readings

After fabrication of dye sensitized solar cell we observe below readings under solar spectrum using multimeter.

Table 2

Short circuit current(mA)	Open Circuit voltage(mv)	Efficiency (%)	Fill Factor (%)
0.31	290	33.45	40.52

CONCLUSIONS

The dye-sensitized nanocrystalline electrochemical photovoltaic system is prototype of a series of optoelectronic and energy technology devices exploiting the specific characteristics of this innovative structure for oxide and ceramic semiconductor films.

Recent developments in the area of sensitizers for these devices have lead to dyes which absorb across the visible spectrum leading to higher efficiencies. The recent development of an all solid-state hetero junction dye solar cell holds additional potential for further cost reduction and simplification of the manufacturing of dye solar cells.

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