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Natural Sensitizer with Different Solvents for DSSC Using Azadirachta Indica

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***Abstract* - Dye Sensitized Solar Cells are expected to be used for future clean energy and mainly depends on the dye used as sensitizer. In DSSCs, a sensitizer plays a key role in absorbing sunlight and transforming solar energy into electric energy. Recently, most of the researchers in this field use Ruthenium complex as dye sensitizer. But the process to synthesize the complex is complicate, costly and undesirable from the point of view of environmental aspect. Another approach is to use natural dyes, which is environmentally friendly, nontoxic, biodegradable, and cheaper compared to the synthetic dyes. The absorption spectrum of the dye and the anchorage to the surface of TiO2 nanoparticles are important parameters in determining the efficiency of the cell. This article presents the experimental data of azadirachta indica dyes are extracted with different solvents used as sensitizers in DSSC and analyzed the UV-VIS absorption spectra, FTIR technique. The surface characteristics of TiO2 thin film have been analyzed using SEM images for improving the absorption into the substrate.**

Keywords: Natural dyes, Chlorophyll, UV-VIS, FTIR, SEM.

I. INTRODUCTION

During the last decade the production of solar cell has grown dramatically. Among all the renewable energy technologies, such as wind turbines, hydropower, wave and tidal power, solar cells etc., photovoltaic technology utilizing solar energy is considered as the most promising one [1]. Dye-sensitized solar cells (DSSCs) are the third generation of photovoltaic devices for the conversion of visible light in electric energy. These new types of solar cells are based on the photosensitization produced by the dyes on wide band- gap mesoporous metal oxide semiconductors. One aspect of these DSSCs photocells that is particularly attractive is the low cost of the solar energy conversion into electricity because due to the use of inexpensive materials and the relative ease of the fabrication processes [2-4]. The charge transport is highly affected by the crystalline quality of metal oxide material; therefore it is important to reduce the charge traps in the films to speed up charge transport [5]. Another crucial parameter in the fabrication of DSSCs is the sensitizing dye. Due to the dye significant role, considerable interest has been directed towards the development and improvement [6] of natural pigments as sensitizing dye for the conversion of solar energy in electricity is very interesting because, on one hand they enhance the economical aspect and on the other they produce significant benefits from the environmental point of view [7,8]. Natural pigments extracted from fruits and vegetables [9-11], such as chlorophyll and anthocyanins, have been extensively investigated as DSSCs sensitizer. The efficiency of DSSC is determined mainly by the sensitizer used [12, 13]. The marketed dyes for commercial use are mostly chemical synthetics, such as N719 and N3 dyes, both of which have satisfactory photoelectric conversion efficiency. However, these dyes always use some heavy metals, which are both expensive and produce environmental pollution. However, ruthenium polypyridyl complexes contain heavy metals, which make this kind of DSSC is unpopular from environmental aspects [14]. Moreover; the synthesis process of this complex is very complicated and expensive. In order to replace the rare and expensive ruthenium compounds, many kinds of natural dyes have been actively studied and tested as low-cost materials. The leaves of most green plants are rich in chlorophyll [15], and the application of this kind of natural dye has been frequently investigated in many related studies.

In this research paper, optical characteristics and comparison of the extracts of Azadirachta indica with different solvents were studied. The results revealed that the natural dyes thus extracted to be used as light sensitizers in the preparation of DSSCs.

II. MATERIALS

2.1 Natural Dyes Extraction

Fresh young green leaves of azadirachta indica were cleaned by deionized water, and 3 grams of leaves were placed into a test tube, after that 10 ml of the ethanol, methanol and acetone were measured accurately which was poured into test tube as shown in the fig.1. Then it is immersed with different solvent medium which is completely closed by aluminum foil and kept at room temperature in the dark for 24 hours to the

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extract the natural dyes. Finally the solids were filtered out and natural sensitizers were prepared.

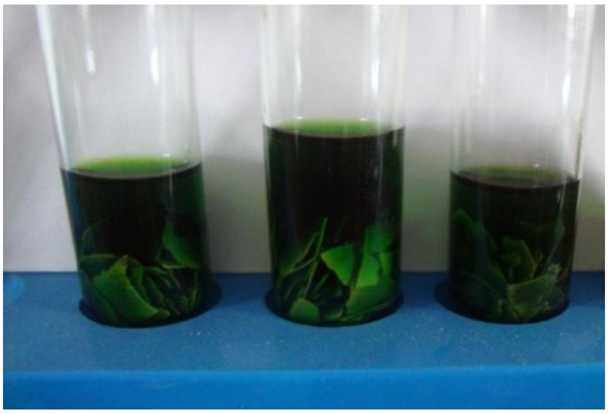


Figure 1: Extraction of azadirachta indica with different medium

III. RESULTS AND DISCUSSIONS

3.1 Absorption Spectra Analysis

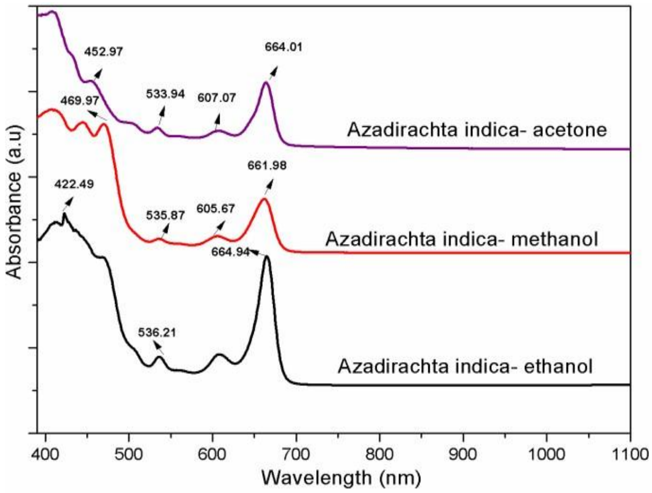
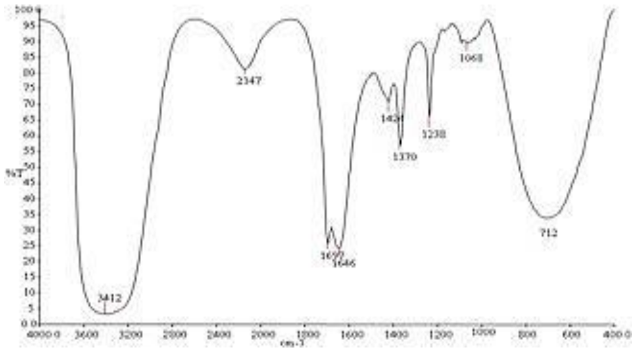


Figure 2: Absorption spectra of azadirachta indica

The UV–VIS absorption spectra of azadirachtaindica sensitizer were measured using a UV-VIS spectrophotometer. The absorption spectra was analyzed in the wavelength range from 350 to 800 nm Fig. 2 show absorption spectra of natural extracts dissolved in different solvent medium. The most prominent feature has been observed from these figures was that extracts have slightly different absorption peak in the visible region. Additionally, this absorption peak does not depend on the extract of the leaves and it was clearly show that the solvent has a vital role in fabrication of dye solar cell. Extract of azadirachtaindica sensitizer shows an absorption peak at 664.01 nm for acetone, 661.48 nm for methanol and 664.94 nm for ethanol. Consequently, we find this combination of chlorophyll with ethanol gives a good absorption range.

3.2 FTIR Analysis



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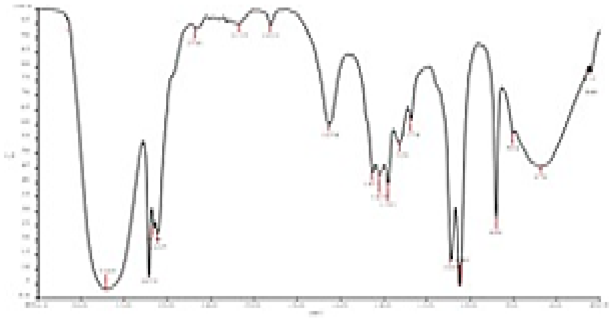

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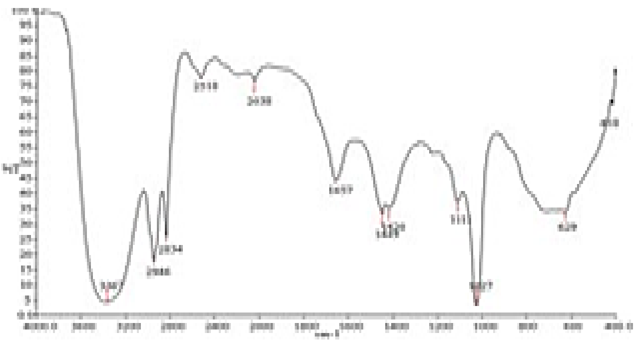

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Figure 3: FTIR analysis of azadirachtaindica

The role of FTIR in DSSC was showing the specific functional groups of three different solvent to be effectively absorbed onto the $TiO2$ substrate as shown in fig.3. The functional groups of chlorophyll dye hydroxyl groups (– OH), bound with $TiO2$. Figure 4 shows the FTIR spectra of the spectral range within the wave band of 4000~400cm−1. As observed from the functional groups of chlorophyll dye extracted from, O-H stretch and C–H3 vibrations are observed at 3412cm−1 and 2417 cm−1, respectively. Moreover, C=O vibration 1697cm−1, C–O vibration 1068cm−1, and C–N vibration of porphyryins at 1646cm−1 are also observed. Finally it was observed that the solvent medium play a major role for the improved dye solar cell.

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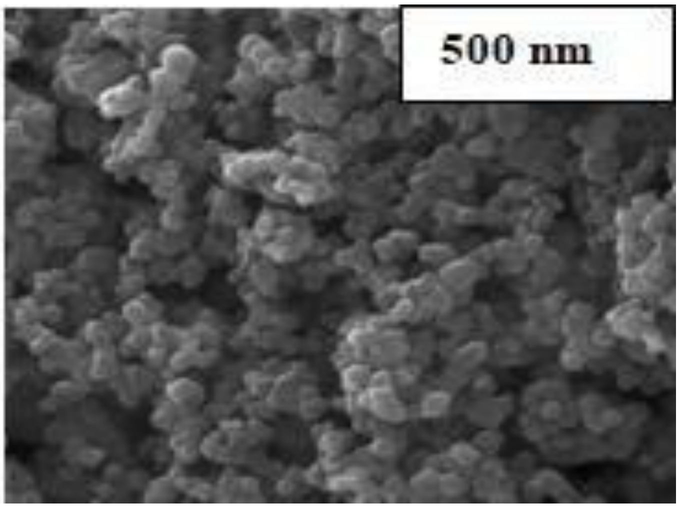
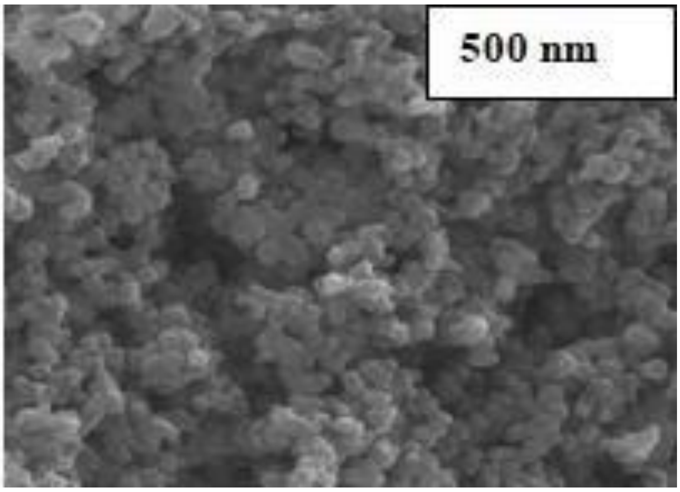
3.3 SEM Analysis



(a)



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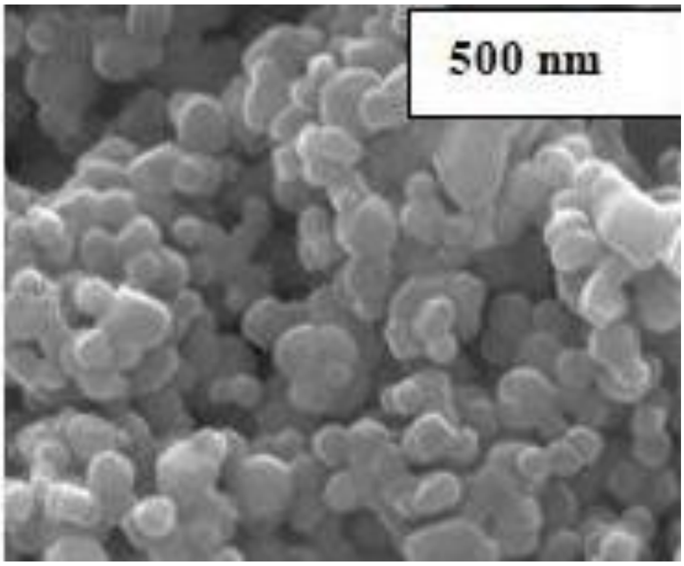

(c)

Figure 4: Morphology analysis of azadirachtaindica

Fig. 4 shows titanium nanoparticles deposited on the FTO substrate with different solvent natural sensitizer medium. . It has been observed that the TiO2 nanoparticles annealed at 450ºC were almost reveals that the primary particles are quite clean and roughly spherical in shape, and that the agglomerates are fused together to form comparatively smaller irregular grains giving rise to highly porous materials. The natural sensitizer was successfully deposited on the FTO substrate which enhancing the photovoltaic performance.

IV. LABORATORY PREPARATION OF DYE-SENSITIZED SOLAR CELL

The FTO glass plates were cleaned by using an ultrasonic bath with acetone, ethanol, and water for about 15 min each. A scotch tape at four sides was used as masking material on the conductive layer to restrict the thickness and area of the paste (1cm x 1cm). A plastic adhesive tape was fixed on the four sides of conductive glass sheet to restrict the thickness. TiO2 paste was spread onto the conductive glass by using a glass rod. Finally, the glass sheet was sintered at 4500C for 30 min to solidify TiO2 deposited glass. When cooling to a temperature of 80–900C, the conductive glass solidified TiO2 was immerged in natural dye sensitizer solution for 24 h to absorb the dye on TiO2 porous film adequately. Excess non-adsorbed dyes were washed using with anhydrous ethanol and dried in moisture-free air.

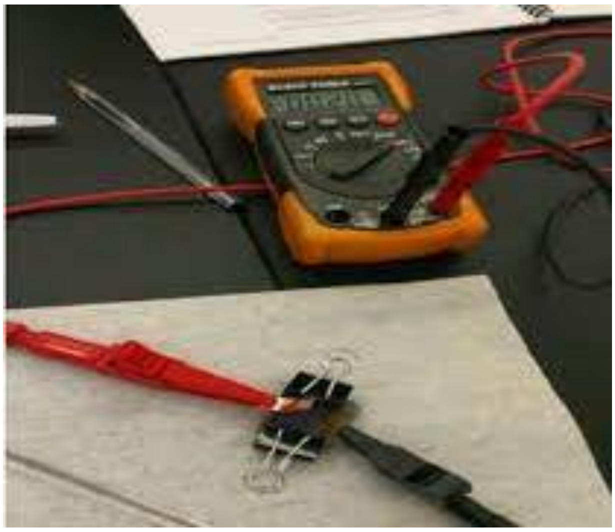

Figure 5: Laboratory prepared Dye solar cell

The Pt electrode was prepared using platinum (platisol-Solaronix). The paste was coated on the FTO glass plate using the doctor-blade technique and heated at 400 0C for 30 min. The dye-covered TiO2 electrode and Pt counter electrode were assembled as a sandwich-type cell. A drop of Iodolyte AN-50 (Solaronix) electrolyte solution was injected into the cell. Fig.5 shows the fabricated dye solar cell in laboratory method.

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V. CONCLUSION

In this summary, we prepared natural sensitizer with ethanol, methanol and acetone medium, we found that the performance of the solar cell was affected by the nature of the solvent medium, under this analysis we extract natural sensitizer with different medium, and choose as ethanol solvent medium shows the better absorption in UV as well as good absorption in TiO2 nano substrate. Finally, we concluded that performance of natural sensitizer with ethanol medium is consider as good sensitizer for future fabrication of DSSC which was simple laboratory preparation method.

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