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DR. MOHAMMED ISAH KIMPA
Department of Physics
Federal University of Technology, Minna

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Proceedings

Preface

Satisfying the nations' energy needs for today and the future in a fair and efficient way is a major goal. Solutions must include the development of renewable energy resources that are environmentally sustainable and economically viable. Research can contribute to the development and integration of such resources into the world energy system through better atmospheric observations, models, predictions, and analysis tools.

The International Renewable Energy Congress (IREC) provides a forum for researchers and practitioners around the world on recent developments in the fields of renewable energy. It consists of plenary and oral sessions as well as poster presentations.

Submissions have been peer reviewed by our International Program Committee. Acceptance has been based on quality, originality and relevance. All contributions are neither published elsewhere nor submitted for publication.

Presented papers are published in the congress website (www.irec.cmerp.net) and the best ones may be selected for publication as special issues in referred international journals such as: Energy Conversion and Management (EC&M), International Renewable Energy Technology (IRET), and International Journal of Electrical Engineering and Transportation (IJEET).

These proceedings present the abstracts of IREC'2011 keynotes and the accepted papers which are organized into four fields:

- EEP: Environment and Energy Policy
- IMC: Instrumentation, Modelling and Control
- STPE: Solar Thermal and Photovoltaic Energies
- WHE: Wind and Hybrid Energies

Finally, we would like to express our deep gratitude to reviewers as well as sessions' chairmen for their assistance and substantial reviews. Special thanks to the members of the organizing committees for their determination to achieve a great success through this event.

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Prof. Maher CHAABENE

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- Wind Energy
- PhotovoltaicEnergy
- Solar Thermal Energy
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Keynote sessions

Keynote 1: General Overview on Nuclear Energy and Renewable Aspects
Prof. Dr.-Ing. Sümer ŞAHİN
ACADEMIC DEGREES: Professor in Nuclear Engineering, University of Ege, İzmir, Türkiye (1981); Habilitation (Doçent-Dozent) in Physics, University of Ankara, Ankara, Türkiye; Doktor-Ingenieur (PhD) in Mechanical Engineering, University of Stuttgart, Stuttgart, Germany. He has assumed ACADEMIC POSITIONS at Gazi University, Ankara, Türkiye; Erciyes University, Kayseri, Türkiye; King Saud University, Riyadh, Saudi Arabia; EcolePolytechniqueFédérale de Lausanne, Lausanne, Switzerland and Karadeniz Technical University, Trabzon, Türkiye. Presently he is Chairman of the Department of Mechanical Engineering, Faculty of Engineering, ATILIM University in Ankara, Türkiye; EDITOR of the Journal "Energy Conversion & Management" and GENERAL CHAIRMAN of the 10th International Conference on Sustainable Energy Technologies.

Keynote 2: Renewable Energy, Global Warming, and the Impact of Power Electronics General

Eur-Ing Dr. Ahmed FaheemZobaa received the B.Sc.(Hons.), M.Sc., and Ph.D. degrees in electrical power and machines from Cairo University,Giza, Egypt, in 1992, 1997, and 2002, respectively. From 2007 to 2010, he was a Senior Lecturer in renewable energy with the University of Exeter,Cornwall, U.K. He was also an Instructor from 1992 to 1997, a Teaching Assistant from 1997 to 2002, and an Assistant Professor from 2003 to April 2008 with the Department of Electrical Power and Machines and the Faculty of Engineering, Cairo University, where he has also been an Associate Professor since April 2008. Currently, he is also a Senior Lecturer in power systems with Brunel University, Uxbridge, U.K. His main areas of expertise are power quality, photovoltaic energy, wind energy, marine renewable energy, grid integration, and energy management.

Dr. Zobaa is an Editor-in-Chief for the International Journal of Renewable Energy Technology. He is also an Editorial Board member, Editor, Associate Editor, and Editorial Advisory Board member for many international journals. He is a registered Chartered Engineer, European Engineer, and International Professional Engineer. He is also a registered member of the Engineering Council U.K., Egypt Syndicate of Engineers, and the Egyptian Society of Engineers. He is a Fellow of the Institution of Engineering and Technology, the Energy Institute of U.K., the Chartered Institution of Building Services Engineers and the Higher Education Academy of U.K. He is a senior member of the Institute of Electrical and Electronics Engineers. He is a member of the International Solar Energy Society, the European Society for Engineering Education, the European Power Electronics and Drives Association, and the IEEE Standards Association.

Keynote1 : General Overview on Nuclear Energy and Renewable Aspects

Prof. Sümer ŞAHİN
Atılım University, Faculty of Engineering, Department of Mechanical Engineering
06836 İncekGölbaşı, Ankara, TÜRKİYE

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- Brief information on fission and fusion.
- Actual reactors (types, cost, nuclear power countries)
- GEN-IV reactors.
- Fusion nuclear technology.
- Space nuclear reactors.
- Renewable aspects/potential of present reactors.
- Our current research activities and possibility of cooperation in nuclear research & education.

Keywords: Fission Reactors, Fusion Reactors, GEN-IV Reactors, Space Nuclear Reactors, Renewability.

ABSTRACT

Nuclear Energy is released as a result of nuclear reactions. Out of many nuclear reactions known, those resulting in fission and fusion have at present the greatest practical significance for energy production.

The absorption of a neutron can split the nucleus in certain heavy elements into two massive fragments, notably uranium and plutonium and other actinides, a process called fission. Each fission reaction releases energy of ~ 200 MeV/nucleus. We note that 1 eV = 10^{-19} Joule. When two light nuclear particles combine or "fuse" together, energy is also released because the product nuclei have less mass than the original particles. The most promising fusion reactions make use of the isotope deuterium, $^2H_1$, abbreviated D. They are (D,T), (D,D) and (D,$^3He_2$). D is present in water as heavy hydrogen with abundance of only 0.015%, i.e., there is one atom of $^2H_1$ for every 6700 atoms of $^1H_1$. However, the tiny amount of D in 1 liter of natural water releases fusion energy equivalent to as much as 300 liters of gasoline.

The abundance of $^3He_2$ in natural helium is 0.0138 %, i. e., ~ 1/8000. Earth has very scarce $^3He_2$ resources. On the other hand, it is estimated, based on sample measurements that the first 50 cm of Moon dust contains ~ 10^9 kg $^3He_2$. Jupiter and Saturn atmospheres contain each ~ 10^{22} kg $^3He_2$. Uranus and Neptun atmospheres contain each ~ 10^{20} kg $^3He_2$. Their fusion energy potential would be sufficient mankind's energy needs for millions of years, i.e., forever. Current Nuclear power reactors in use can be classified as CANDU reactors, BWRs and PWRs. Presently, Generation III and Generation III+ reactors are offered by reactor constructors, which have the advantage of higher operation safety, longer lifetimes of 60 up to 100 years, Earthquake protection safety at 9 Richter scale, lower construction and operation costs, etc.

Intensive research is pursued on the development of Generation IV reactors for electricity generation with higher efficiency, lower cost, process heat, hydrogen production, thorium utilization and nuclear waste incineration. Independently, fusion technology research is also making great progress. Progress on The National Ignition Facility (NIF) at the Lawrence Livermore National Laboratory (LLNL) brings fusion a viable energy source in foreseeable future. Fusion reactors have the potential to operate also as fusion/fission hybrids, opening new horizons in the utilization of nuclear energy.

Keynote2 : Renewable Energy, Global Warming, and the Impact of Power Electronics General

Eur.Ing Dr. Ahmed F. Zobaa
Brunel Institute of Power Systems, School of Engineering and Design, Brunel University, Uxbridge, UB8 3PH, Middlesex, United Kingdom.

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Keywords:Renewable Energy, Global Warming, Power Electronics, Climate Change

ABSTRACT

Global energy consumption is increasing in a dramatic manner due to the increase of world population. Most of our energy comes from fossil fuels which cause global warming problem due to burning these fuels. There are many affects such as raising the sea level, bringing drought in tropical regions near the equator, increasing hurricanes, tornadoes and floods, and spreading diseases.

Renewable energy is energy generated from natural resources such as sunlight, wind, rain, tides, and geothermal heat, which are renewable (naturally replenished). In 2006, about 18% of global final energy consumption came from renewables, with 13% coming from traditional biomass, which is mainly used for heating, and 3% from hydroelectricity. New renewables (small hydro, modern biomass, wind, solar, geothermal, and biofuels) accounted for another 2.4% and are growing very rapidly. The share of renewables in electricity generation is around 18%, with 15% of global electricity coming from hydroelectricity and 3.4% from new renewables.

This presentation particularly highlights the impact of power electronics in solving or mitigating this problem and supporting renewable energy.

CONTENTS

Dye-sensitized solar cell with natural dyes extracted from Indian almond plant and Cashew leaf

Kasim Uthman Isah[1], Mohammed Isah Kimpa[1], Egwim Evans Chidi[2] and Adamu Nchama Baba-Kutigi[1]
[1]Department of Physics, Federal University of Technology, Minna. Nigeria.
e-mail: kasim309@futmina.edu.ng, e-mail: kimpabala2@yahoo.com, e-mail: nchama3101@yahoo.com
[2]Department of Biochemistry, Federal University of Technology, Minna. Nigeria.
e-mail: evanschidi@gmail.com

Abstract - *Dye-sensitized solar cells are expected to be used for future clean energy. Recently, most of the researchers in this field use Ruthenium complex as dye in the dye-sensitized solar cells. However, Ruthenium is a rare metal, so the cost of the Ruthenium complex is very high. In this paper, dye obtained from ethanolic extracts of Indian almond leaf, bark and cashew leaf were used as natural sensitizers for dye-sensitized solar cells. The photo-electrochemical performance of the DSSC shows a conversion efficiency of 0.14% with open-circuit voltage (Voc) of 0.508V, short-circuit current density (Jsc) of 0.402mAcm^{-2}, and fill-factor(FF) of 0.603 from extracts of the green leaf of Indian almond while its bark had a conversion efficiency of 0.039 with open-circuit voltage (Voc) of 0.47609V, short-circuit current density (Jsc) of 0.174mAcm^{-2} and fill-factor (FF) of 0.399. The conversion efficiency of the DSSCs of extracts from the cashew leaf was 0.06% with open-circuit voltage (V_{oc}) of 0.49V, short-circuit current density(J_{sc}) of 0.2mAcm^{-2} and a fill factor (FF) of 0.617.*

Keywords- *Dye-sensitized solar cell; Natural dye; Indian almond; Cashew leaf; Ruthenium complex*

1. Introduction

Dye-sensitized solar cells (DSSCs) was developed as a new type of solar cells, in 1991 [1], due to their environmental friendliness and low cost of production, DSSC have attracted considerable attention. A dye-sensitized solar cells (DSSCs) is composed of a nanocrystalline porous semiconductor electrode-absorbed dye, a counter electrode, and an electrolyte containing iodide and triiodide ions. In DSSCs, the dye as a sensitizer plays a key role in absorbing sunlight and transforming solar energy into electric energy. Numerous metal complexes and organic dyes have been synthesized and utilized as sensitizers. By far, the highest efficiency of DSSCs sensitized by Ru-containing compound absorbed on nanocrystalline TiO_2 reached 11-12% [2,3]. Although such dye-sensitized solar cells have provided arelatively high efficiency with several disadvantages of using noble metals in them: noble metals are considered as resources that are limited in amount, hence very costly in production. On the other hand, organic dyes are not only cheaper but have also been reported to reach an efficiency of 9.8% [4]. However organics dyes have often presented problems as well, such as complicated synthetic routes and low yields.

Nevertheless, the natural dyes found in flowers, leaves, and fruits can be extracted by simple procedures. Due to their cost efficiency, non-toxicity, and complete biodegradation, natural dyes have been a popular subject of research. Thus, several natural dyes have been utilized as sensitizers in DSSCs, such as cyanin [5-10] carotene [11,12], tannin [13], and chlorophyll [14]. Gomez-Ortiz et al. reported that a conversion efficiency of 0.53% was obtained using bixin-sensitized TiO_2 extracted from achiote seeds as sensitizer [11]. Calogero and Marco reported a conversion efficiency of 0.66% from red Sicilian orange juice extract used as dye sensitizers [15,16]. Chang and Lo also reported that the conversion efficiency of 0.597% DSSCs prepared by chlorophyll dyes from pomegranate leaf extract and that prepared by anthocyanin dyes from mulberry extract was 0.548% but its cocktail dyes shows up to 0.722% conversion efficiency [17]. Wongcharee *et al.*, employed rosella flower as sensitizer in their DSSC, which achieved a conversion efficiency of 0.70% [8]. Roy *et al.*, indicated the use of rose Bengal dye as sensitizer, resulting in a 2.09% conversion efficiency [18]. Furthermore, Wang *et al.*, carried out structural modification of coumarin and used the coumarin derivation dye as sensitizer in their DSSC, which provided an efficiency of 7.65% [19]. Thus, optimization of the structure of natural dyes to improve efficiency is promising.

In this paper, natural dye extracts from Indian almond leaf, bark and cashew leaf were used as sensitizers for dye-sensitized solar cells.

2. *Experimental*

2.1. Preparation of natural dye sensitizer

20 gramms of Indian almond leaf, bark and cashew leaf each was weighed on an electronic weighing balance. These samples were crushed with a

porcelain mortar and pestle and then mixed with 200ml of ethanol (99% absolute) at room temperature in a dark room. Then, the mixture were filtered to extract the dye. The filtrate is the sensitizer dye solution for the cell.

2.2 Preparation of dye-sensitized solar cells

Transparent conducting oxide glass (TCO glass) 3mm thick sodalime glass coated with electrically conducting FTO (Asahi Glass, fluorine-doped SnO_2, sheet resistance:15ohm/sq), were first cleaned in a detergent solution using an ultrasonic bath for 15 min, rinsed with water and ethanol, and then dried. Ti-nanoxide-D pastes (Solaronix, Co. Ltd.) were deposited on the FTO conductive glass by rigid squeegee and screen printing procedure (polyester mesh of 90) in order to obtain a TiO_2 film with a thickness of 9 μm and an area of 0.2 cm^2. This screen-printing procedure with the paste, coating, storing and drying was repeated to obtain a working electrode of appropriate thickness of 9 μm [20]. The film was preheated in a furnace at 150°C for 2 min., 200°C for 2 min., 250°C for 2 min., 300°C for 2 min., 350°C for 2 min., 400°C for 2 min., 450°C for 2 min. and then sintered at 500°C for 30 min. After cooling to 80°C, the TiO_2 electrode was immersed in an ethanol solution containing a natural dye for 18 h. The dye-sensitized TiO_2 electrode and screen printed platinum counter electrode were assembled to form a solar cell by sandwiching a redox (I^-/I_3^-) electrolyte solution. In the performance test of the prepared DSSC a solar simulator, Model 4200-SCS semiconductor characterization System under the irradiation of AM 1.5 (1000mWcm^{-2}) was employed to measure the photoelectric conversion efficiency of the prepared DSSC. The measured results was plotted in an I–V curve, from which the data of open-circuit voltage V_{OC} (V), short-circuit current density J_{SC} (mA/cm2), fill factor (FF) and conversion efficiency (η %) could be further acquired. A SEM micrograph of the TiO_2 thin film was obtained using **EVO I** MA10 and its composition determine by EDX system coupled to the SEM.

3. Results and discussion

Fig. 1. shows the scanning electron micrograph of the TiO_2 (anatase) film (deposited by screen printing on a conducting glass sheet). This was done using scanning electron microscope (SEM) **EVO I MA10** at Sheda Science and Technology Complex (SHESTCO), Abuja. The TiO_2 nanoparticles thus produced have a mean particle size of around 25 nm. Fig. 2. shows the analysis of the elemental composition of TiO_2 compound using EDX analysis. Fig. 3-5. Shows absorption spectrum of dye extracted from cashew leaf, green leaf Indian almond, its bark and dyes adsorbed on TiO_2 using UV-Vis Spectrophotometer at **Engineering materials development institute (EMDI), Akure, Ondo State.**. The main absorption peak of dye extracted from cashew leaf and adsorbed on TiO_2 is about 300 nm; the absorption peak of green leaf Indian almond is at 310 and 620 nm; the absorption peak of dye extracted from the bark of Indian almond is 310 nm. Hence, green leaf Indian almond absorbability is better in the range of 600-640 nm for only dye molecule. It is found that the absorption peak of the cashew leaf, Indian almond bark and leaf have poor absorbability compared to the expected wavelength of 920nm [21], thereby making the cell to perform poorly.

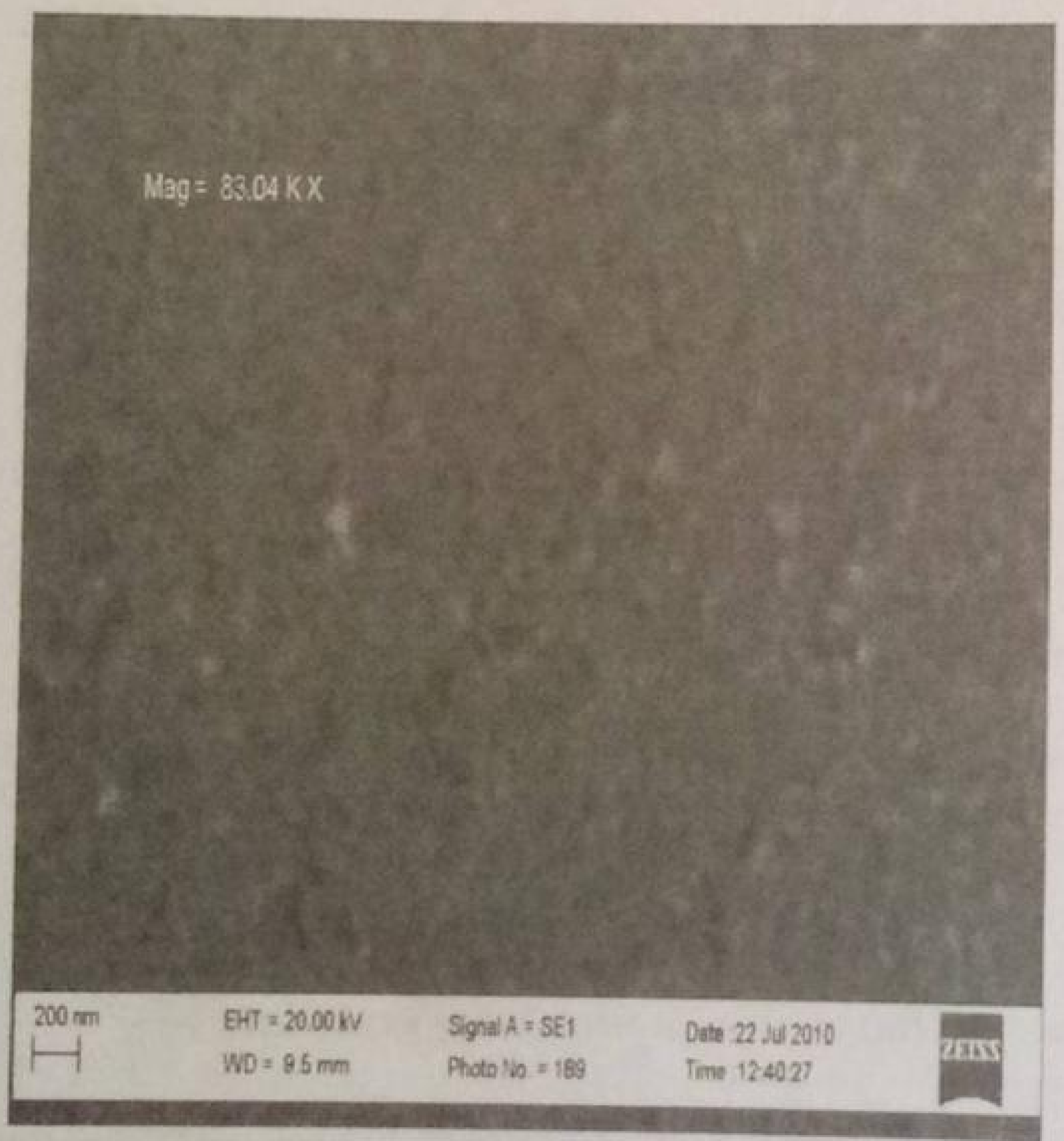

Fig. 1. SEM Image of the fabricated TiO_2 nanoparticle

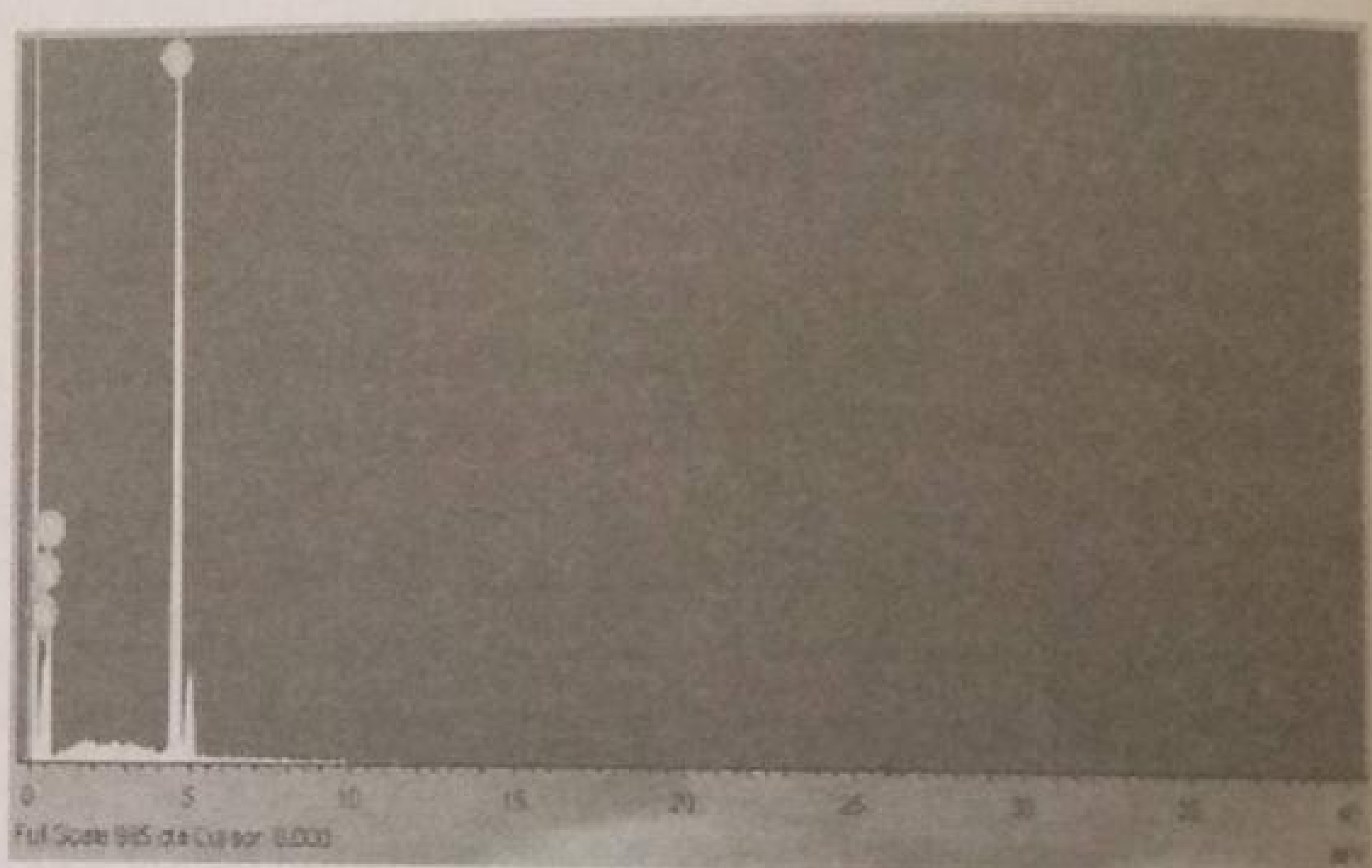

Fig. 2. Elemental composition of TiO_2 compound

The typical J-V curves of the DSSCs using the sensitizers extracted from cashew leaf, Indian almond green leaf, and the bark are shown in fig. 6. Obviously, the efficiency of cell sensitized by the Indian almond green leaf extract was significantly higher than that sensitized by the cashew leaf and bark of the almond plant. This is due to a higher intensity and wide range of the light absorption of the extract on TiO_2(fig. 6) and Table 1. It is in agreement with Wongcharee *et al.* [8] that the higher interaction between TiO_2 and anthocyanin lead to a better performance of the extract sensitization.

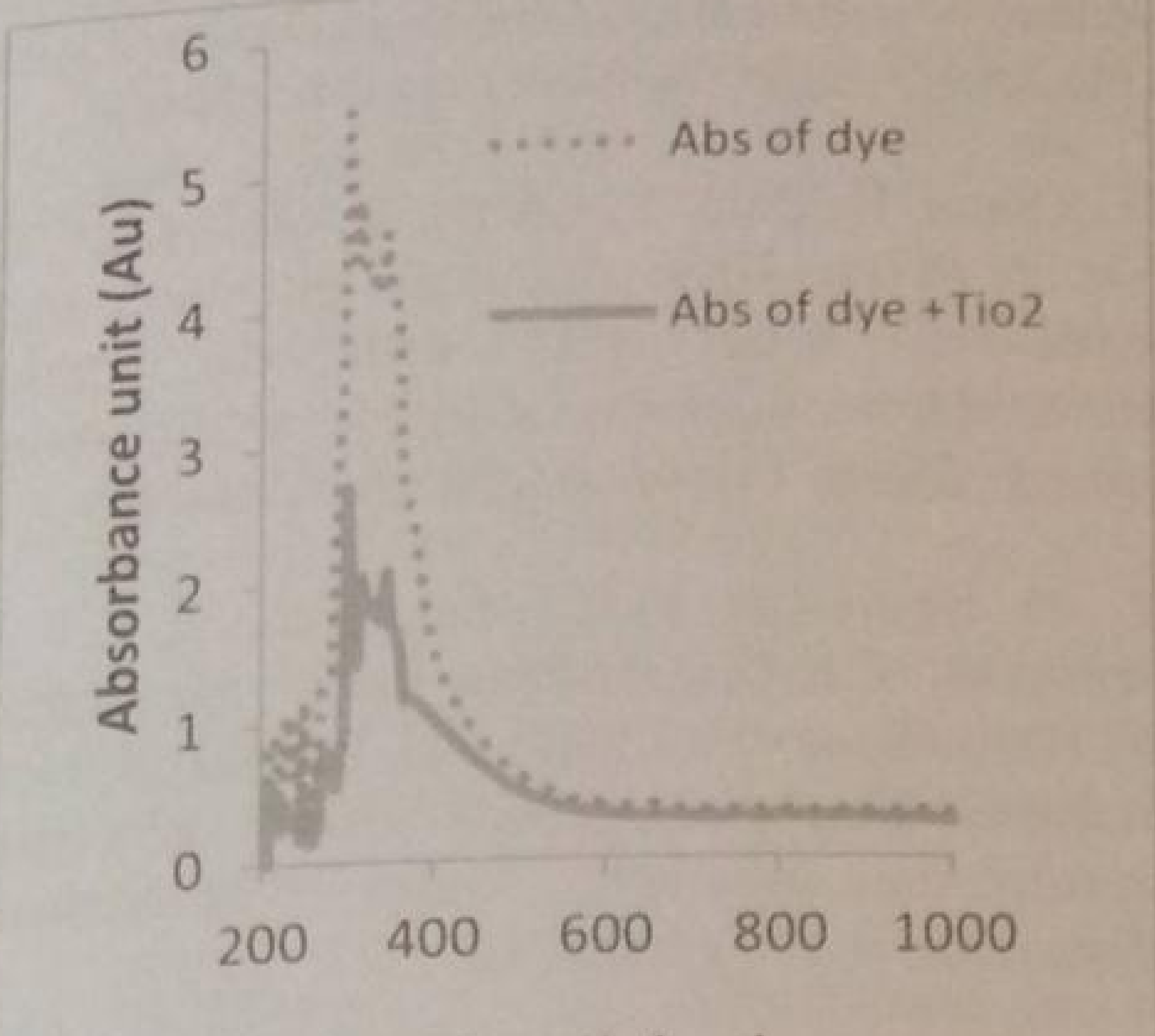

Fig 3. Absorbance of dye from cashew leave extract

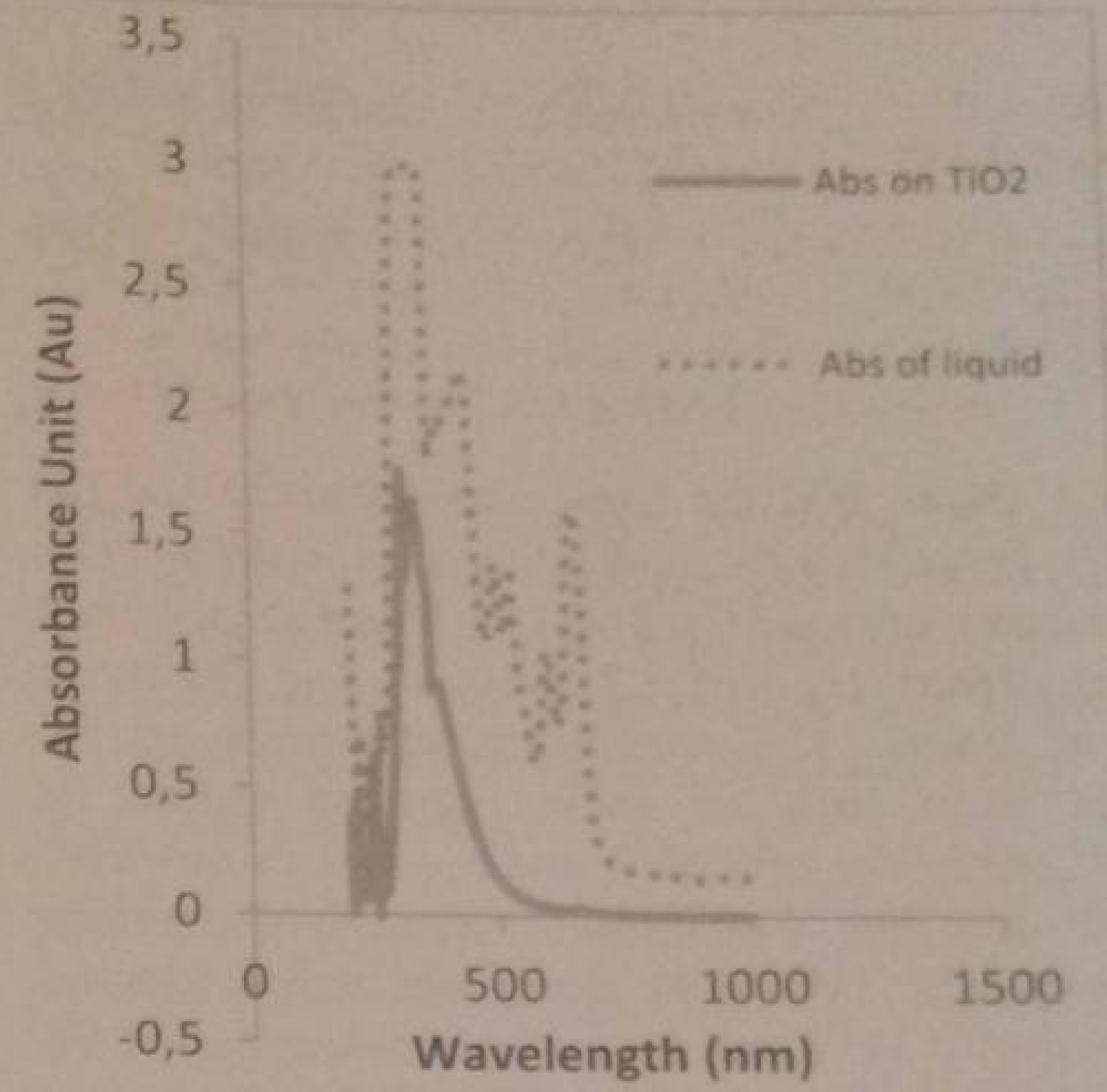

Fig. 4 Absorbance of Dye Indian-almond (green leaves)

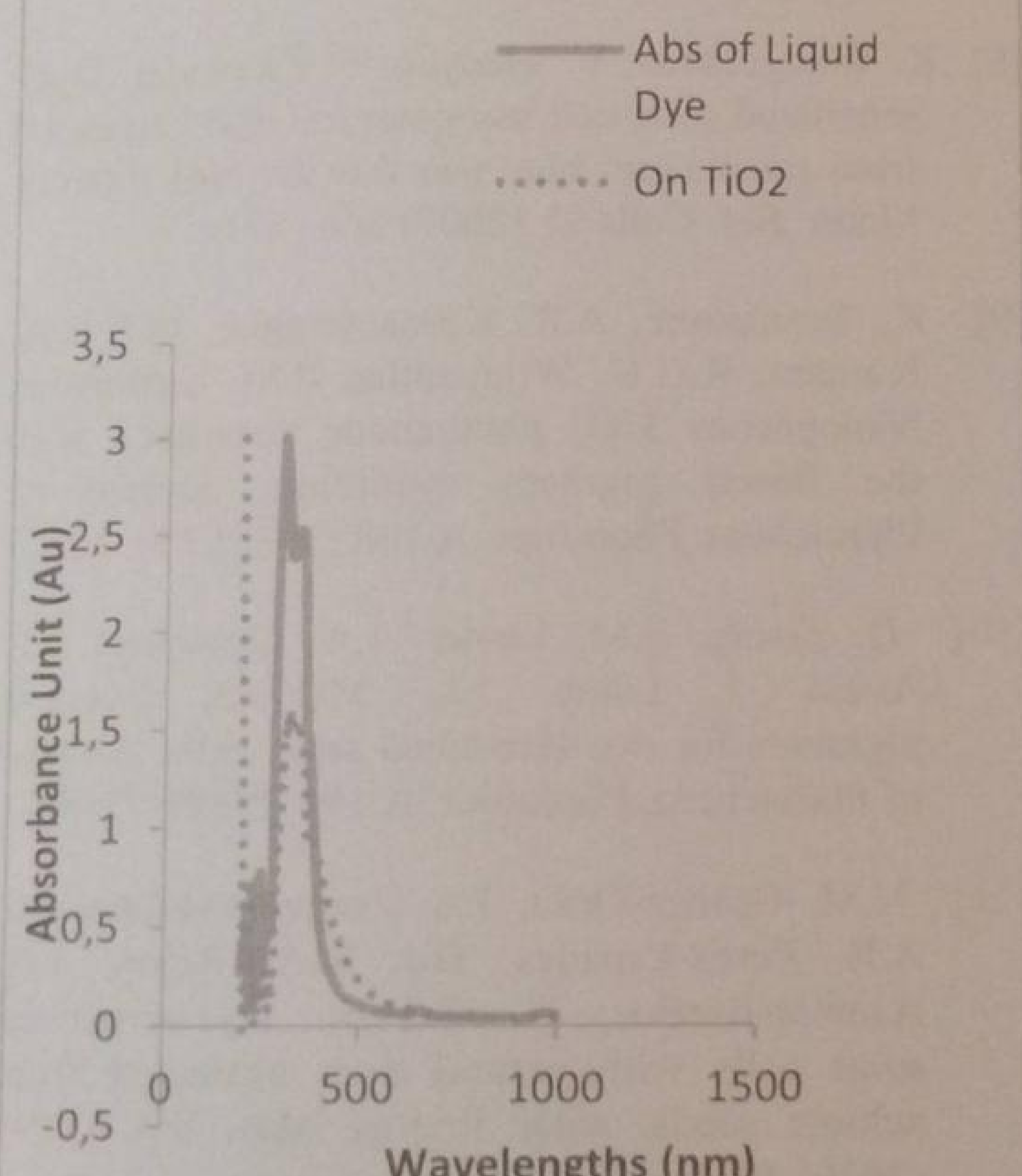

Fig 5. Absorbance of dyes from Indians-almond bark extract

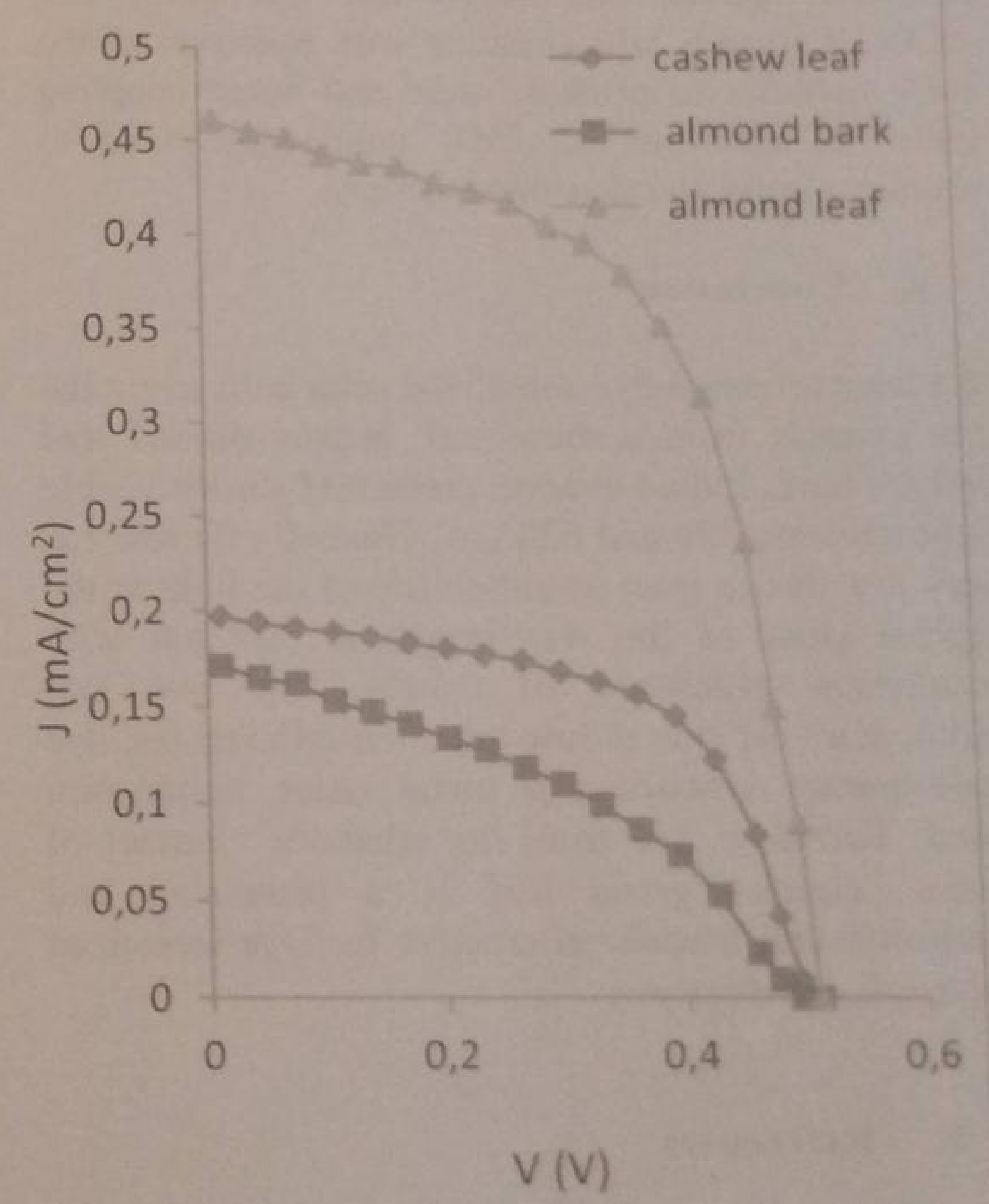

Fig. 6. J-V characteristics of the DSSC of Cashew leaves , almond bark and leave extracts

Table 1. Characteristics of dye-sensitized solar cell.

Dye	V_{OC} (V)	J_{SC} ($mAcm^{-2}$)	FF	η (%)
Cashew leaf	0.49	0.2	0.617	0.06
Indian almond (leaf)	0.51	0.40	0.603	0.14
Indian almond (bark)	0.48	0.17	0.399	0.039

Table 1 shows that the conversion efficiency of the DSSCs from cashew leaf extract is 0.06%, with open-circuit voltage (V_{OC}) of 0.49 V and short-circuit current density (J_{SC}) of 0.2 mA/cm^2, and fill factor (FF) of 0.617. The conversion efficiency of the DSSCs from bark of Indian almond extract is 0.039%, with V_{OC} of 0.48 V and J_{SC} of 0.17 mA/cm^2, and FF of 0.399. Furthermore, there is conversion efficiency of 0.14% from green leaf Indian almond with V_{OC} of 0.51 V and J_{SC} of 0.40 mA/cm^2, and FF of 0.603. It can be seen from Table 1 that green leaf Indian almond dye extract can improve the photoelectric conversion efficiency of DSSCs. The V_{OC} of natural dye is lower than that of N719 dye because of molecular structure of natural dye which mostly has OH ligands and O ligands and lacks ACOOH ligands that N719 dye has [17]. The ACOOH ligands will combine with hydroxyl of the TiO_2 particles to produce ester and boost coupling effect of electrons on TiO_2 conduction band to acquire a rapid electron-transport rate.

4. Conclusion

We have prepared dye-sensitized solar cells using the dye extracts from cashew leaf, Indian almond leaf and the bark. Indian almond green leaf absorb visible light between 320 and 620 nm. The cell efficiency is very low due to poor absorbability of the light at the highest peak of the wavelength at 320 nm with conversion efficiency of 0.14%. The low cell efficiencies are due to low injection efficiencies, dye regeneration kinetics and metal oxide conduction band. Therefore dye from the ethanolic extract of Indian almond green leaf is a promising and environmental friendly alternative for Dye-sensitized solar cell development

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