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Toward Eco Green Energy: Fabrication of DSSC from Recycled Phone Screen

Muhammad Ayaz[1], Jafar Khan Kasi[2], Ajab Khan Kasi[3], Samiullah[4] and Mustafa Ali[5]

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ABSTRACT: The dye-sensitized solar cell was fabricated using discarded mobile phone. The recycled mobile screen was used as counter electrode. In the fabrication process, the use of recycled materials promotes eco green energy and alternative source for dye-sensitized solar cells (DSSC). The ITO substrate was used as photoelectrode growing zinc oxide (ZnO) by hydrothermal growth. The natural plant Alkanna tinctoria root extract was used as photosensitizer and N719 was used as reference dye. The power to conversion efficiency achieved as 0.0244% by natural plant Alkanna tinctoria root. The aim of this study is to develop a culture of using recycled items toward eco green energy production as well as research work may also be carried out by these discarded mobile screen as photo and counter electrode.

KEYWORDS: Dye-Sensitised Solar Cell, Natural Plants Dyes, Alkanna Tinctoria Roots.

[1] M.Phil scholar, Department of Physics, University of Balochistan, Quetta 87300, Pakistan.
E-mail: muhammadayazphy@gmail.com
[2] Assistant Professor, Department of Physics, University of Balochistan, Quetta 87300, Pakistan.
E-mail: jafarkhankasi@gmail.com
[3] Associate Professor, Department of Physics, University of Balochistan, Quetta 87300, Pakistan.
E-mail: ajabkasi@gmail.com
[4] Assistant Professor, Department of Chemistry, University of Balochistan, Quetta 87300, Pakistan.
E-mail: sami43588@yahoo.com
[5] MS scholar, Department of Biotechnology, Balochistan University of Information Technology, Engineering and Management Sciences, Quetta, 87300, Pakistan. *E-mail: mustafa.alibio@gmail.com*

1. INTRODUCTION

In 1991 Grätzel *et al.* assembled dye-sensitized solar cells (O'Regan and Grätzel, 1991) . The use of nanoscale devices challenges the conventional photovoltaic devices. The DSSC converts sun energy into electrical energy through easy process and cover green energy range (Hagfeldt, 2010). The dyes work as photosensitizer which absorbed sunlight and convert into chemical energy. Many metal complexes and natural dyes yet investigated and used as dye. Natural dyes have large absorption coefficients because of intramolecular changes and easily to modify its structures (Zhou, 2011). Biradar and Ramesha (2014) used Syzygium cumini extract as photosensitizer over ZnO based DSSC and achieved PCE 0.5%. The ZnO growth substrate annealed at 400^{o}C temperature enhanced the efficiency 4.7 % (Hosni, 2015). El-Agez *et al.* assembled ZnO DSSC and employed natural plants extract; Rhubarb, Walnuts obtained PCE 0.0104(M. El-Agez, 2012). The ZnO based photoelectrode provides large surface area. ZnO have limitation as compared to TiO_2, but improve power to conversion efficiency (PCE) (Zhang, 2009). The photoelectric properties of mallow cell such as fill factor and PCE achieved 55% and 0.215% respectively (Torchani, 2015). The twenty natural dyes extract used as photosensitizers over DSSC, gave the open circuit voltage (Voc) range from 0.689 to 0.337 V (Zhou, 2011). Bokhari *et al.* obtained ZnO efficiency on FTO 1.37 % (Bokhari, 2015). Kasi *et al*. adopted hydrothermal growth of ZnO nanorods for sensor devices (Kasi, 2014).The different morphology of ZnO considered and compared, the effect discovered, which is value able for development and enhancement of energy conversion efficiency of ZnO based solar cells (Guill, 2011).The reported photovoltaic parameter ZnO based DSSC (Anta, Guillén, and Tena-Zaera, 2012). The DSSCs assembled through printed electrolyte obtained 6% performance in whole cell PCE compared to the reference cells (Hashmi, 2015). In this research we used natural plant Alkanna tinctoria extract as photosensitizer. The natural dyes could not achieve such a high power to conversion efficiency as well as ruthenium (Ru) complex dyes yet. But efficiency improvement for dye-sensitized solar cells based on natural dyes possible.

2. EXPERIMENT

2.1. Natural plant dye preparation

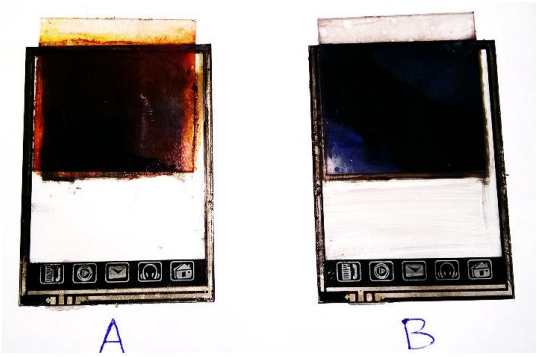
The Alkanna tinctoria roots was washed several time under tap water and ensured no more mud particles remained, than washed with deionized water many times for removing remaining impurities and dried with hot air at room temperature for two hours. Subsequently the Alkanna tinctoria roots were grinded into powder form. A quantity of 10g of Alkanna tinctoria root powder mixed into 100ml ethanol (M. W: 46.07, purity: 96-98%) by BDH laboratory supplies England. The solution was then covered with aluminium foil to protect light and places into dark room for several hours. Than filtered out the solvent and dyes extracted. To preserve and stored the dye was put into air tight bottle. Figure 1 illustrates the Alkanna tinctoria root extract have dark red colour.

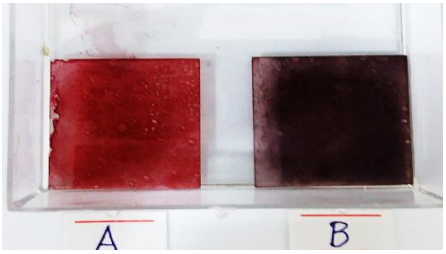
Figure.1.1.Extracted dyes Alkanna tinctoria root

2.2. Fabrication of DSSC

The recycled mobile phone conductive screen was detached from phone and cut into required size removing all extra glass from screen; the conductive glass sheet was used as counter electrode. Prior to use as counter electrode it was cleaned with detergent and placed in ultrasonic machine (CT-408) for ultrasonic bath for 10 min, and washed with acetone the deionized water respectively. In the last dried the conductive glass at room temperature. Then carbon composite layer deposited with candle flame on the substrate which was used as counter electrode. The ZnO growth were done on ITO substrate by hydrothermal method and sintered at 450^{o}C for 30min for crystalline structures. Then cool down at room temperature. The photoelectrode covered area 2.5mm x 2.5mm were used for DSSC. The two different ITO substrate as photoelectrode were sensitized with natural plant extract Alkanna Tinctoria roots and dye N719 (Di-tetrabutylammonium *cis*-bis (isothiocyanato) bis (2, 2′-bipyridyl - 4, 4′-dicarboxylato) ruthenium (II) by Solaronix for overnight respectively. The electrolyte made as per reported previously 2.075g potassium iodide (KI) analytical reagent grade by Fisher Scientific UK, 0.19g Iodine (I) analytical reagent grade by Omicron Sciences Ltd-UK. Figure 2 illustrates the ITO sample sensitized with (A) N719 and (B) Alkanna Tinctoria root extract.

Figure. 3 Recycled mobile screen used as counter electrode
(A) N719 (B) Alkanna tinctoria root.





2.3. Measurements

The extracted dyes UV-Visible spectroscopy absorption spectra were measured under UV-1700 Spectrophotometer by Shimadzu-Japan. For functional group analyses used FTIR 8400S Shimadzu-Japan. The sun light source is like the solar visible spectrum used R7S J118-Arik linear halogen bulb 500W. Digital meter GwInstek GOM-8034 was used for measurement of current and voltage.

3. Result and Discussion

The UV absorption spectra of natural plant Alkanna tinctoria root extract used as dye illustrates in figure1. The peak is at 492 and absorption at 0.142. The main component of this dye extract contains anthocyanin. The sunlight spectra 470-500 blue green area which contains much energy as in N 719 dye. Table 1 illustrates the photoelectrochemcial properties of fabricated DSSCs. Meanwhile, FTIR used for finding functional group of Alkanna tinctoria root, the peak shown on 1026 which belong to P-OR esters group. The FTIR spectrum derived for 30 scan at resolution 2 cm-^{1}. The figure 3 shows assembled DSSC with help of recycled mobile phone screen used as counter electrode. Table 1 shows photo electrochemical properties

of fabricated dye-sensitized solar cell and comparison of dye N719 and natural plant dye achieved efficiencies.

Figure 3. UV-vis spectra of Alkanna tinctoria root

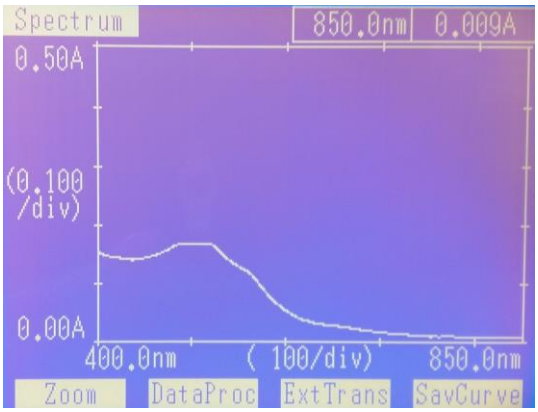


Fig.4. FTIR result of Alkanna tinctoria root

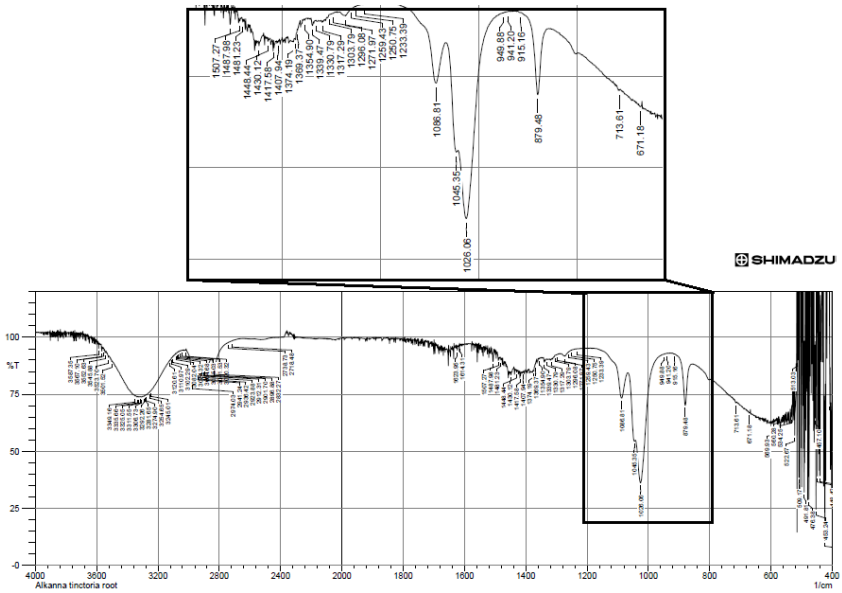


Table 1 Photoelectrochemical parameters of DSSC

Sample	*Isc*/mA	V_{oc}/mV	Fill factor (FF)	Power Efficiency (%)
N719	0.0969	0.319	0.675	0.0582
Alkanna tinctoria root	0.02	0.166	0.670	0.0244

4. CONCLUSION

The main aim of this study was to utilize the recycled mobile phone screen for DSSC; it is toward eco green energy production. This research provided a significant use of recycled items for fabrication for DSSC. Furthermore, the natural plants extract used as dye which is environmental friendly instead of ruthenium based N719 dye. The photoelectric conversion efficiency will be possible enhance by modification of natural dyes structures.

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ETHICAL CONSIDERATION

Authenticity of the texts, honesty and fidelity has been observed.

AUTHOR CONTRIBUTIONS

Planning and writing of the manuscript was done by the authors.

CONFLICT OF INTEREST

Author/s confirmed no conflict of interest.

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