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The Influence of Bio Natural Dye on the Optical Properties of Liquid Polyvinyl Alcohol

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ABSTRACT

The use of bio liquid electrolytes in solar cells improves the efficiency of the cell, reduces the resulting electrostatic charge on the surface and reduces the potential leakage of solid electrolyte. The research aims to prepare liquid electrolyte of polyvinyl alcohol in addition to yellow dye extracted from flowers. The yellow dye of the flowers growing in Carthage, Tunisia, was extracted using acetone and diluted with ionized water to prepare different concentrations of dye. The dye molecules works as a collector of light and is produced excitation of electrons .Polyvinyl alcohol was dissolved in 100 ml of various solvents (water, diluted dye and concentrated dye) separately to obtain a constant concentration of all solutions 0.01 g / ml. optical. The optical properties, including absorbance, transmittance, and energy gap using ultraviolet spectrum were studied. Results proved that the optical properties including absorbance, absorption coefficient increased with increasing dye concentration, transmittance decreased with increasing of the pigment concentration. The energy gap decreases by increasing the concentration of the dye and has the lowest value at the concentrated dye about 1.7 eV. However, when adding the concentrated dye to the polyvinyl alcohol, the energy gap decreases from 4 eV to 1.8 eV.

Keywords: Solar cell; liquid electrolyte; UV- spectrum; natural dye; energy gap; optical properties

1. INTRODUCTION

Dye-sensitized solar cells (DSSCs) are energy tools used for changing light energy into electrical energy [1-2]. DSSC have many advantages as a low cost and easy to production, and can achieve high [3]. The dye is one of the main parameter which affect in the DSSC efficiency. The dye molecules works as a collector of light and is produced excitation of electrons [4]. Some natural dyes such as betacyanin, flavonoid, chlorophyll, anthocyanin, and β-carotene have been successfully used as sensitizers of DSSCs [5].

Optical properties like absorption, transmittance, reflection, absorption coefficient, extinction coefficient and energy band gap is very important parameters for fabricated an solar cell. Absorption is ability of materials on absorption of electromagnetic wavelength. Transmittance is ability of materials on transmitting of electromagnetic wavelength, and there are logarithmic relationship between absorption and transmittance [6].

Many previous research and references have dealt with natural extracts as a base in the solar cell industry. Argha D. and co-workers 2016, Extract the green tea from the washed tea l eaves, isolate the ingredients and dry the catechins. They were examined using x-ray diffraction, electron microscopy and ultraviolet spectroscopy. Nanoparticles were determined for deposition on a thin membrane of TiO2 -$CH_3NH_3PbI_3$ to produce a solar cell. They concluded there are a good light-electrical sensitivity property, and it is suitable to fabricate of bio-solar cell tool [7].

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Chang and co-workers 2013, made two kinds of natural pigments chlorophyll dye and anthocyanin dye, by extracting them from wormwood and purple cabbage, respectively. For use in the manufacture of solar cells instead of chemical dyes [8].

Paudel et al. 2018, studied optical properties, which include absorption, transmittance, and fluorescence of natural pigments extracted from flowers, roots, bark and leaves of plants found in Nepal and studied the possibility of their use in the manufacture of solar cells. Results proved that, some of plants extracts exhibited strong fluorescence emission in the visible region, and it is suitable for use in fabricated of OLED devices [9].

2. MATERIALS AND METHODS

2.1 Materials

Poly vinyl alcohol (PVA 2488), chemical formula $[C_2H_4]n$ as a white powders with 0.95% purity, hydrolysis (86-90 mol/mol) was used , De-ionized water as a solvent was used. Extracted of natural dye of yellow flowers Located in Carthage, Tunisia was used. Table 1 shows the contents of natural extract.

Table 1. Water / dye analysis contents

Sample type	pH	EC ds/m	N ppm	O.M	CL Meq/L	Ca meq/L	So_4 meq/L	CO_3 Meq/L
Water s	6.3	0.31	20.2	0.4	2.8	3	0.5	0

2.2 Methods

Yellow flowers were collected from their place of origin, washed with water and then squeezed using an electric mixer. The resulting dye was filtered to obtain a concentrated yellowish-brown dye. Table 2 shows the solutions used in this search.

Table 2. The samples used in this search

No. of samples	Contents	Ratios of dye
1	PVA + concentrated dye	1g of PVA + 100 ml concentrated dye
2	Dilute dye	25 ml of concentrated dye + 75 ml of De-ionized water
3	PVA + Dilute dye	1 g of PVA + 100 ml of dilute dye
4	PVA solution	1 g of PVA + 100 ml of water
5	Concentrated dye	50% of dye + 50% of water

3. RESULTS AND DISCUSSION

3.1 UV- absorption Spectrum

Fig. 1, shows the UV- spectrum of natural dyes and its solutions , we noted from this figure the absorption spectra of the PVA solution and the PVA solution with diluted dye samples were locating in the ultraviolet region about (200-225 nm) of wave length . While the absorption spectra of both concentrated dye and polyvinyl alcohol combined with concentrated dye were locating in the visible spectrum about (400-550 nm) of wavelength. Because of, the dye extract contains nitrogen, oxygen, sulfur and halogens, which contain n electrons and can be absorb visible or ultraviolet radiation, because these rays have more energy than the energy needed to stir up electrons. In addition, Fig. 1 indicates that the dye extracted in this research can be used as a photosensitizer for DSSC because the absorption spectrum is located within the visible region [10,11].

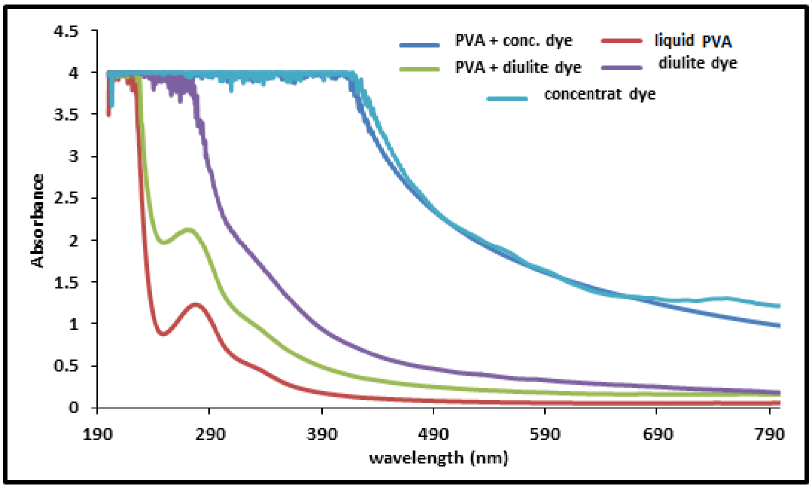

Fig. 1. UV- Spectrum of absorption of samples

3.2 UV- transmittance Spectrum

Fig. 2 shows the UV- Transmittance Spectrum of all samples we observe from Fig. 2. The displacement of the transmittance curve towards short wavelengths and we observe the opposite behavior between absorption and transmittance due to logarithmic relationship between absorptivity and transmittance [12]. Optical properties as absorbance and transmittance are very important properties for semiconductors tools as detectors and solar cell, and we can calculated from equations (1) and (2) respectively:

Absorbance (A) = IA /Io (1)

Transmittance (T) = IT / Io (2)

Where IA is intensity of absorbance light, Io is intensity of incident light, and IT is intensity of transmitted light [13].

It known that the absorbance behavior is the opposite of the transmittance behavior, by increasing the absorption, the intensity of the transmitted light decreases due to impurity atoms and the accompanying formation of local levels within the prohibited energy gap between the valence and conduction beams, thus increasing the absorption and decreasing permeability [12,13].

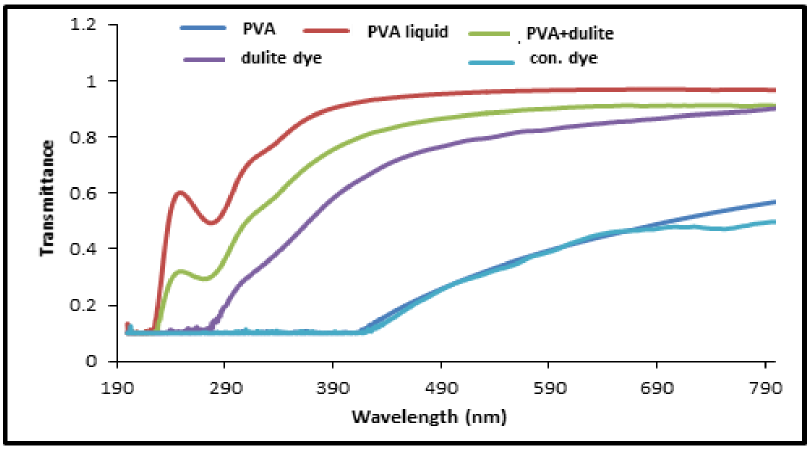

Fig. 2. Transmittance spectrum of all samples

3.3 Absorption Coefficient

Fig. 3 shows the absorption coefficient of all samples. We noted from Fig. 3. The absorption coefficient of (liquid PVA, water, and PVA + dilute dye) increases with increasing of photon energy, while, the concentrated dye and PVA + concentrated dye have highest of absorption coefficient. Because of, the dye extract contains Nitrogen, oxygen, sulfur and halogens which contain n electrons and can absorb visible or ultraviolet radiation because these rays have more energy than the energy needed to stir up electrons [14].

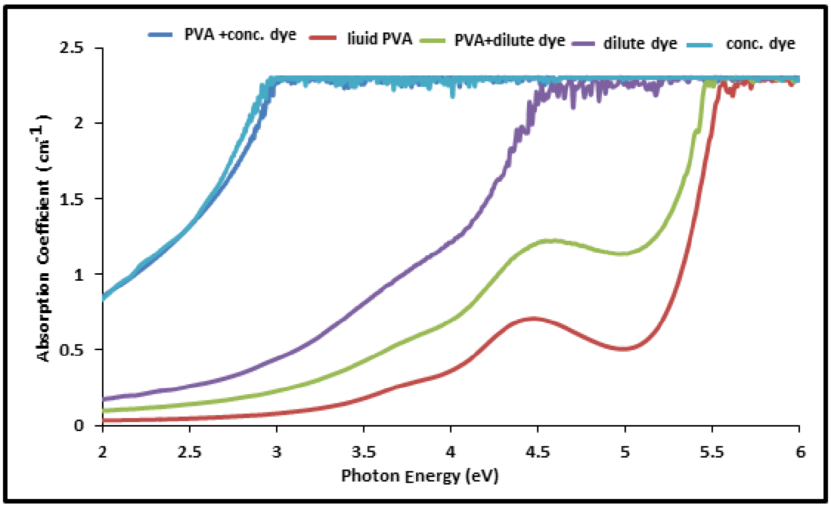

Fig. 3. Absorption coefficient versus photon energy of all samples

3.4 Indirect Energy Gap

Fig. 4 shows the indirect energy gap versus the photon energy of all samples, and Table 3 shows the slope tangent results of all samples, which calculated from Fig. 4. We can notice that, the indirect energy band gap decreases with increasing of concentration dye, the result of the natural dye with lowest energy band gap works on assist the electron to excite from valence band to the conduction band with very low energy and very short time this is leads to high efficiency solar cell [15]. In addition of, Table 3 explained the intensity of the local levels formed by atoms. The dye between the valence and conduction beams that worked to absorb photons with energies less than (eV 2.8) and up to (eV 1.7) for the concentrated dye [13-15].

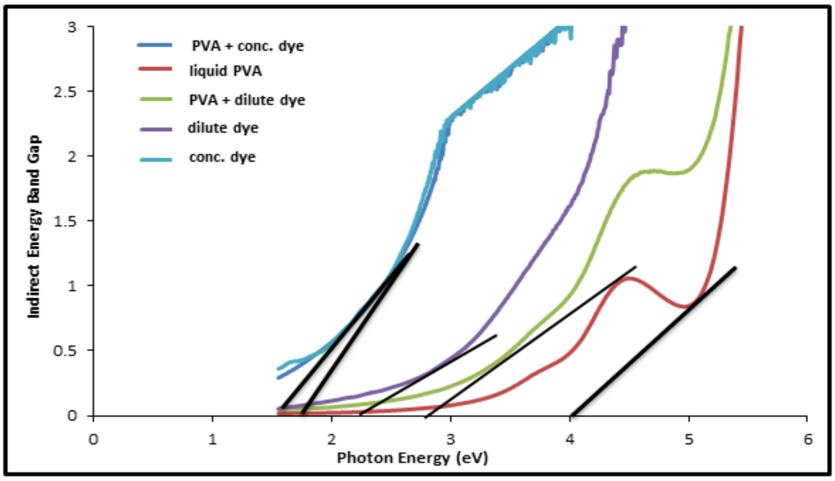

Fig. 4. Indirect energy band gap versus photon energy of all samples

Table 3. Shows the slope tangent results of all samples

No. of samples	Contents	Energy gap (Ev)
1	PVA + concentrated dye	1.8
2	Dilute dye	2.5
3	PVA + Dilute dye	2.8
4	PVA solution	4
5	Concentrated dye	1.7

4. CONCLUSION

We concluded from our current research, the addition of dye improves the optical properties of the solar cell, which include absorbance, transmittance, reflectivity, and coefficient of absorption as well as reducing the energy gap of the resulting cell. The dye extracted from yellow flowers can be used to improve the optical properties of polyvinyl alcohol for use as a liquid electrolyte medium in cells.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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