Journal of Chemical Health Risks

www.jchr.org

JCHR (2023) 13(3), 1027-1035 | ISSN:2251-6727

Luminous Solar Concentrates Using Natural Dyes Mixed With (Magnesium Oxide) Nanomaterial

[1]Najlaa Mohammad Hadi, [2]Adnan Falh Hassanm, [3]Talib Mohsen Abaas
[1]University of Babylon
[2]university of kufa
[3]university of Babylon

(Received: 04 August 2023 Revised: 12 September Accepted: 06 October)

KEYWORDS

ABSTRACT:
In this study, different concentrations (0.001,0.002,0.003) g of natural dyes (lemon, orange, beetroot) were prepared and dissolved in 100 ml of pure water because it does not affect the properties of the material and its absorption is very low in the visible spectrum. After preparing the concentrations, they were added in a square basin with four solar cells installed on its sides. 18 samples, first by the presence of a dye solution, and second by adding Mgo (Magnesium Oxide) nanomaterials at a ratio of 1.6 g to each dye solution. The results showed that the absorption spectrum increases with increasing concentration, while the fluorescence spectrum increases with decreasing concentration. The results showed that all samples participated in raising the efficiency of the solar cell over the efficiency of the primary solar cell, but in varying proportions The percentage increase in the efficiency of the solar cell of lemon dye with magnesium oxide was (η= 1.912), and the efficiency of the basic solar cell was (η= 0.500).

1-Introducation

Sun is one of the most important sources of energy on earth. The energy of sun is mainly in two types which are heat and light [1]. Several studies have been done on developing methods to transfer the energy of sun We see the world around us through light. Light from the Sun is one of the sources of energy without which human beings cannot survive in this planet. Light plays crucial role in understanding the structure and properties of various things from atom to universe. Without light, even our eyes cannot see objects. What is light?. This puzzle made many physicists sleepless until middle of 19th century. Earlier, many scientist thought that optics and electromagnetism are two different branches of physics. But from the work of James Clerk Maxwell, who actually enlightened the concept of light from his theoretical prediction that light is an electromagnetic wave which moves with the speed equal to 3 × 108 ms–1 (in free space or vacuum). Later, it was confirmed that visible light is just only small portion of electromagnetic spectrum, which ranges from gamma rays to radio waves [2].

heat and light to electrical energy [3,4]. The photovoltaic solar cells are used to convert the solar energy to electrical energy. Many researches have been done to improve the conversion efficiency of the solar cells [3,4]. Some researches focused on developing techniques to form a Nano sized porous structure on the surface of silicon photovoltaics by simple wet chemical etching process [5,6]. Other researches focused on constructing and using concentrators on the solar cell [7,8]. These concentrators are plastic or glass panels contain or are coated with luminescent materials or dyes that absorb sunlight and emit light at longer wavelengths. The used dyes can be organic dyes or inorganic dyes [9,10]. The organic dyes are organic chemicals made from plants, animals or metallic materials. The organic dyes have high fluoridation and it is available widely and inexpensive if compared with inorganic dyes [11].

In this research, the optical properties (absorbance, fluorescence, and efficiency of the solar cell) of natural

Journal of Chemical Health Risks

www.jchr.org

JCHR (2023) 13(3), 1027-1035 | ISSN:2251-6727

dyes (Lemon, Orange, and Beetroot) are studied, and their effect on improving the efficiency of the solar cell, and their measurements are compared after adding nanomaterials to it.

2-Experimental:

Natural dyes were used extracted from the (Lemon , Orange, and the Beetroot) fruits, which were prepared after washing them well and soaking them with water, then putting them on a low heat and boiling them at 75 degrees Celsius, and eliminating 20 percent of the water to preserve its fragrance. Finally, drying was completed by a dryer at 75 degrees Celsius. for 10 hours, resulting in a dry paste that was crushed to generate dye powder, where 1g, 2g, and 3g of each dye were dissolved in one liter of distilled water, The absorbance was calculated by the UV Spectrum device, as well as the fluorescence was calculated by the fluorescence device for all the dyes after dissolving them with water and then the , Magnesumoxide nanomaterials (Mgo) who is certified Sky Spring Nanomaterials is an ISO 9001, Which was purchased from international company with value (10-30)nm , were added after mixing them with pure water at a rate of0.8 grams according to the application of the concentration equation [15] .

$C = \frac{WX1000}{MwXV}$ ………………………….(1)

Where:

C : the Mgo concentration

W : is the weight of the Mgo (in gram) measured using sensitive weighting

balance,

Mw : Molecular weight of the Mgo

V : the volume of the solvent (ml)

and mixing them with 200 ml of pure water and then mixing the mixture of the nanomaterial with the dye solution at a rate of 10 ml to 100 ml for each concentration of each dye, and both the absorbance and fluorescence were calculated for each mixture and then , the cell efficiency was also calculated for the dye solution Before adding the nanomaterials and after As shown in Tabl adding the nanomaterialse (1,2,3) where The illuminating solar concentrator (LSC) was manufactured using four silicon solar cells placed at the edge of the basin containing the prepared dyes. The parameters of the solar cell were calculated for the three concentrations prepared in the presence and absence of the nanomaterial (Mgo) , and the efficiency of the solar cell was calculated and the amount of increase and decrease in the amount of this efficiency also calculated wereThe solar cell efficiency without dyes was (η= 0.500) .The SEM of the magnesium oxide nanomaterial, as well as the TEM , were calculated and the results were as shown in Figure (5,6) .

3-Measrements:

3-1-Luminescent Materials:

Luminescent materials must have particular properties to maintain an efficient system of concentration. Among these properties is a broad range of absorbance, and higher absorbance efficiency an emission spectrum tailored to the band gap of the employed photovoltaic cell, small overlap between absorbance and emission spectrum to prevent reabsorbance and sustaining stability under external weather circumstances . When the first luminescent materials are used in LSC, they generally have high quantum efficiency and are relatively inexpensive compared to inorganic fluorescent dyes. Some of them are also found to be quite stable. However, they have a large overlap between absorption and emission spectra causing large losses due to re – absorption [9].

3-2-Photovoltaic Cell (Solar Cell) :

A **solar cell**, or **photovoltaic cell**, is an electronic device that converts the energy of light directly into electricity by the photovoltaic effect, which is a physical phenomenon.[1] It is a form of photoelectric cell, defined as a device whose electrical characteristics, such as current, voltage, or resistance, vary when exposed to light. Individual solar cell devices are often the electrical building blocks of photovoltaic modules, known colloquially as solar panels. The common single-junction silicon solar cell can produce a maximum open-circuit voltage of approximately 0.5 to 0.6 volts [19] .

A PV panel is known as a semiconductor device made of semiconductor material. Materials that semi-conduct are typically crystalline or amorphous solids. At a temperature close to absolute zero (0 Kelvin), solids act as insulators and do not have any free electrons. However, at room temperature, a part of insulators contains a number of free electrons. The bond energies between the valence electrons and nucleus in an atom have (3-5) eV. Materials of electrical conductivity that exhibit change from absolute zero to room temperature are known as semiconductors [12].

Journal of Chemical Health Risks
www.jchr.org
JCHR (2023) 13(3), 1027-1035 | ISSN:2251-6727

3-3-Photovoltaic Parameters :

The open-circuit voltage, short-circuit current, power output, fill factor and efficiency of a solar cell are collectively called the photovoltaic parameters.

3-4- **Open Circuit Voltag**e :

(V_{oc}) It is the maximum value of the voltages that can be obtained on both ends of the solar cell when the cell's electrical circuit is open. The load resistance (RL =∞) can be represented by equation [13].

V_{oc} =KT/q Ln(I_L/I_O +1) ……………………………..……..(2)

Where: q is the electron charge, k is Boltzmann constant, T is the absolute temperature [14].

3-5-Short Circuit Current (Isc) :

The short circuit current, I_{sc}, is the maximum current produced by a solar cell when its terminals are shorted to generated current when the load is zero in the circuit. On the other hand, the I_{sc} is the current of the PV-cell when the voltage at the terminals of the PV-cell is zero, i.e. :

$I_{SC} = I_O (e^{qVoc/KT} -1)$ ……………………(3)

$I = I_L = I_{SC}$……………………………….(4)

3-6- scanning electrons microscopy (SEM)

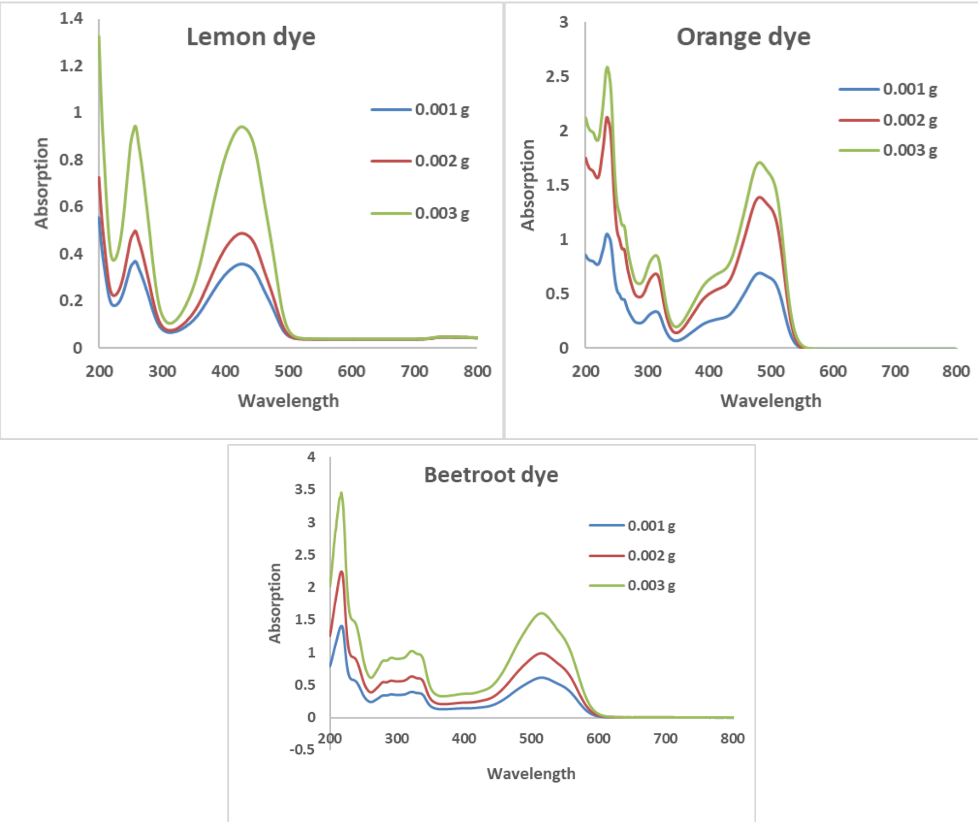
Scanning electron microscopy (SEM) is widely used to study EVs and provides information on size and morphology. SEM is based on a focused beam of electrons that scan the sample, which interacts with the atoms in the sample to provide three-dimensional surface topography. However, conventional SEM is performed under high vacuum and requires complex and extensive sample processing, including dehydration, fixation and metallization [20] .

3-7-Transmission electron microscopy (TEM)

Transmission electron microscopy (TEM) is an analytical technique used to visualize the smallest structures in matter. Unlike optical microscopes, which rely on light in the visible spectrum, TEM can reveal stunning detail at the atomic scale by magnifying nanometer structures up to 50 million times. This is because electrons can have a significantly shorter wavelength (about 100,000 times smaller) than that of visible light when accelerated through a strong electromagnetic field, thus increasing the microscope resolution by several orders of magnitude [21] .

4- **Results and Discussion**:

The absorbance of each dye solution in the difference concentration (0.001,0.002,0.003) g was plotted through the UV device as shown in fig.(1) .



Journal of Chemical Health Risks
www.jchr.org
JCHR (2023) 13(3), 1027-1035 | ISSN:2251-6727

(a) (b) (c)

Figure (1) curve Absorbance of dyes nature (Lemon, Orange and Beetroot dyes) .

Figure 1: shows the Absorbance of nature dyes extension .Section (a) shows the Absorbance curve of Lemon dye type where a peak at wavelength (415 nm) (b)shows the Absorbance curve of Orange dye at wavelength (500 nm) (c) shows the Absorbance curve of Beetroot dye at wavelength (522 nm) .

We notice in figure (1) that the absorbance increases with increasing dye concentration .

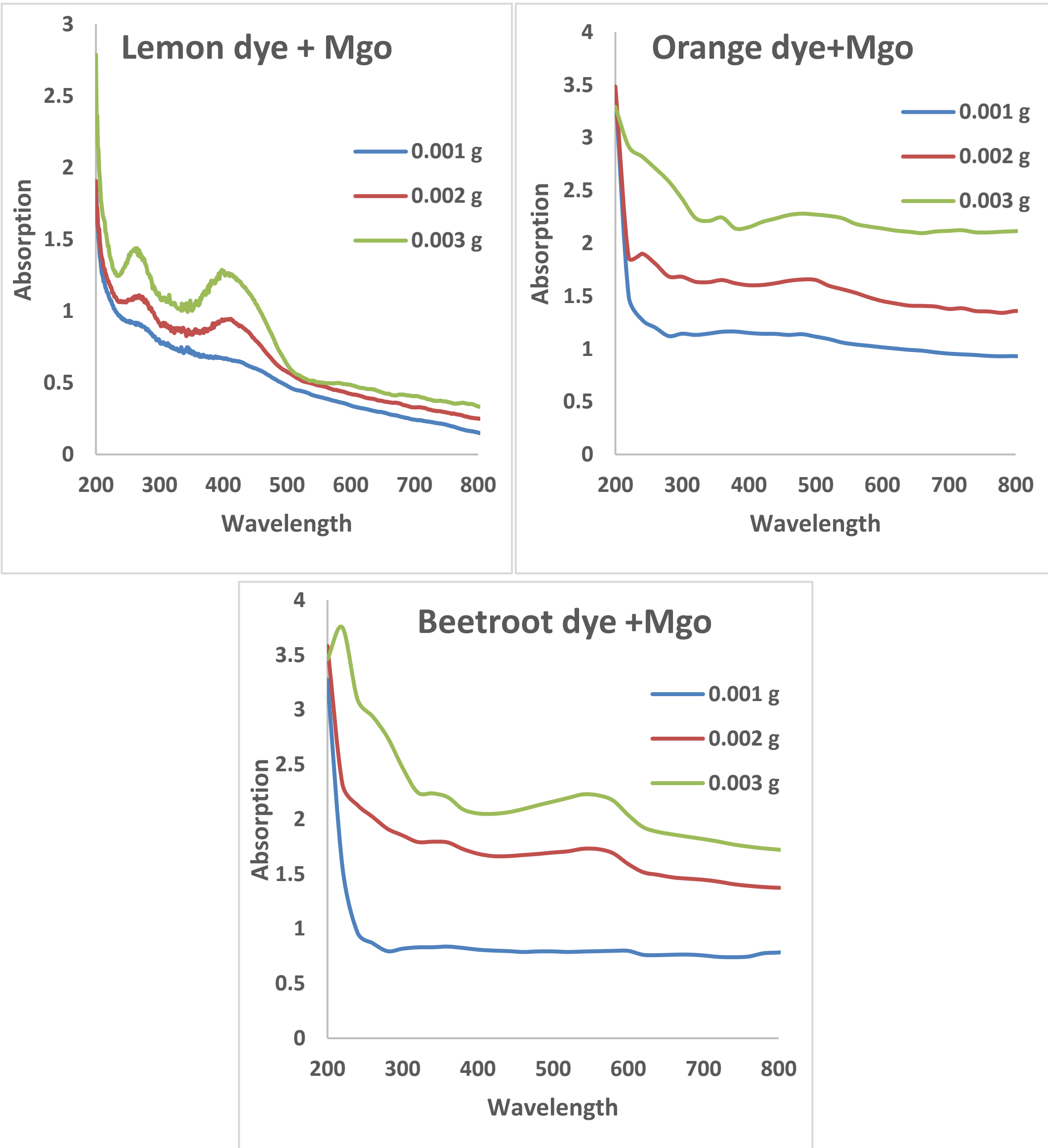


Figure (2) Absorption spectrum of each of Lemon , Orange and Beetroot dyes mixed with nanomaterial Mgo (Magnesium oxid).

We notice an increase in the absorbance when the nanoparticles are added, and it increases with the increase in the dye concentration According to Beer-Lambert's law [15][22].

Journal of Chemical Health Risks
www.jchr.org
JCHR (2023) 13(3), 1027-1035 | ISSN:2251-6727

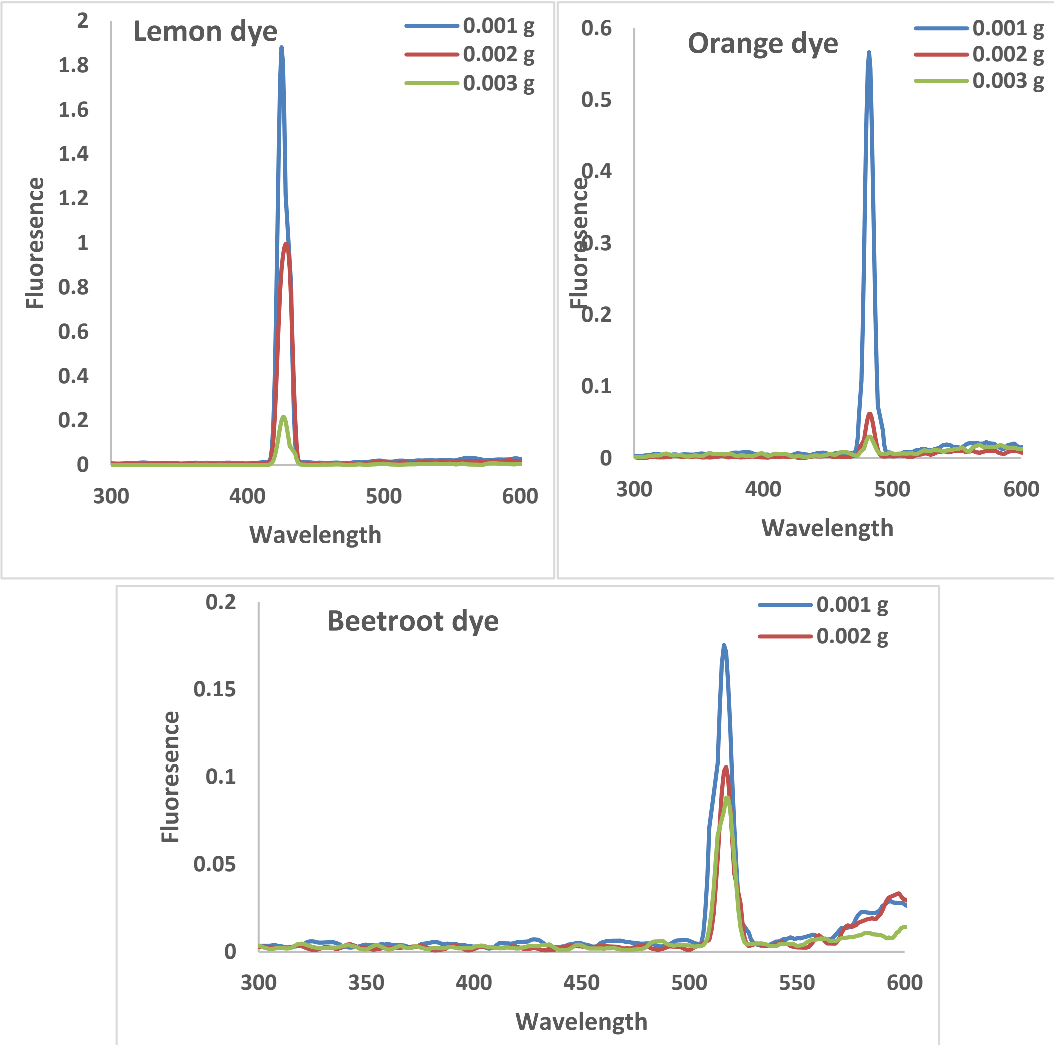
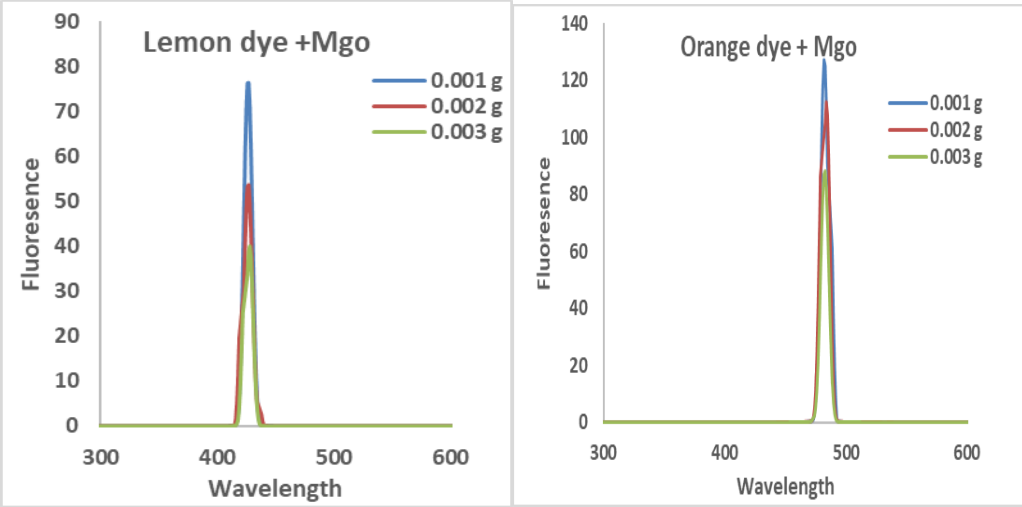


Figure (3) fluorescence spectrum of each of Lemon ,Orange and Beetroot dyes .

We notice in figure (3) that the fluorescence decreases as the dye concentration increases .



Journal of Chemical Health Risks
www.jchr.org
JCHR (2023) 13(3), 1027-1035 | ISSN:2251-6727

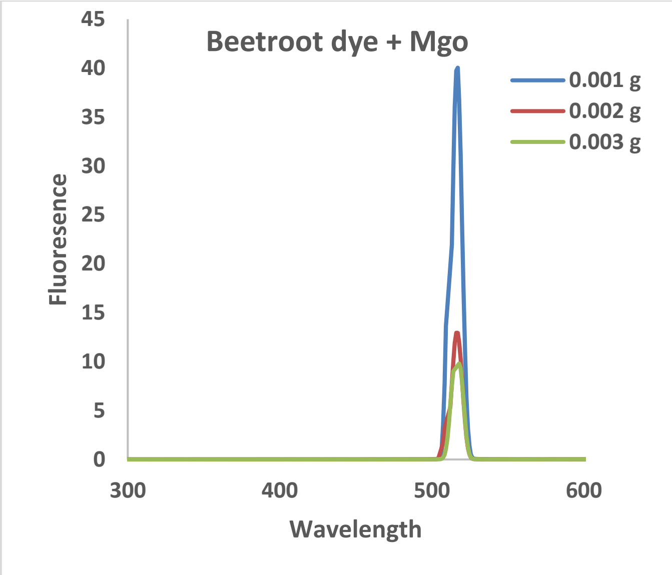


Figure (4) fluorescence spectrum of each of Lemon , Orange and Beetroot dyes mixed with nanomaterial Mgo (Magnesium oxide) [23][24].

We notice in figure (4) a high increase in fluorescence when adding the nanomaterial due to a decrease in the energy gap due to the formation of local levels, where the electron is picked up in two stages from the valence band to the local levels and then from the local levels to the conduction band [18] [25].

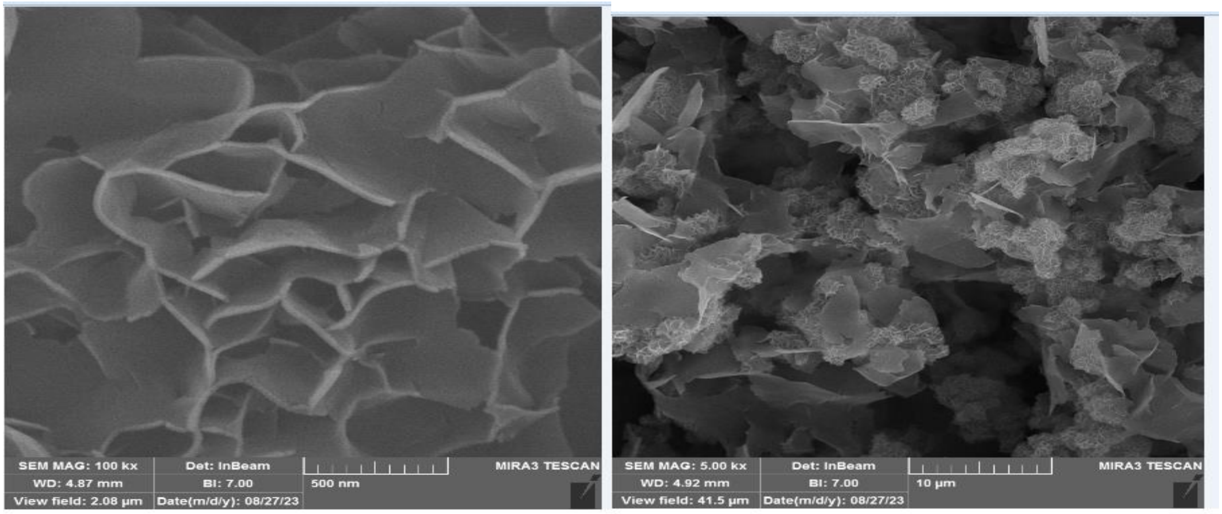


Figure (5) SEM study of magnesium oxide nanomaterial at (10 Mm) and (5nm) distances .

Journal of Chemical Health Risks

www.jchr.org

JCHR (2023) 13(3), 1027-1035 | ISSN:2251-6727

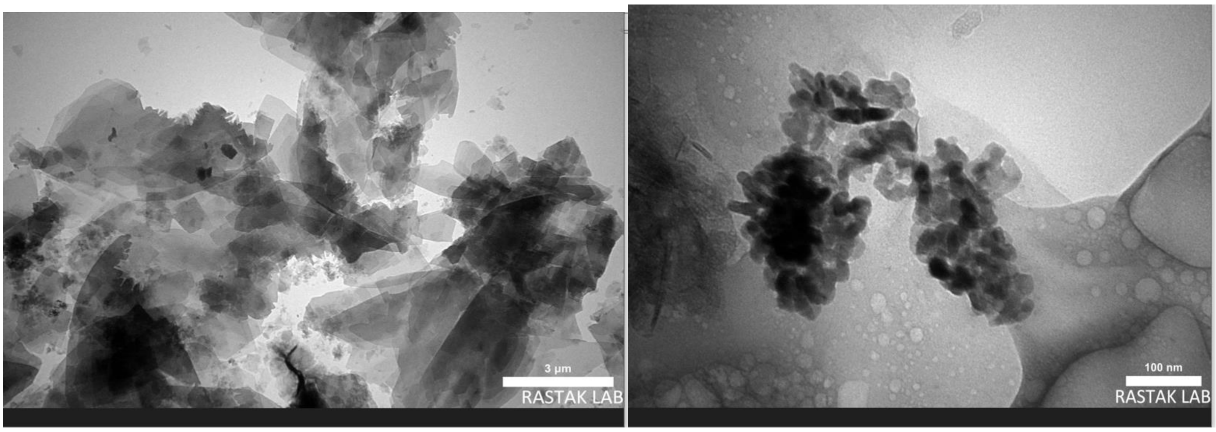


Figure (6) Tem Transmission electron microscopy study of magnesium oxide nanomaterial at (3Mm)and (100nm) distances .

Table (1) Solar Cell Efficiency (η) of Mixture (Lemon dye and Magnesium oxide) at Different Concentrations[26][27].

Weight ratio	Nanomaterial	V_{max}	I_{max}	FF	η%	ηΔ%
0.001		4.670	31.70	0.757	0.948	0.666
0.001	Mgo	4.997	38.80	0.736	1.428	1.509
0.002		4.881	39.40	0.755	1.182	1.077
0.002	Mgo	4.912	57.20	0.808	1.800	2.163
0.003		4.961	39.60	0.755	1.196	1.109
0.003	Mgo	4.915	58.30	0.812	1.912	2.360

Table (2) Solar Cell Efficiency (η) of Mixture (Orange dye and Magnesium oxide) at Different Concentrations.

Weight ratio	Nanomatrail	V_{max}	I_{max}	FF	η%	ηΔ%
0.001		4.458	22.30	0.773	0.637	0.119
0.001	Mgo	4.672	31.20	0.795	0.934	0.641
0.002		4.552	24.90	0.773	0.726	0.275
0.002	Mgo	4.676	34.20	0.792	1.024	0.799
0.003		4.676	26.50	0.783	1.025	0.029
0.003	Mgo	4.677	35.30	0.799	1.191	1.093

Table (3) Solar Cell Efficiency (η) of Mixture (Beetroot dye and Magnesium oxide) at Different Concentrations.

Weight ratio	Nanomatrail	V_{max}	I_{max}	FF	η%	ηΔ%
0.001		4.798	27.60	0.756	0.849	0.492
0.001	Mgo	4.577	26.40	0.764	1.511	1.655
0.002		4.762	26.10	0.766	0.913	0.604
0.002	Mgo	4.688	26.70	0.782	0.681	0.196
0.003		4.822	27.20	0.812	1.180	1.073
0.003	Mgo	4.767	27.90	0.709	1.822	2.202

The higher increase in the efficiency of the solar cell in the Lemon dye mixed with(Mgo) nanometrail Δη=2.360 % .

The reason for increasing the efficiency of the solar cell by adding the nanomaterials is the scattering of the photons of light due to the presence of the nanomaterials in different directions, and due to the distribution of the

solar cells in four directions, all the scattering photons were obtained . This is because the scattering depends on the wavelength, where the dimension of the nanoparticle ranges from (10-30)nm , according to the information of the company from which the purchase was made, and the wavelength of light absorption is (200-800)nm , which is greater than the dimension of the nanoparticle, and thus the scattering is done according to the Rayleigh scattering [16] [28].

5-Conclusion:

by using natural dyes in addition to the presence of nanomaterials that work to improve the optical properties, where the highest value of the efficiency of the solar cell was obtained in the dye of Lemon dye with (Mgo) nanopartical (η=0.921%) while the efficiency of the solar cell without a light center was(η=0.500%) .

References

1. Armaroli, Nicola, and Vincenzo Balzani. "The future of energy supply: challenges and opportunities." Angewandte Chemie International Edition, 46(1-2): 52-66, 2007.
2. Weinstein, L. A. "Electromagnetic waves." *Radio i svyaz', Moscow* (1988).
3. Tara P. Dhakal. Available from: URL: http://theconversation.com/getting-more-energy-from-the-sunhow-to-make-better-solar-cells-54090
4. SRELR. Available from: URL: http://www.stelr.org.au/solar-cells/
5. Rui Li1, S. W. Nanoscale Silver-Assisted Wet Etching of Crystalline Silicon for Anti-Reflection Surface Textures. Journal of Nanoscience and Nanotechnology, 1–5, 2013.
6. X X Lin, Y. Z. Realization of improved efficiency on nanostructured multicrystalline silicon solar cells for mass production. Nanotechnology (IOP Science), 1-9, 2015.
7. Van Sark, Wilfried GJHM, Luminescent Solar Concentrators-A review of recent results. Optics Express, 16(26): 21773-21792, 2008.
8. Alaa Meahdy Mohamed, and Adnan F. Hassan. Improve solar cell energy conversion efficiency by using illuminescent dyes concentrators. Journal of Kufa-Physics, 7(2): 8-15, 2015.
9. Rowan, Brenda C., Lindsay R. Wilson, and Bryce S. Richards. Advanced material concepts for luminescent solar concentrators. IEEE Journal of Selected Topics in Quantum Electronics 14(5): 1312-1322, 2008. 85
10. Reisfeld, Renata. Future technological applications of rare-earthdoped materials. Journal of the Less Common Metals, 93(2): 243- 251, 1983.
11. Truant, J. P., W. A. Brett, and Jr W. THOMAS. Fluorescence microscopy of tubercle bacilli stained with auramine and rhodamine. Henry Ford Hospital Medical Bulletin, 10: 287-296, 1962
12. Kajsa sols "simulation of solar cell losses depending on cell design" MSC. Chalmers University of Technology, Sweden, 2010.
13. W.Palz , " Solar electricity " , (Butterworths) , 1979.
14. Sol Weider, "Introduction to Solar Energy for Science and Engineering Students," translated by Dr. Shaker Jaber Dr. Khalil Ibrahim Saeed Dr. Youssef Mawloud Hassan and Mr. Imad Mamdouh, Ministry of Higher Education and Scientific Research, University of Mosul, 1989 .
15. Dr. Jamil Dhabab - Modern methods and techniques in automated chemical analysis, Al-Mustansiriya University. College of Science, 2013.
16. Mohammad, Khalid K. "Extinction Coefficient Measurements of Turbid Media." 2010 .
17. Rajagopal, K. *Textbook Of Engineering Physics (Part I)*. PHI Learning Pvt. Ltd., 2008.
18. Zhang, Wenjun, Jian Lin, Mingzhao Cheng, Shuo Zhang, Yujie Jia, and Junhong Zhao. "Radiative transition, local field enhancement and energy transfer microcosmic mechanism of tellurite glasses containing Er3+, Yb3+ ions and Ag nanoparticles." *Journal of Quantitative Spectroscopy and Radiative Transfer* 159 (2015): 39-52.
19. "Solar cells – performance and →use". solarbotic s.net.
20. Pallares-Rusiñol, Arnau, et al. "Advances in exosome analysis." *Advances in Clinical Chemistry; Elsevier: Amsterdam, The Netherlands* 112 (2023): 69-117.
21. Tang, C. Y., and Z. Yang. "Transmission electron microscopy (TEM)." *Membrane characterization*. Elsevier, 2017. 145-159.
22. Mall, Pawan Kumar, et al. "Rank Based Two Stage Semi-Supervised Deep Learning Model for X-Ray Images Classification: AN APPROACH

Journal of Chemical Health Risks

www.jchr.org

JCHR (2023) 13(3), 1027-1035 | ISSN:2251-6727

TOWARD TAGGING UNLABELED MEDICAL DATASET." Journal of Scientific & Industrial Research (JSIR) 82.08 (2023): 818-830.

23. Narayan, Vipul, et al. "A Comprehensive Review of Various Approach for Medical Image Segmentation and Disease Prediction.
24. Mall, Pawan Kumar, et al. "A comprehensive review of deep neural networks for medical image processing: Recent developments and future opportunities." Healthcare Analytics (2023): 100216.
25. Narayan, Vipul, et al. "Severity of Lumpy Disease detection based on Deep Learning Technique." 2023 International Conference on Disruptive Technologies (ICDT). IEEE, 2023.
26. Saxena, Aditya, et al. "Comparative Analysis Of AI Regression And Classification Models For Predicting House Damages İn Nepal: Proposed Architectures And Techniques." Journal of Pharmaceutical Negative Results (2022): 6203-6215.
27. Kumar, Vaibhav, et al. "A Machine Learning Approach For Predicting Onset And Progression"“Towards Early Detection Of Chronic Diseases “." Journal of Pharmaceutical Negative Results (2022): 6195-6202.
28. Chaturvedi, Pooja, A. K. Daniel, and Vipul Narayan. "A Novel Heuristic for Maximizing Lifetime of Target Coverage in Wireless Sensor Networks." Advanced Wireless Communication and Sensor Networks. Chapman and Hall/CRC 227-242.