ISSN: 2458-8989

Natural and Engineering Sciences

NESciences, 2025, 10 (2): 231-238 doi: 10.28978/nesciences.1733120

# Prepared Panel and Film From Nano Pigment it Used to Improve the Efficiency Conversion of Solar Cells

Alaa M. Mohamed [1], Hussam M. Hwail [2], Ahmed M. Hassan [3], Basim A. Almayahi [4*]

[1] Department of Physics, Faculty of Science, University of Kufa, Najaf, Iraq.
E-mail: aalaam.ahmad@uokufa.edu.iq

[2] Department of Physics, Faculty of Science, University of Kufa, Najaf, Iraq.
E-mail: hussamm.daham@uokufa.edu.iq

[3] Department of Physics, Faculty of Science, University of Kufa, Najaf, Iraq.
E-mail: ahmadm.ali@uokufa.edu.iq

[4*] Department of Physics, Faculty of Science, University of Kufa, Najaf, Iraq.
E-mail: basim.almayahi@uokufa.edu.iq

## Abstract

The nano pigment synthesized from chloroauric acid was utilized in the fabrication of panels and films, which served as luminescent solar concentrators (LSCs) to enhance the energy conversion efficiency of solar cells. Based on the optical measurements, the nano pigment demonstrated the ability to both absorb and transmit a significant portion of solar radiation, indicating its high potential for efficient light management in photovoltaic applications. Based on the results, production with the panel and film led to solar cells that work more efficiently than before. Analysis with XRD determined that the pigment forms in nanoscale crystals with sizes of (30–60) nm. The thicknesses of the panel and the film, along with the concentration of nano pigments, were maintained at constant values. All epoxy polymer and glycerin liquid used during the preparation process were maintained at constant levels, as they did not significantly affect the characteristics or performance of the panels and films integrated with solar cells.

## Keywords:

*Crystal, film, nano pigment, solar cells, dye.*

## Article history:

Received: 19/03/2025, Revised: 02/06/2025, Accepted: 04/07/2025, Available online: 30/08/2025

**Corresponding Author: Basim A. Almayahi, E-mail: basim.almayahi@uokufa.edu.iq*

## Introduction

Light, particularly visible sunlight, constitutes a major portion of optical radiation and plays a significant role as a renewable energy source (Aadiwal et al., 2025). Solar panels can harness this energy to generate thermal energy or convert sunlight directly into electricity through photovoltaic processes. As a result, we get a clean and renewable source of energy that is also environmentally safe. It is now common to see solar cells made from organic pigments instead of the usual silicon parts. In the study, Nano Chlorogoldsaure was picked to dissolve the pigment which played the role of a luminescent solar concentrator (LSC) that helped improve solar cells efficiency (Abbas, 2013). BSCs are special because they can generate electricity when hit by light from either side which is much more effective than using conventional styles (Figure.1) (Alkhayatt et al., 2019).

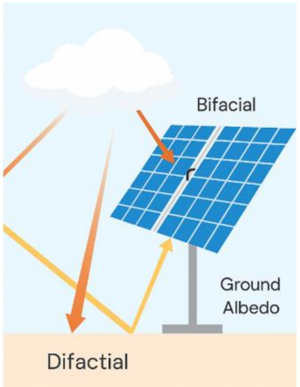


Figure 1. The bifacial solar cells

## Nano Chlorogoldsaure Solvent

The formula structure of Nano Chlorogoldsaure solvent is (HAuCk4.xH2O) and Molar mass (339.79 g/mol) (Ataiwi & Abdul-Hamead, 2009).

## Experimental Details

The concentration of the NanoChlorogoldsaure solvent was evaluated through UV-Vis spectrophotometry by measuring its absorbance at the characteristic wavelength:

The concentration of the nano pigment solvent found by using the equation (1) as following (Tauc, 2012):

$$C = 22.2(\text{absorbance at } 645) + 9.02\ (\text{absorbance at } 663) \times (V/\ 1000 \times W) \qquad (1)$$

Where:

C: concentration of the Nano Chlorogoldsaure

V: volume of the Nano Chlorogoldsaure solvent

W: weight soft to the Nano Chlorogoldsaure

The concentration of the nano pigment derived from chloroauric acid in the solvent was 1×10−81mg/g.

***Transmission , Absorption and Reflectance Spectra of the Nano Pigment Solvent***

The absorption and transmission spectra of the solvent containing the nano pigment are shown in Figures 2, 3, and 4. When the wavelengths are changed to higher values but the concentration is fixed, the intensity of pigment-solvent absorption increases slightly. A Stokes shift is marked by the maximum transmission value which is reached as the transmission curve moves toward the red color, while the sampled concentration is unchanged.

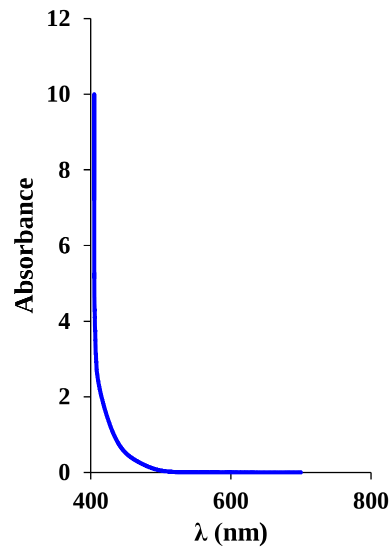


Figure 2. Absorption spectrum of the nano pigment solvent at a concentration of $2.34\times10^{-2}$ mg·g$^{-1}$

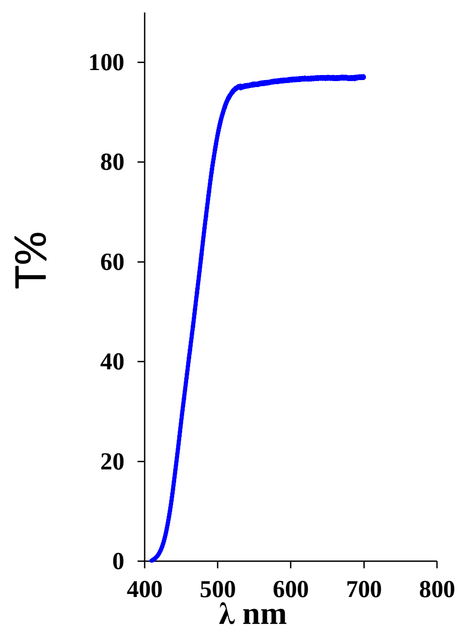


Figure 3. Spectrum transmission for nano pigment solvent of ($2.34\times10$-2 ) mg.g-1

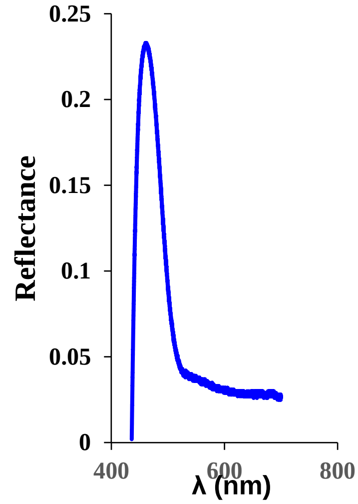


Figure 4. spectrum reflectance for nano pigment solvent of (2.34×10-2 ) mg.g.

***Measurement of the Energy Band Gap (Eg)***

Figure 5 shows the plot of $(\alpha h\nu)^2$ versus hν for the nano pigment solvent. The data were fitted using the Tauc equation to determine the energy band gap (Eg) (Bakari, 2016; Alhindi et al., 2021).

$$\alpha h\upsilon = J(h\upsilon - E_g)^k \tag{2}$$

Here, α represents the absorption coefficient, J is a constant, Eg denotes the optical band gap, and k indicates the type of possible optical transition. Based on the calculations, the indirect optical band gap was found to be 2.37 eV.

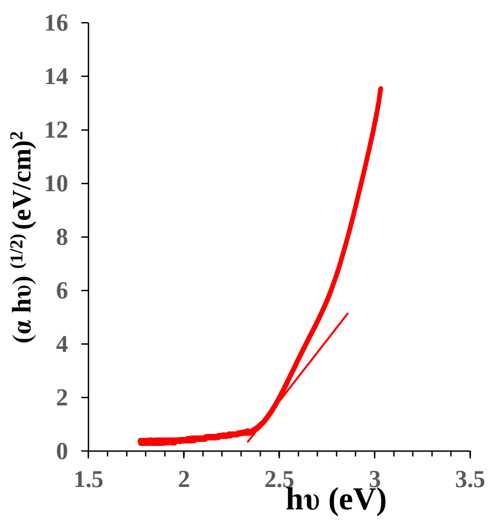


Figure 5. Eg is shown for the nano pigment when dissolved in the chosen solvent.

***Measurement of the XRD Data for the Nano Pigment on the Panel and Film***

The nano pigment solvent was coated onto a glass substrate using the drop casting method to examine the crystallinity and structural features of the nanoparticles via X-ray diffraction analysis, as shown in Figure 6. The crystal size was estimated using the Scherrer equation (7,8).

$$D = \frac{0.9\,\lambda}{\beta\, COS\theta} \quad \ldots\ldots\ldots\ldots\ldots\ldots. \quad (2)$$

The crystal size ranged from 36 to 60 nm, indicating that the formed structures are of nano-dimensions, as illustrated in Table 1.

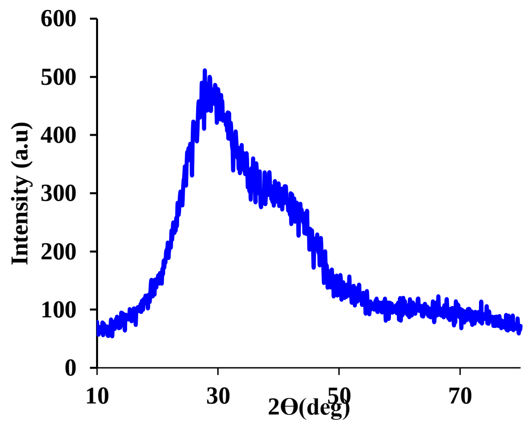


Figure 6. XRD pattern of the nano pigment solvent

Table 1. The XRD data of nano pigment for the panel and film

| **2Θ (deg)** | **d (nm)** | **FWHM** | **D (nm)** |
|---|---|---|---|
| 26.796 | 3.3243 | 0.154 | 53 |
| 28.605 | 3.118 | 0.167 | 49 |
| 36.35 | 2.4695 | 0.232 | 36 |
| 46.392 | 1.9556 | 0.207 | 41 |
| 69.357 | 1.3538 | 0.194 | 49 |
| 71.504 | 1.3183 | 0.163 | 60 |

## Preparation of the Panel and Film

Two components make up the epoxy: part A which is the resin and part B, the hardener. Together, they were put into the nano pigment solvent to ensure proper adhesion on the panel. I combined the resin and hardener used in the ratio of two parts resin to one part hardener, and I stirred it for 2 minutes. Next, the nano pigment solvent was put into the resin-hardener solution and it was stirred for another 3 minutes. After making the resin-epoxy, it was put in a glass mold and cured at 25 °C for 50 hours. The film making process did not require the use of polymer epoxy. Rather, the nano pigment solvent was distributed on a glass plate by means of the spin coating technique (VTC). Figure 7 presents the panel with the performing thin film layer that gives light when the panel is used (Abbas, 2013; Mohammed Rubin & Yusuf, 2014; Milev et al., 2024).

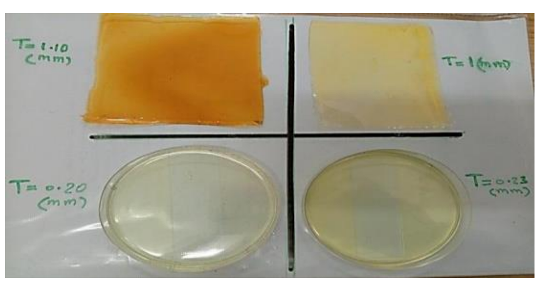


Figure 7. Solar concentrators can be fabricated using thin films or assembled panel elements

Measurements in the laboratory included a computer, a panel and film of nano pigment, and a crystalline silicon solar cells (model F–TNY 1180) with sides 75 × 75 mm and an efficiency of 4.190%. A solar module analyzer was used to measure the solar cells performance, and to measure the thickness of the cells, panel, and film a digital caliper was used (Figure. 8) (Araby, 2006).

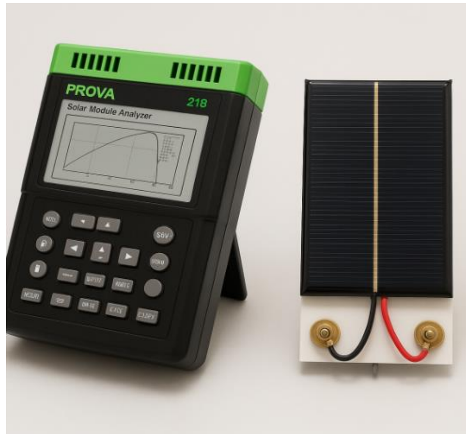


Figure 8. Setup for the measuring system

## The Measurements for the Solar Cells

The efficiency of The solar cells improves when a panel or film containing the nano pigment is applied over its surface. Looking at Table 2, you can tell that the maximum efficiency happens when the panels and films are applied to the solar cells (Thahab et al., 2016).

Table 2. Solar cells performance with nano pigment panel and film.

| **Samples** | **Concentration (mg.g$^{-1}$)** | **Thickness(mm)** | **η%efficiency of solar cells** | **Panel η%** | **Film η%** |
|---|---|---|---|---|---|
| Panel | $1 \times 10^{-8}$ | 1.10 | 4.190% | 7.122 | 6.341 |
| film | | 0.23 | | | |

## Conclusions

1. Chloroauric acid-based nano pigment exhibits excellent optical properties, strongly transmitting, absorbing, and reflecting light in the visible spectrum. The crystal size of the pigment was determined using X-ray diffraction analysis, revealing particles approximately 30 to 60 nanometers in length.

2. Nano pigment derived from Chlorogoldsaure added to panels and films raises the efficiency of solar cells. Therefore, panels made with these nano pigment-based materials can be used to boost the energy collection of bifacial solar cells (Zhang et al., 2010; Skoog, 2010; Tauce, 1974).

3. By examining its optical properties, the optical band gap was measured (2.37 eV), making it suitable for use in solar cells(Thahab et al., 2016).

4. When making panels and films, using low concentrations is better and produces effective results.

5. Single or multiple layers of the extracted pigment may be applied to the surface of solar cells to enhance their performance.

## Author Contributions

All Authors contributed equally.

## Conflict of Interest

The authors declared that no conflict of interest.

## References

Aadiwal, V., Upadhyay, S., Nagappan, B., & Wani, T. A. (2025). Investigating the Influence of Physiographic Factors on Habitat Selection by Cetacean Species in Marine Environments. *Natural and Engineering Sciences*, *10*(1), 301-311. https://doi.org/10.28978/nesciences.1646474

Abbas, F. S. (2013). Luminescent solar concentrators to improve solar cells conversion efficiency, MSc. Thesis, College of Science –University of Kufa.

Alhindi, H., Traore, I., & Woungang, I. (2021). Preventing Data Loss by Harnessing Semantic Similarity and Relevance. *J. Internet Serv. Inf. Secur.*, *11*(2), 78-99.

Alkhayatt, A. H. O., Habieb, A. A., Al-Noaman, A. H. A., & Hameed, A. A. (2019, July). Structure, surface morphology and optical properties of CuxZn1-xS/Au NPs layer for photodetector application. In *Journal of Physics: Conference Series* (Vol. 1234, No. 1, p. 012012). IOP Publishing. . https://doi.org/10.1088/1742-6596/1234/1/012012

Araby, F. H. (2006). Study the effect of three factors on the output parameters of silicon solar cells, MSc. Thesis, Babylon University.

Ataiwi, A. H., & Abdul-Hamead, A. A. (2009). Study some of the structure properties of ZrO2 ceramic coats prepared by spray pyrolysis method. *Eng. and Tech. Journal*, *27*(16), 2918-2930.

Bakari, S. (2016). Impact of exports and imports on economic growth in Canada: empirical analysis based on causality.

Milev, N., Takashi, K., Shoei, O., & Atsunori, N. (2024). State-of-the-art Application of the Log-piling Method in the Role of Shallow Ground Improvement for Liquefaction Mitigation. *Archives for Technical Sciences*, *1*(30), 59-78. https://doi.org/10.59456/afts.2024.1630.059M

Mohammed Rubin, D., & Yusuf, A. (2014). *General Physics*, 9th edition.

Skoog, D. A. (2010). Analytical Chemistry, skoog west Holler Crouch-Michigan state University, U.S.A.

Tauc, J. (Ed.). (2012). *Amorphous and liquid semiconductors*. Springer Science & Business Media.

Tauce, J. (1974). *Amorphous & Liquid Semiconductors.* Plenum, London & New York.

Thahab, S. M., Alkhayatt, A. H. O., & Zgair, I. A. (2016). Influences of post-annealing temperature on the structural and electrical properties of mixed oxides (CuFeO2 and CuFe2O4) thin films prepared by spray pyrolysis technique. *Materials Science in Semiconductor Processing*, *41*, 436-440. https://doi.org/10.1016/j.mssp.2015.10.013

Thahab, S. M., Alkhayatt, A. H. O., & Zgair, I. A. (2016). Influences of post-annealing temperature on the structural and electrical properties of mixed oxides (CuFeO2 and CuFe2O4) thin films prepared by spray pyrolysis technique. *Materials Science in Semiconductor Processing*, *41*, 436-440. https://doi.org/10.1016/j.mssp.2015.10.013

Zhang, J., Chen, C., & Cohen, R. (2010). A Scalable and Effective Trust-Based Framework for Vehicular Ad-Hoc Networks. *J. Wirel. Mob. Networks Ubiquitous Comput. Dependable Appl.*, *1*(4), 3-15.