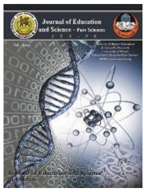
Journal of Education and Science (ISSN 1812-125X)



Study Optical Properties of Nickel Oxide Syntheses by Chemical Spray Pyrolysis

N. S. Khairallah (1), **M. A. Al-Jubbori** (2*), **A. E. Elzwam**(3)

(1,2) Department of Physics, College of Education for Pure Sciences, University of Mosul, 41001, Mosul, Iraq
(3) Department of Physics, College of Sciences, Tripoli University, Libya

Article information

Article history:
Received: October 28, 2025
Revised: January 15, 2026
Accepted: January 22, 2026
Available online: April 01, 2026

Keywords:
CSP
Nickel Oxide
Absorbance
Energy Gap
Optical Properties

Correspondence:
Mushtaq Abed Al-Jubbori
mushtaq_pht@uomosul.edu.iq

Abstract

In this study, thin nickel oxide nanomembranes were obtained using thermal chemical spraying technology, which involves spraying a green-colored chemical solution at a rate of 30 sprays onto glass substrates with an area of 6.25 cm². This thin layer was prepared at a temperature of 450 °C under a pressure of 2 bar. The optical properties of nickel oxide films were studied using analytical methods such as dual spectral analysis of ultraviolet and visible light and their relationship to wavelengths which ranging from 190 nm to 1100 nm. The surface morphology was also studied using a scanning electron microscope (SEM). The analysis results showed that the nickel oxide film particles were irregularly spherical, with diameters ranging from 10 to 55 nm. These glass substrates were then exposed to ultraviolet radiation UVC for (1-3) hours, with each irradiation session lasting only one hour. By using a visible ultraviolet spectrometer before and after each hour, the results showed that the absorbance spectrum, changes with wavelength and also changes with irradiation time, decreasing with increasing wavelength and increasing with increasing irradiation time. The energy gap for NiO films prepared at a temperature of 450 °C was also calculated, and it was found that its value before irradiation was 3.70 eV and then began to decrease with increasing irradiation hours, reaching 3.63 eV. These results are consistent with those of previous studies, including studies [Faycal et al ,2018] and [kamal et al, 2004], which recorded energy gaps of (3.8 and 3.65) eV respectively.

DOI:10.33899/jes.v35i2.53669, ©Authors, 2026, College of Education for Pure Science, University of Mosul.

Introduction

Since ancient times, thin films have been used. It is one of the oldest arts, and due to its importance, it has kept pace with modernity and development, to the extent that it is now considered one of the sciences that attract the attention of researchers [1-2]. Its importance in solid-state physics has become apparent, and it has contributed to its development through theoretical research and practical applications. It has been widely used in the electronics industry, particularly in semiconductors, where it has demonstrated distinctive properties in the circuits and devices in which it has been used [3-4]. A thin film is a small material formed on a glass substrate produced by depositing various types of materials (ionic, molecular, atomic) using physical or chemical methods, each with its own advantages, properties, and disadvantages. The thickness of a thin film is usually a few tens of nanometers. There is another type of film called a thick film, which is a small-dimensional material formed by the accumulation of grains or masses of large groups of materials or by the thinning of a three-dimensional material [5]. Oxide semiconductors have made significant progress and are now widely used in many electronic devices, including thin-film transistors, light-emitting diodes, photovoltaic cells, non-volatile memory devices, sensors, and catalysts [6-7]. Metal oxides are used in various technologies such as catalysis. Thin films made of oxides and formed on heat-resistant metal substrates provide solutions to many practical difficulties and experimental problems caused by bulk oxidation [8].Recently, there has been a surge of scientific interest in nickel oxide-based nanomaterials due to their exciting physical and electronic properties [9], and its various applications, including battery cathodes, catalysts, electrochromic films, and gas sensors [10-11]. Nickel oxide (NiO) is a semiconductor and is a stable, transparent p-type transition metal oxide [12].The structural arrangement of nickel oxide (NiO) is similar to that of the chemical compound NaCl [13]. Several methods have been used to form thin layers of nickel oxide, including pulsed laser deposition (PLD), chemical vapor deposition (CVD), magnetic sputtering, atomic layer deposition (ALD), thermal spray decomposition, electron beam evaporation, electrodeposition, sol-gel process, chemical bath deposition, and other methods. One of these methods is chemical spray pyrolysis, which has several advantages and characteristics: it is easy to prepare, inexpensive, allows for control of deposition conditions without the need for high vacuum, and provides the possibility of deposition over a large area [14,15-16]. This technology is used in many new industries to deposit a layer on the surfaces of substrates [17].Thin film deposition process using thermal spray technology The substrate is heated and a metal solution is sprayed onto it. When the solution droplets hit the substrate surface, they spread out in a disc-like structure and undergo thermal decomposition. The momentum and size of the droplet are the main factors affecting the shape and size of the disc, in addition to the temperature of the substrate. Thus, oxide will form on the hot substrate after its conversion from the metal salt, which is usually in the form of overlapping discs [18]. Removing organic components from the solution as part of the work process, where ultraviolet rays are used for this procedure. Low-pressure mercury lamps with a wavelength ranging from 185 to 254 nanometers and excimer lamps are the most common sources of ultraviolet rays. These rays work to convert oxygen into active oxygen, which in turn breaks the chemical bonds of organic compounds. This means that ultraviolet rays are used to remove these compounds [19]. The aim of this paper is to study the effect of U-VC irradiation on the optical properties of nickel oxide films.

2. EXPERIMENTAL DETAILS

2.1.Preparation of glass bases

Use glass bases measuring (2.5 × 2.5) cm and a thickness of (1) mm. These substrates are thoroughly cleaned of any dirt stuck to their surface in order to obtain a surface free of impurities, as these negatively affect the accuracy of the results. The next steps begin with washing the glass substrates with regular water, then with distilled water, and then placing them in an ultrasonic device after immersing them in acetone and water for a period of (30) minutes. The glass substrates are then dried using lens cleaning cloths and exposed to heat using an electric heater to dry them completely for (3) minutes.

2.2. Preparation of the solution

The solution was prepared using nickel nitrate with the chemical formula [$Ni(NO_3)_2 \cdot 6H_2O$] and molecular weight [M.W = 290.81 gm/m] consisting of a green powder of Indian origin and supplied by the company (THOMAS BAKER) at a concentration of (0.3) by adding (8.7243gm) of the substance to (100) ml of distilled water and placing it on a magnetic mixer for 60 minutes to completely dissolve the solution, avoid clumping, and obtain a homogeneous solution. The solution is then filtered using filter paper to obtain a high-purity solution free of impurities. To obtain the desired weight to be melted from eq.(1)[20].

$$M = \frac{M_t}{M_{wt}} * \left(\frac{1000}{V}\right) \qquad (1)$$

Where, M: Molar concentration, M_t: Mass of nickel nitrate, M_{wt}: Molecular weight of the substance and V: Volume of distilled water (100) mL.

2.3. Deposition process

After cleaning, the glass substrates are placed on an electric heater and heated to 450°C and 2 bar using an air compressor. The prepared solution is placed in a sprayer with a diameter of 2 cm and a length of 12 cm. The distance between the sprayer and the substrates is 30 cm. The spraying process begins with the solution falling in an inverted cone shape onto the glass substrates to obtain thin films of nickel oxide, as shown in Fig.1

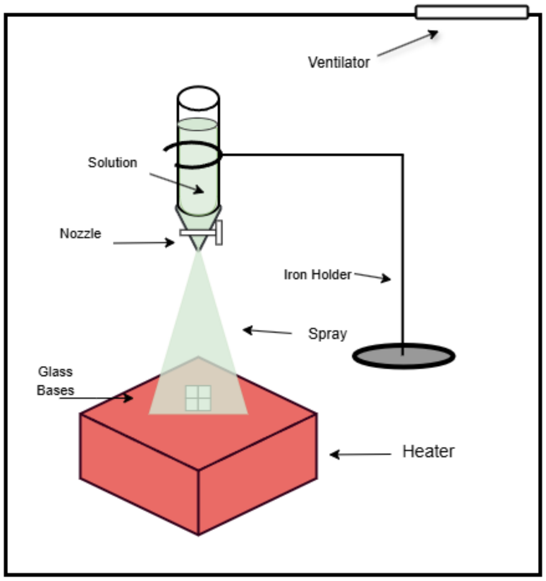


Fig.1. Spraying system

3. RESULTS AND DISCUSSIONS

3.1. Measure the thickness of the prepared film

The thickness of the resulting NiO films was measured using the manual gravimetric method according to the eq.(2)[4] at a deposition temperature of 450 °C. The thickness of the films is calculated based on the surface area of the glass substrate on which they are deposited and the mass and density of the deposited film. The average thickness of the film obtained by this method was approximately 200+10 nm.

$$\text{Thickness}=\frac{w}{\rho A} \qquad (2)$$

3.2. The Optical absorption analysis

The interaction of light with thin NiO films was analyzed to learn more about their optical properties. An ultraviolet-visible spectrophotometer (Shimadzu UV-1800) was used to analyze the optical properties of thin NiO films at a scanning rate of 400 nm/min. The wavelength range of the absorption spectrum was (190-1100) nm. When light interacts with the thin film, photoabsorption occurs against the wavelength spectra of the thin films created at a temperature of 450 °C for the glass substrates on which the material was deposited.

3.2.1 Absorbance

When nickel oxide films are subjected to UV light with a wavelength of (254 ±10), their optical characteristics are impacted. This results from the rays' interaction with the film's atoms. The absorption spectrum's wavelength variation is depicted in Fig.2 At 450°C, that the absorption spectra increases as the irradiation time increases.

3.2.2 Energy gap

The connection between ahv^2 and the incident photon energy for three distinct UV irradiation intervals is displayed in Fig.3 in comparison to the non-irradiation state, which is (1, 2, 3) hours. Drawing an extension of the curve after the absorption state, where it is tangent to the curve and intersects the photon energy axis at the point $ahv^2=0$, yields the energy gap. It was discovered that as the irradiation period increases, the energy gap value at 450°C decreases. An eq.3 is used to calculate it[20]:

$$(\alpha.h\nu)^{1/r} = B_o(h\nu - E_g) \qquad (3)$$

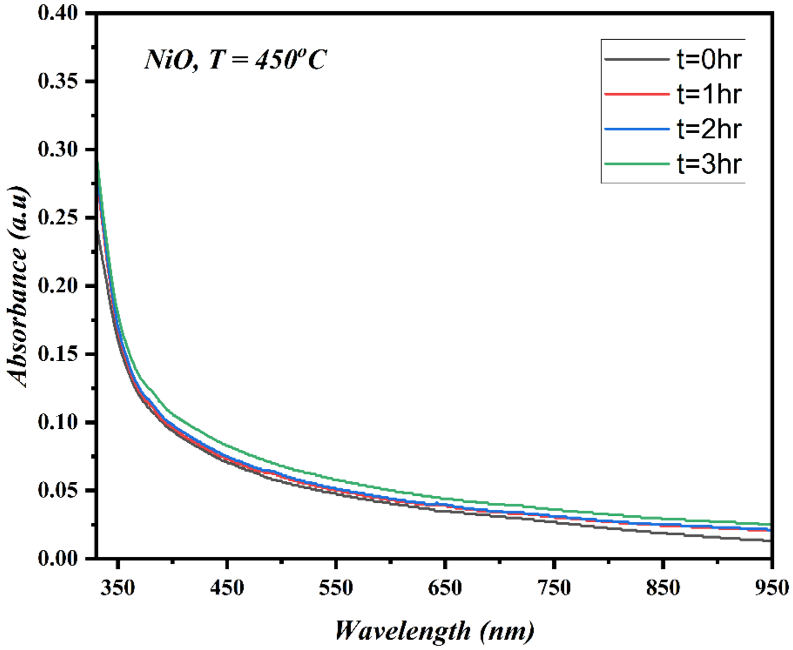


Fig.2. shows the change in the absorption spectrum as a function of wavelength for nickel oxide (NiO) membranes at different exposure time.

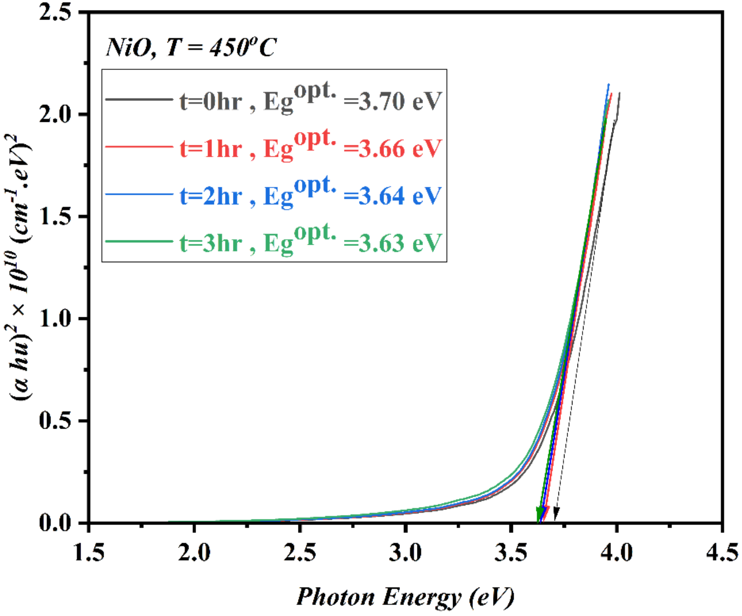


Fig.3. Optical band gap values for prepared NiO thin films at different exposure time.

3.2.3 Absorption coefficient

The **Fig.(4)** shows the relationship between wavelength and absorption coefficient at 450°C for three different irradiation times compared to the non-irradiated condition. It shows that the absorption coefficient increases with increasing irradiation time., The absorption coefficient can be calculated using the eq.(4) [21]:

$$\alpha = 2.303\ \mathrm{A/t} \qquad (4)$$

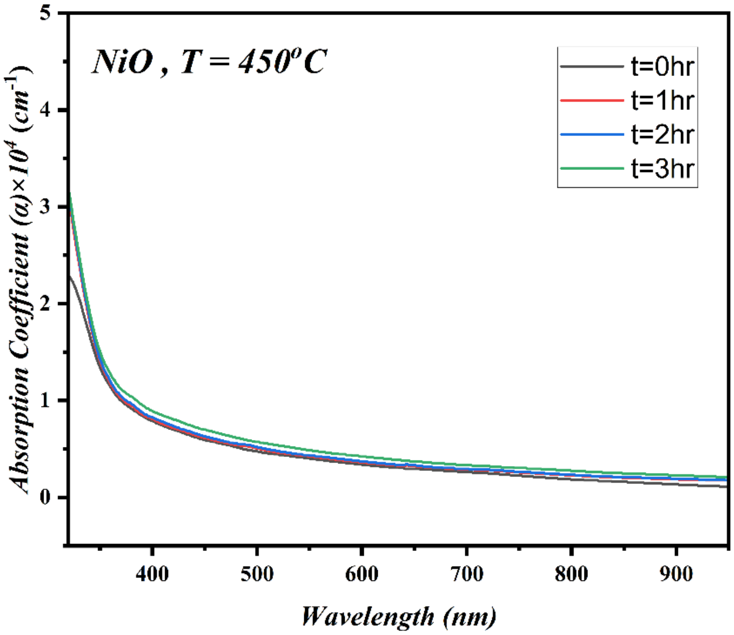


Fig.4. Absorption coefficient of NiO thin films as a function of wavelength at different exposure time.

3.2.4 Refractive index

The **Fig.(5)** shows the relationship between the refractive index and wavelength for different irradiation times at a constant temperature. The figure clearly the refractive index increases with increasing irradiation time. It was calculated based on the eq.(5),[22] The refractive index depends on the composition and type of material.

$$n = \sqrt{\frac{4R}{(R-1)^2} - K^2} - \left(\frac{R+1}{R-1}\right) \tag{5}$$

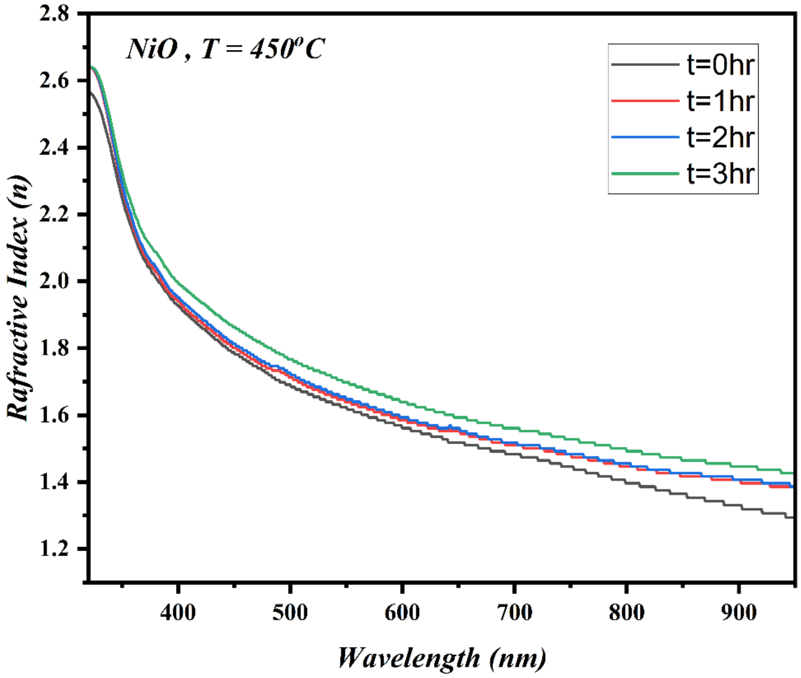


Fig.5. Refractive index function of wavelength for NiO thin films at different exposure time.

3.2.5 extinction coefficient

The **Fig.(6)** shows The extinction coefficient of nickel oxide thin films prepared at a temperature of 450 °C. An increase in the extinction coefficient is observed with an increase in irradiation time for three consecutive hours. Through an eq.(6) [23]that was calculate

$$K=\frac{\alpha\lambda}{4\pi} \qquad (6)$$

3.2.6 Real dielectric constants

From the **Fig.(7)**, the real dielectric constant of nickel oxide films increases with increasing irradiation times, reaching its maximum value at short wavelengths at the third hour of irradiation, then begins to decrease with increasing wavelength. Using the eq.(7)[24], the true dielectric constant is calculated.

$$\varepsilon_r = n^2 - K^2 \qquad (7)$$

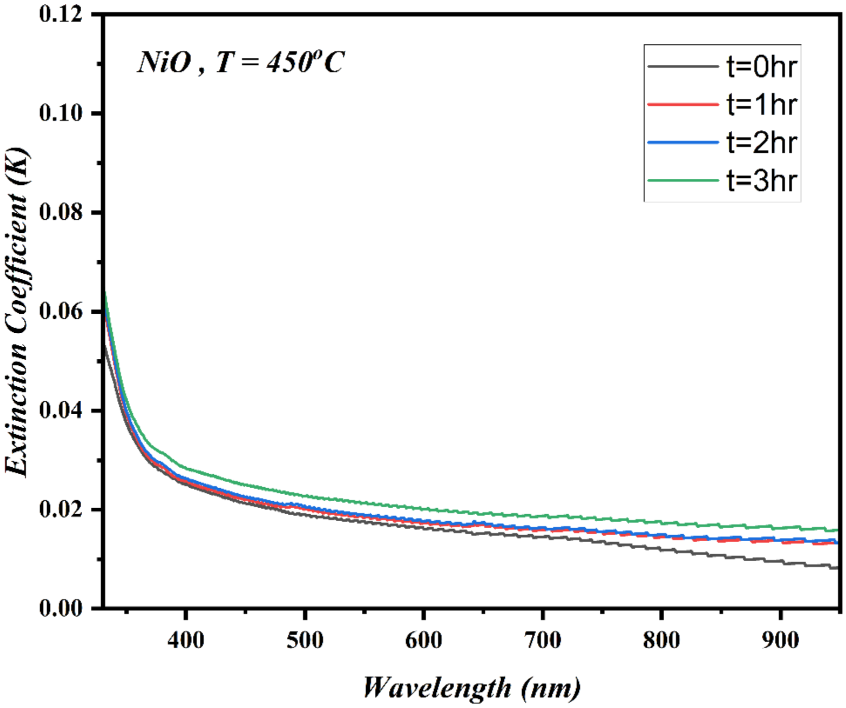


Fig.6. extinction coefficient as a function of wavelength for NiO thin films at different exposure time.

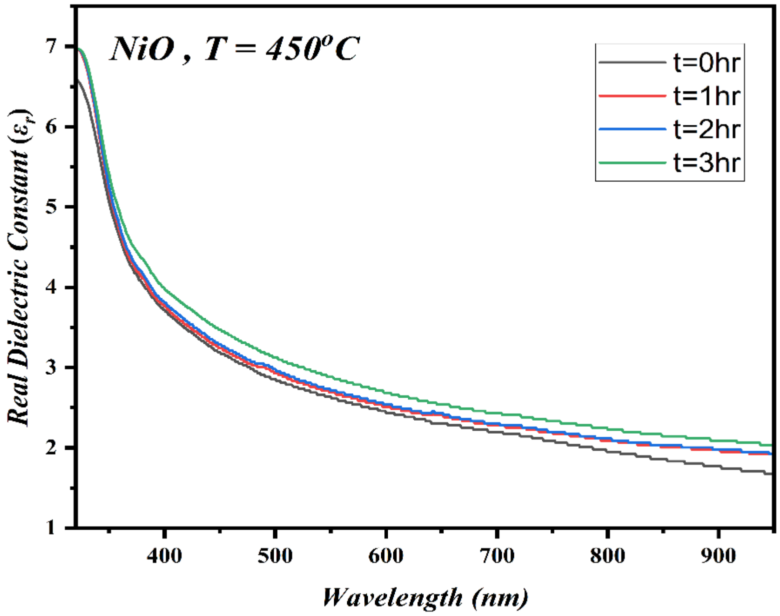


Fig.7. Real dielectric constants as a function of wavelength for NiO at different exposure time.

3.2.7 Imaginary dielectric constants

By observing the graph **Fig.(8)**, increase in the imaginary dielectric constant with a gradual increase in the exposure time of nickel oxide membranes to ultraviolet radiation prepared at a temperature of 450°C. The imaginary dielectric constant is calculated using the eq.(8)[24]

$$\varepsilon_i = 2nK \qquad (8)$$

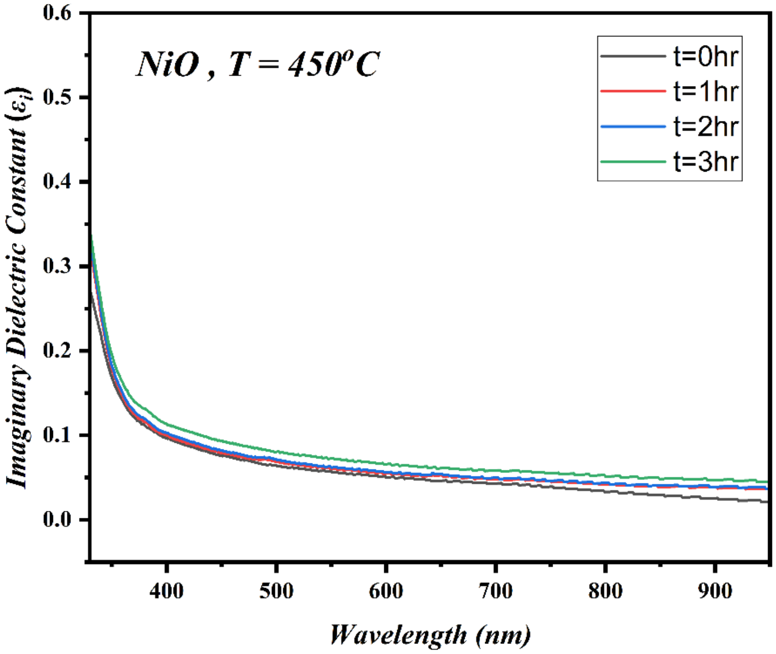


Fig.8. Imaginary dielectric constants as a function of wavelength for NiO at different exposure time.

The fig.9 illustrates the relationship between the energy gap and the duration of exposure of the nickel oxide membrane to ultraviolet radiation for (0-3)hours. It was observed that when the irradiation time increased, the energy gap decreased, with the lowest energy gap of 3.63 recorded at the third hour of irradiation.

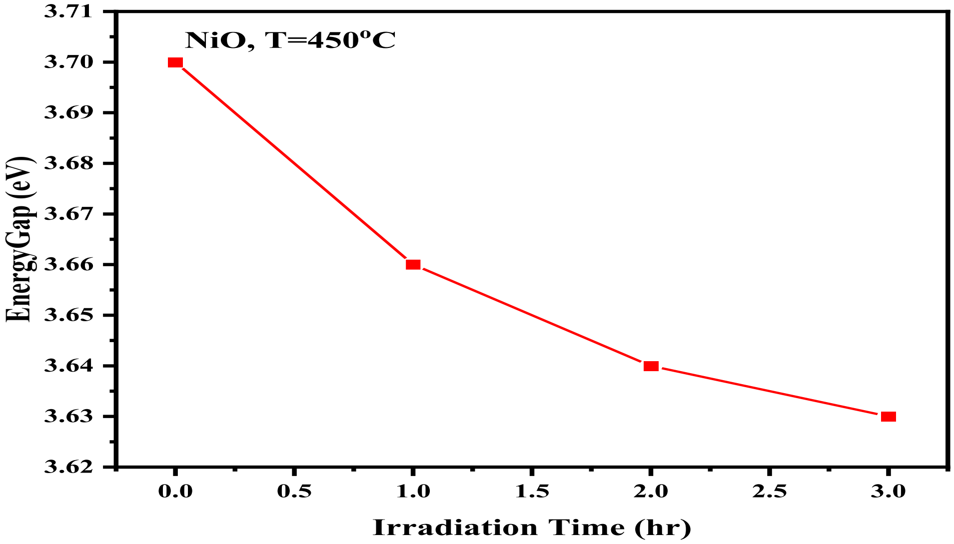


Fig. 9. Shows the relationship between the energy gap and the irradiation time for nickel oxide membranes.

3.3. Field emission scanning electron microscopy (FE-SEM) results

SEM analysis revealed the surface morphology of the nickel oxide films and the average size of the nanostructures. FE-SEM analysis was used at 200 kX magnification. **Fig.(10)** shows the nickel oxide nanoparticles deposited on glass substrates, exhibiting irregular spherical shapes with diameters ranging from 10 to 55 nm at a temperature of 450 °C.

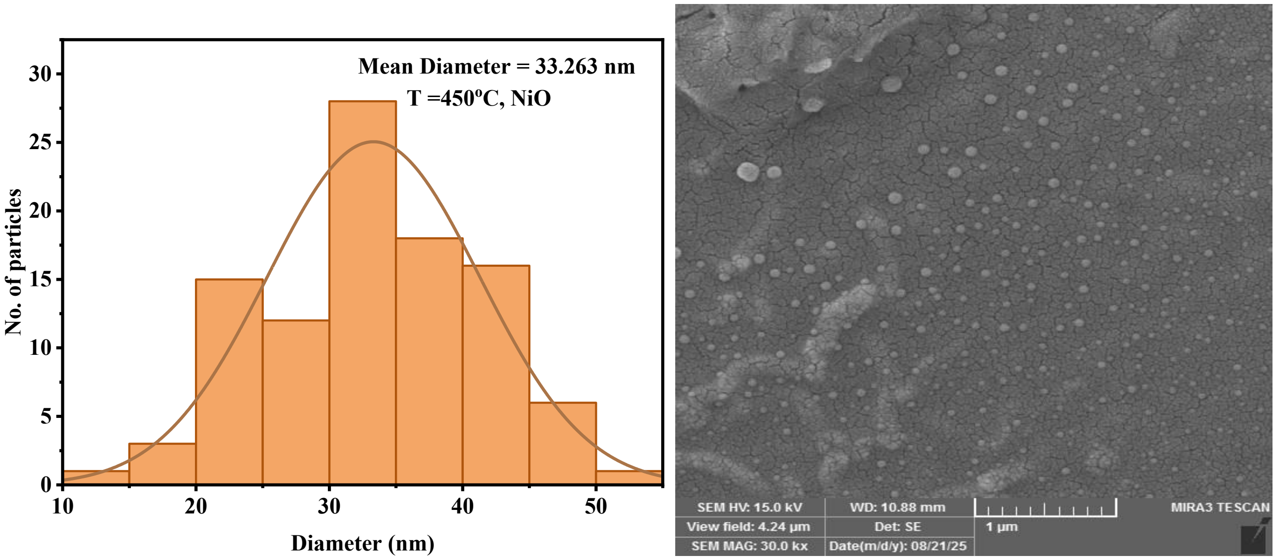


Fig.10. FE-SEM micrographs of NiO thin films for substrate temperature 450°C and the particle size distribution.

Table 1 Comparison of thickness, Energy gap, and optical constants of NiO thin films with recent literature.

Deposition Method	Thickness (nm)	Bandgap (eV)	Refractive Index (n) at 550 nm	Reference
thermal chemical spraying	200 ± 10	3.70	2.62	Present work
Sol-Gel	213	3.92	1.55	Tatyana Ivanova(2022)[25]
spray pyrolysis	200	3.65	2.6	kamal et al (2004)[26]
Spin coating	221	3.94	-	Abdelghani & Said (2024)[27]
Spray coating	-	3.8	3.7	Faycal et al (2018)[28]

4. Conclusions

Thin nickel oxide nanomembranes were produced using chemical thermal chemical spraying, which is a simple, fast and inexpensive method. These membranes were exposed to ultraviolet radiation for a total of three hours, with each irradiation session lasting one hour. The thickness of the films was found to be approximately 200 nm using the gravimetric method. Optical properties such as absorption coefficient, conductivity, extinction coefficient, real dielectric constant, imaginary dielectric constant, and refractive index were found to Increase with increased irradiation times. also note that the energy gap for allowed direct transitions decreases with increasing irradiation times, with values of 3.70 before irradiation and 3.66, 3.64, and 3.63 after irradiation, respectively. For irradiation times of 1 to 3 hours with a sequential increase of one hour, this indicates the occurrence of atomic rearrangement and the emergence of additional energy states, which provides effective optical tunability based solely on irradiation time control. An increase in the absorption spectrum was observed with increasing irradiation time, indicating the presence of permanent photonic activation. This opens the door to the use of membranes in optical sensors and memories based on long-term changes in optical properties. Through scanning electron microscope analysis, the nanoparticles appeared to be irregularly spherical in shape, with diameters ranging from 10 to 55 nanometers. The irregularity of the particles suggests a non-linear growth mechanism, which allows for the manufacture of membranes with surface roughness that is useful for increasing light absorption and surface sensitivity. This is suitable for flexible electronics and low-power processors, as these results were achieved without high temperatures.

Declarations

☒ The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Ethics approval and consent to participate

Not applicable.

Consent for publication

I agree

Availability of Data and Materials

Data will be provided upon receiving a valid request.

Conflicts of interest

The authors declare that there is no conflict of interest

Funding

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments

The authors would like to express their appreciation to warmest thanks to the University of Mosul, College of Education for Pure Science, Department of Physics for supporting this work. for supplying the materials for this study.

5. References

[1] O. O. Abegunde, E. T. Akinlabi, O. P. Oladijo, S. Akinlabi, and A. U. Ude, "Overview of thin film deposition techniques", *AIMS Materials Science*, vol. 6, no. 2, pp. 174–199, 2019, https://doi.org/10.3934/matersci.2019.2.174

[2] M. N. Abdullah, "The effect of doped and undoped ZnO-V thin films on nanostructural and optical properties", *Rafidain Journal of Science*, vol. 34, no. 2, pp. 62–71, 2025, https://doi.org/10.33899/rjs.2025.187745

[3] O. Ayed, M. A. Al-Jubbori, and H. H. Algdirree, "Study of the optical properties of copper oxide thin films prepared by chemical spray pyrolysis technique", *Journal of Education and Science*, vol. 33, no. 2, pp. 47–57, 2024, https://doi.org/10.33899/edusj.2024.146903.1426

[4] M. S. Sinjar, M. A. Al-Jubbori, and H. H. Algdirree, "Study of the effect of irradiation on some optical properties of cadmium oxide films prepared by the thermal chemical spraying method", *Journal of Education and Science*, vol. 34, no. 1, pp. 1–12, 2025, https://doi.org/10.33899/edusj.2024.154469.1511

[5] D. A. Jameel, "Thin film deposition processes", *International Journal of Modern Physics and Applications*, vol. 1, no. 4, pp. 193–199, 2015, https://doi.org/10.14419/ijmpa.v1i4.474

[6] M. Napari, T. N. Huq, R. L. Z. Hoye, and J. L. M. Driscoll, "Nickel oxide thin films grown by chemical deposition techniques: potential and challenges in next-generation rigid and flexible device applications", *InfoMat*, vol. 3, pp. 536–576, 2021, https://doi.org/10.1002/inf2.12146

[7] M. N. Chaudhari, R. B. Ahirrao, and S. D. Bagul, "Thin film deposition methods: a critical review", *International Journal for Research in Applied Science & Engineering Technology (IJRASET)*, vol. 9, pp. 5215–5232, 2021, https://doi.org/10.22214/ijraset.2021.36154

[8] S. C. Street, C. Xu, and D. W. Goodman, "The physical and chemical properties of ultrathin oxide films", *Annual Review of Physical Chemistry*, vol. 48, pp. 43–68, 1997, https://doi.org/10.1146/annurev.physchem.48.1.43

[9] S. Barala, S. A. Panda, and S. Gangopadhyay, "Growth and characterization of NiO thin films for selective detection of formaldehyde vapor", *Physica Status Solidi (A)*, vol. 240, pp. 1-9, 2024, https://doi.org/10.1002/pssa.202400695

[10] K. H. Musa and T. M. Al-Saadi, "Investigating the structural and magnetic properties of nickel oxide nanoparticles prepared by precipitation method", *Ibn Al-Haitham Journal for Pure and Applied Sciences*, vol. 35, no. 4, pp. 94–103, 2022, https://doi.org/10.30526/35.4.2872

[11] P. A. Sheena, K. P. Priyanka, N. Aloysius Sabu, S. Ganesh, and T. Varghese, "Effect of electron beam irradiation on the structure and optical properties of nickel oxide nanocubes", *Bulletin of Materials Science*, vol. 38, no. 4, pp. 825–830, 2015, https://doi.org/10.1007/s12034-015-0953-5

[12] S. Benhamida, B. Benhaoua, R. Barir, A. Rahal, and A. Benhaoua, "Effect of sprayed solution volume on structural and optical properties of nickel oxide thin films", *Journal of Nano- and Electronic Physics*, vol. 9, no. 3, pp. 1-5, 2017, http://doi.org/10.21272/jnep.9(3).03004

[13] Z. T. Khodair, A. A. Kamil, and Y. K. Abdalaah, "Effect of annealing on structural and optical properties of $Ni_{(1-x)}Mn_xO$ nanostructures thin films", *Physica B: Condensed Matter*, vol. 503, pp. 55–63, 2016, http://dx.doi.org/10.1016/j.physb.2016.09.016

[14] B. Brioual, Z. Rossi, A. Aouni, M. Diani, M. Addou, and M. Jbilou, "Electrochemical behavior of spray deposited nickel oxide (NiO) thin film in alkaline electrolyte", *E3S Web of Conferences*, vol. 336, pp. 1-8, 2022, https://doi.org/10.1051/e3sconf/202233600045

[15] S. Allahyar, M. Taheri, A. Abharya, and K. Mohammadi, "Simple new synthesis of nickel oxide (NiO) in water using microwave irradiation," *Journal of Materials Science: Materials in Electronics*, vol. 28, no. 3, pp. 2815–2846, 2017, https://doi.org/10.1007/s10854-016-5868-4

[16] J. A. Rasho and A. J. Jarjees, "CaO thin-film preparation using chemical bath deposition", *Rafidain Journal of Science*, vol. 34, no. 3, pp. 124–132, 2025, https://doi.org/10.33899/rjs.2025.189224

[17] A. S. A. Hussein, Y. A. K. Salman, and E. E. Khadeer, "Study of the effect of using various ceramic powders in thermal spraying technology on the sliding corrosion resistance of steel alloys (AISI446) ", *Rafidain Journal of Science*, vol. 34, no. 3, pp. 91–101, 2025, https://doi.org/10.33899/rjs.2025.189221

[18] S. Y. Han, D. H. Lee, Y. J. Chang, S. O. Ryu, T. J. Lee, and C. H. Chang, "The growth mechanism of nickel oxide thin films by room-temperature chemical bath deposition", *Journal of The Electrochemical Society*, vol. 153, no. 6, pp. C382–C386, 2017, https://doi.org/10.1149/1.2186767

[19] H. Miyazawa, K. Tanaka, and H. Uchiki, "Effect of UV irradiation on Cu2ZnSnS4 thin films prepared by the sol-gel sulfurization method", *Journal of Alloys and Compounds*, vol. 652, pp. 400-406, 2015, https://doi.org/10.1016/j.jallcom.2015.08.231

[20] M. A. AL-Jubbori, M. S. Sinjar, and A. saleh, "Chemical spray pyrolysis of cadmium oxide thin films: UVC-induced structural and optical modifications for enhanced photodetector performance", *Optical Materials*, vol. 168, pp.117430, 2025, https://doi.org/10.1016/j.optmat.2025.117430.

[21] E.Weingartner, H.Saatho, M., Schnaiter, et al., “Absorption of light by sootParticles: determination of the absorption coefficient by means of aethalometers”, *Aerosol Sci.* Vol.34, pp.1445–1463, 2003, doi.org/10.1016/S0021-8502(03)00359-8.

[22] M.D. Migahed, and H.M., Zidan, “ Influence of UV-irradiation on the structure and optical properties of polycarbonate films”, *Current Applied Physics*, 6(1), pp.91-96, 2006, doi:10.1016/j.cap.2004.12.009.

[23] A. Kurt, “Influence of AlCl3 on the optical properties of new synthesized 3-armed Poly(methyl methacrylate)film”, *Turk. J. Chem.* Vol. 34, pp.67–79, 2010, doi.org/10.3906/ kim-0903-29.
[24] Q. Zhou, Z. Ji, B. Hu, C. Chen, L. Zhao, C. Wang, “Low resistivity transparent conducting CdO thin films deposited by DC reactive magnetron sputtering at room temperature“, *Mater. Lett.* Vol.61 ,pp. 531–534, 2007, http://dx.doi.org/10.1016/j.matlet.2006.05.004.
[25] T. Ivanova, A. Harizanova, M. Shipochka, and P. Vitanov, "Nickel Oxide Films Deposited by Sol-Gel Method: Effect of Annealing Temperature on Structural, Optical, and Electrical Properties", *Materials*, vol.15, pp.1742, no.5, 2022, https://doi.org10.3390/ma15051742
[26] H. Kamala, E.K. Elmaghrabyb, S.A. Alic, K. Abdel-Hadyc, "Characterization of nickel oxide films deposited at different substrate temperatures using spray pyrolysis", *Crystal Growth*, vol. 262, pp. 424–434, 2004, doi:10.1016/j.jcrysgro.2003.10.090
[27] A. Lakel, and S. Benramache, "Spin coating method deposited nickel oxide thin films at various film thickness",*Power Technologies* vol. 104, no.3, pp.201-208, 2024, DOI:10.1177/17475198211066535
[28] F. Chandoul, H. Moussa, K. Jouini, A. Boukhachem, F. Hosni ,M. S. Fayache, and R. Schneide, "Investigation of the properties of nanostructured nickel oxide NiO thin films irradiated at different γ-doses", *Materials Science: Materials in Electronics*, vol. 30,pp.348–358, 2019, https://doi.org/10.1007/s10854-018-0299-z

دراسة الخصائص البصرية لأوكسيد النيكل المحضر بطريقة التحلل الكيميائي الحراري بالرش

نورا سنان خيرالله (1), مشتاق عبد داود الجبوري(2) , عياد الهادي الزوام (3)

(1,2) قسم الفيزياء، كلية التربية للعلوم الصرفة، جامعة الموصل، الموصل، العراق
(3) قسم الفيزياء، كلية العلوم، جامعة طرابلس، ليبيا

الخلاصة

في هذه الدراسة، تم الحصول على أغشية نانوية رقيقة من أكسيد النيكل باستخدام تقنية الرش الكيميائي الحراري، والتي تتضمن رش محلول كيميائي أخضر اللون بمعدل 30 رشة على ركائز زجاجية بمساحة 6.25 سم^2. تم تحضير هذه الطبقة الرقيقة عند درجة حرارة 450 درجة مئوية تحت ضغط 2 بار. تمت دراسة الخصائص البصرية لأغشية أكسيد النيكل باستخدام طرق تحليلية مثل التحليل الطيفي المزدوج للأشعة فوق البنفسجية والضوء المرئي وعلاقتهما بالأطوال الموجية التي تتراوح من 190 نانومتر إلى 1100 نانومتر. كما تمت دراسة شكل السطح باستخدام المجهر الماسح الالكتروني (SEM). أظهرت نتائج التحليل أن جزيئات غشاء أكسيد النيكل كانت كروية بشكل غير منتظم، بقطر يتراوح من 10 إلى 55 نانومتر. ثم تعرضت هذه الركائز الزجاجية للأشعة فوق البنفسجية UVC لمدة (3-1) ساعات، مع استمرار كل جلسة إشعاع لمدة ساعة واحدة فقط. باستخدام مقياس طيف الأشعة فوق البنفسجية المرئية قبل وبعد كل ساعة، أظهرت النتائج أن طيف الامتصاص يتغير مع الطول الموجي ويتغير أيضًا مع زمن التشعيع، حيث ينخفض مع زيادة الطول الموجي ويزداد مع زيادة زمن التشعسع. كما تم حساب فجوة الطاقة لـ NiO الأغشية المحضرة عند درجة حرارة 450 درجة مئوية، ووجد أن قيمتها قبل التشعيع كانت 3.70 eV إ ثم بدأت في الانخفاض مع زيادة ساعات التشعيع، لتصل إلى 3.63 eV. تتوافق هذه النتائج مع نتائج الدراسات السابقة، بما في ذلك دراستي [Faycal et al,2018] و[kamal et alm,2004]، اللتين سجلتا فجوات طاقة قدرها [eV (3.8 and 3.65) على التوالي.