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Synthesis And Characterization Of Nanocomposite Sno_2/Zno And Sno_2/Al_2O_3 And Its Biomedical Application

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Abstract
Two nanocomposites were produced by the sol-gel method: ZnO/ SnO_2 and SnO_2/Al_2O_3. Both nanocomposites' optical and structural characteristics are described in detail in the study. In this study, two semiconductors (ZnO- SnO_2) and one insulator-semiconductor (SnO_2/Al_2O_3) are examined. The Miller indices of the ZnO- SnO_2 and SnO_2/Al_2O_3 nanocomposites were used to determine their particle sizes through powder XRD analysis. Using photoluminescence, optical properties were investigated. It was used to calculate the absorbance band and band gap energy of nanocomposites. Model pollutants such as methylene blue were used to assess the photocatalytic activity of ZnO- SnO_2 and SnO_2/Al_2O_3 photocatalysts under UV light. There are many uses for nanocomposites in the biomedical industry. Both NCs' antimicrobial activity was investigated.
Keyword: *SnO_2/ZnO, SnO_2/Al_2O_3, Nanocomposites, Sol-Gel Method, Characterization, Biomedical Applications.*

INTRODUCTION

A composite is a material made up of two or more different materials, combined to take advantage of their best properties. A nanocomposite is a type of composite material that contains at least one phase with one, two or three dimensions below 100 nm. This can result in a structure with the different phases having a repeating distance on a nano-scale. which can give the material unique and often superior properties compared to its components.

Nanocomposite films are thin layers that combine two or more unrelated materials at the nanoscale, providing a unique opportunity to regulate and create new and enhanced features. Because of these materials' remarkable qualities and adaptability, they are becoming increasingly popular. Future materials science research and development could focus on nanocomposites.

Semiconductor -Semiconductor

The oxide semiconductor materials, ZnO and SnO_2, have been extensively studied due to their distinguished characteristics. These materials have energy band gaps of 2.64 and 3.54 eV, respectively. The energy band gap of ZnO/SnO_2 composites can be adjusted by controlling the Zn/Sn molar ratio in the composite material. The study of coupled oxide semiconductors made of ZnO and SnO_2 is crucial in tailoring their properties to meet the needs of various applications. ZnO/SnO_2 systems exhibit high photo-catalytic efficiency, with higher charge separation and a wider range of photo-excitation energy compared to single semiconductor photo-catalysts. Moreover, ZnO/SnO_2 nanostructures have been found to possess higher photo-catalytic activities than SnO_2 or ZnO rods alone, making them a viable candidate for future photo-catalytic applications.

Semiconductor -Insulator

Due to their exceptional optical and mechanical features at the nanoscale, SnO_2 and its composites offer a wide range of exciting possibilities. However, to fully realise their potential, it is crucial to consider both the electrical and optical properties of the transparent electrodes and the method of their preparation. By carefully selecting the composition, size, and surface area of nanopowders, we can greatly enhance the optical and mechanical features of these materials. One promising approach is to use a composite of a hard-

nanostructured material, such as Al_2O_3 with SnO_2 matrix, to produce an excellent composite material that improves the structural and optical properties of the matrix, such as its size and transparency.
Aluminium oxide is an excellent insulating material with band gap energy values of over 5 eV.
Both semiconductor and insulator-based photocatalysts have separated the CB and VB, but the difference lies in the width of the band gap. Semiconductor-based photocatalysts are easily excited by sunlight, making them a popular choice for photocatalytic applications. In contrast, insulator-based photocatalysts are less explored in this field due to their larger bandgap.
However, by introducing photosensitizers and lattice defects, insulator materials can be modified to become light-responsive and more useful in photocatalytic applications. For example, Al_2O_3, an abundant insulator, can be modified to drive a significant increase in selective photooxidation. These modifications can help to tailor the light-responsive range of insulators and make them an active topic in the field of photocatalytic applications.
However, we can enhance its energy efficiency by reducing the content of defects on its surface, which can reduce the energy gap to as low as 2.5 eV. This modification of the surface creates a new phase with unique properties such as new surface chemistry and chemical activity. Much research shows that we can produce Al_2O_3 with photocatalytic activity to degrade organic pollutants in water using the sol-gel method. However, we believe that it is possible to improve the photocatalytic performance and achieve a higher conversion rate in a shorter time.
The material in question has shown promise as a photocatalyst, but its high band gap energy has limited its effectiveness. However, researchers have significantly improved the material's photocatalytic activity by altering its surface morphology. Building upon this progress, an Al_2O_3-SnO_2 nanohybrid was developed to overcome the limitations of the original material and create a more efficient photocatalyst. This hybrid material forms a heterojunction that enhances charge separation and visible light sensitization, improving performance. These advancements are exciting and hold great potential for the future of photocatalysis.

Sol-Gel Process

Metal nanocomposites can be synthesised using a variety of techniques; we use the chemical sol-gel process.
The sol-gel method is one effective chemical technique for producing different kinds of nanostructures, and nanoparticles. By carefully controlling the molecular precursor, water or alcohol, as well as heating and stirring techniques, this process can produce gels with exceptional properties and numerous applications. The resulting gels are then dried and calcined, resulting in a final product that is both stunning and highly functional. It is an inexpensive and accessible method that presents us with a revolutionary way to create and explore the world around us.

Fig 1 Steps of the Sol-Gel method

This is a method that has been used for a long time to create mineral, ceramics and glass materials effectively. It has been extensively researched since the mid-19th century by scientists such as Ebelman and Graham, leading to the synthesis of various ceramics and glass structures. The sol-gel process allows for the creation of

a range of mineral oxides, including TiO_2, SiO_2, and ZrO_2. The resulting dry gels, namely aerogels and xerogels, depend on the drying conditions and method of moisture removal used. Aerogels, in particular, retain the primary gel structure, making them an excellent choice for various applications. The wet gel is a gel that results from the conversion of tuberculosis to gel during the compaction process. The sol-gel process involves transferring the "cell" (colloidal solution) from the liquid phase to the "gel" phase. The process can produce products in powder-thin layers and porous or dense materials.

Sol-gel is an extremely successful technique that is widely used for synthesizing nanophosphors. This method offers great potential for controlling the entire. It can be broadly classified into two types: aqueous sol-gel and nonaqueous sol-gel, each with its specific benefits. In the aqueous sol-gel method, water is used as the solvent medium, while in the nonaqueous sol-gel method, an organic solvent is used. The process must involve a precise sequence of chemical reactions, including hydrolysis, gelation, drying, and thermal treatment, to guarantee a superior quality final product. The sol is formed through hydrolysis and polymerisation reactions, which create a rigid and porous gel. The result is obtained by removing the solvent, and any residuals from the gel pores, and by ageing, drying, and annealing.

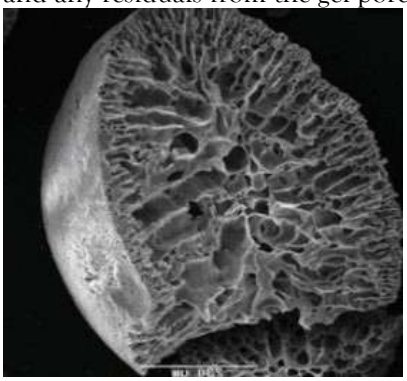

Fig 2. SEM image of a dried gel after the sol-gel process.

Experimental methods:

Materials

All the chemicals were used as analytical grade without any further purification. Zinc acetate dehydrate (Zn $(CH_3COO)_2.2H_2O$), tin chloride dehydrate ($SnCl_4.2H_2O$), methanol and ammonia were used to prepare the ZnO-SnO_2 nanocomposites for this study. The materials used in this study, including $SnCl_2 \bullet 2H_2O$ (97% purity), aqueous ammonia (28-30%/14.8 M), and $AlCl_3$ (99.5% purity), were commercially purchased to prepare SnO_2-Al_2O_3.

Synthesis of ZnO - SnO_2 Nanocomposites

To create the ZnO-SnO_2 mixed nanocomposite, Zinc acetate dihydrate and tin chloride dihydrate were used as starting materials, with methanol and ammonium hydroxide solution serving as the solvent and additive, respectively. All chemicals were of analytical grade and required no further purification. The synthesis process involved gradually adding a 0.01 M methanol of Zn $(CH3COO)_2.2H_2O$ (dissolved in 37 mL of methanol) to a 0.01 M methanol solution of $SnCl_4.2H_2O$ under the same conditions. $SnCl_4.2H_2O$ solution was adjusted to obtain powders with the desired molar ratio of ZnO- SnO_2, either 0.01 or 0.025. The resulting solutions were stirred continuously at 80 °C for 2 hours, with NH_4OH solution added dropwise until the pH reached 8. The solutions then became gels which were dried to produce the powder.

Synthesis of SnO_2-Al_2O_3 Nanocomposites

A series of SnO_2-Al_2O_3 nanomixed materials were synthesized by changing the Al to Sn molar ratio, in the order of 1:1.

To create the nano-mixed materials, an ethanolic solution of stannous chloride dihydrate ($SnCl_2 \bullet 2H_2O$) was mixed with an ethanolic solution of aluminium trichloride ($AlCl_3$) under vigorous stirring to form a

transparent sol. A controlled amount of aqueous ammonia solution (7-8 ml) was added dropwise under constant stirring until a gel was formed. The resulting gel was filtered and washed with methanol to remove impurities and then dried at 100°C for 2 hours to obtain a dried gel. Both the dried gel was calcined at 450°C for 4 hours at a rate of 5°C per minute, and the resulting powder was crushed to a fine consistency using a mortar and pestle.

Characterization

Morphological Studies

XRD

The XRD pattern analysis of the SnO_2/ZnO and SnO_2/Al_2O_3 Nanocomposites was conducted using a powder X-ray diffractometer. The analysis involved the use of CuKα (λ=0.154 nm) radiation and a diffraction angle between 20° and 80°.

Scherrer's formula is applied for the calculation of the crystallite size of nanocomposites from the resulting XRD patterns

$$D= K\lambda/ \beta\cos\theta$$

where 0.94 is attributed to constant (k) and β is full width at half maximum (FWHM) in radian.

These results were obtained through XRD analysis and are widely accepted. It is interesting to note that as the peak intensity decreases, the crystallite size also decreases. The concentration of SnO_2 decreases with the addition of ZnO, which may cause the aggregation of SnO_2 particles. It is important to note that dislocation and strain are directly related to concentration, which can be calculated using the following methods.

$$\delta = ¼\ 1\ D2$$

$$\varepsilon ¼ \beta\cos\theta/ 4$$

Scanning electron microscope (SEM)

A scanning electron microscope (SEM) was used to study the surface morphologies of nanocomposites It describes the dimensions and distribution of particles present in the given samples. SEM was used to study the morphologies of all the samples. The SEM images of the ZnO/SnO_2 and SnO_2-Al_2O_3 nanocomposites prepared via a cost-effective sol-gel method revealed the formation of nanocomposites.

Photoluminescence (PL)

The rate of electron and hole migration in the ZnO/SnO_2 NCs and SnO_2-Al_2O_3 NCs was measured using photoluminescence. PL spectroscopy also called resonance fluorescence is a precious technique used to characterize semiconductors and molecules' optical and electronic properties. Photoluminescence investigations determine material parameters. This technique measures semiconductor purity, crystalline quality, and disorder. When a material absorbs light energy, it takes in the energy from the light., it can generate pairs of electrons and holes. The radiative recombination of these pairs results in a phenomenon called photoluminescence.

Photodecolorization

In conducting the photodecolorization experiments, the researchers used an Ace Glass photoreactor cooled by water circulation. They opted for a reaction vessel made of borosilicate glass with a 250 mL capacity and a double-walled quartz immersion well that had inlet and outlet tubes for cooling the reactor one angled joint for the sparger tube, one vertical joint for the condenser, and a side arm with an Ace-Thread for the thermometer. The reactor had a flat bottom that made it compatible with a magnetic stirrer.

For the radiation source, the researchers chose a 450-W medium-pressure mercury-vapor lamp, which emits about 39-45% ultraviolet and 42-45% visible light. The radiated watt density was 0.37W/cm2. The researchers then prepared suspensions by adding 50mg of the SnO_2-ZnO nanocomposite powder to a 100mL 20ppm MB aqueous solution. They stirred the suspensions in dark conditions for 15 minutes before exposing them to radiation. During irradiation, samples were taken at regular intervals and centrifuged. The concentrations of the MB solutions were then calculated by measuring their absorbance at the maximum absorption peak of MB (672nm). Overall, the experimental setup and methodology allowed for precise and reliable measurements, which are essential for obtaining accurate results.

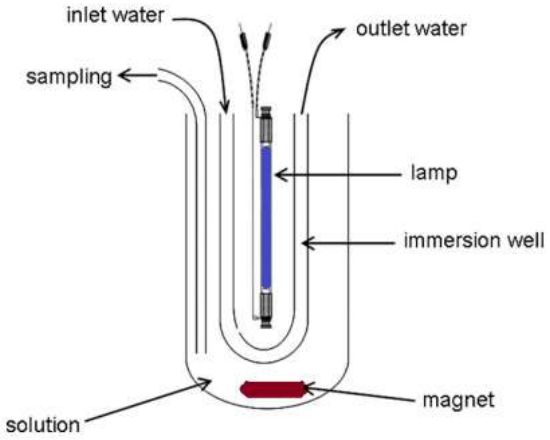

Fig 3 Photochemical experiment setup.

Antibacterial activity

It has been noted that Gram-positive and Gram-negative bacteria resistant to antibiotics are significant contributors to bacterial illnesses. Using the agar diffusion test and the diameter of the zone of inhibition, both SnO_2–ZnO and SnO_2–Al_2O_3 were evaluated for their qualitative antibacterial activity against E. coli bacteria. The agar diffusion method is a semi-quantitative test that can quickly ascertain the antibacterial activity of diffusible antimicrobial drugs. The vial's original bacterial concentration was roughly 10^8 CFU/mL to confirm that exposure to the NCs was most likely the cause of any decline in the suppression of bacterial growth. These samples were autoclaved for 15 minutes at 120^0C and 103 kPa in covered glass universals to sterilize them before testing. The Luria-Bertani medium solid agar-cultured bacterial strains were cultivated in Petri dishes containing the treated NCs and control samples. Following a 24-hour incubation period at 37°C, the inhibitory zone was measured.

The tested samples' zone of inhibition was quantified in millimeters (mm) as a qualitative indicator of antimicrobial activity. It investigated how various NCs affected the antibacterial activity. Every single-metal oxide has demonstrated more effective antibacterial activity. This could be because ZnO has a lower band gap energy than SnO_2 (2.74 vs. 3.54 eV), which makes the former more effective against bacteria in dark environments. Superoxide anions can be produced by single electron reduction of dissolved oxygen in the solution; this process does not require UV irradiation. ZnO nanoparticles have a well-established antibacterial mechanism and are widely reported to be effective antibacterial agents. ZnO's antibacterial action is well known to involve the dissolution of Zn2+ in response to oxidative stress.

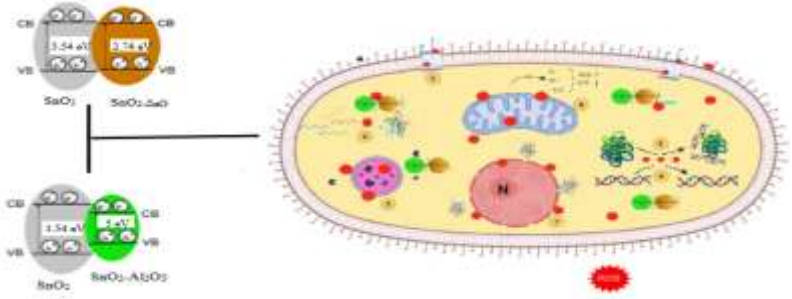

Fig 4 Schematic representation shows the mechanisms involved in bacterial cell wall damage.

Due to the high solubility of the nanosized ZnO, Zn2+ ions released from samples may electrostatically interact with the negatively charged E. Coli cell wall, causing wall leakage and bacterial death.

To the best of our knowledge, the toxicity of SnO_2 nanoparticles against different bacteria lacks a detailed mechanism. SnO_2 is a compound that dissolves poorly in aqueous solutions; in a physiological saline medium, nanosized SnO_2 (70–92 nm) exhibited extremely low solubility. One of the following mechanisms is generally responsible for the toxicity of SnO_2 nanoparticles: (1) the solubility and released metal ion of the nanoparticles; (2) the interaction of the nanoparticles with the bacterial membrane cell; (3) entry into the cell that results in the death of the bacteria by rupturing the membrane, allowing intracellular contents to escape, and damaging the cell membrane as well as the respiratory system, (4) the electrostatic interaction of nanostructures with oppositely charged cell walls, and (5) the strong oxidative stress caused by the production of reactive oxygen species (ROS) as a result of the high surface area of nanoparticles, which accounts for their enhanced chemical and biological characteristics.

RESULTS AND DISCUSSION

XRD for SnO_2/ZnO

The synthesized SnO_2/ZnO nanocomposite's X-ray diffraction pattern is shown in the illustration, and its tetragonal structure was confirmed by the presence of characteristic peaks around (1 1 0), (1 0 1), (2 0 0), (2 1 1), (1 1 2), and (3 0 1) planes. The hexagonal wurtzite structure of ZnO was also evident from the diffraction peaks of the (1 0 0), (0 0 2), (1 0 1), (1 0 2), (1 1 0), (1 0 3), and (1 1 2) planes. The XRD pattern of the SnO_2/ZnO nanocomposite exhibited all the diffraction peaks for both SnO_2 (tetragonal phase) and ZnO (hexagonal wurtzite phase). The phenomenon indicates a strong confirmation of the nanocomposite's structure.

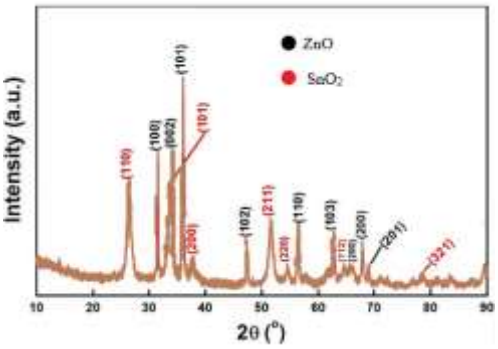

Fig 5 XRD pattern for SnO_2/ZnO

The XRD results were used to determine the phases and mean grain size of the coupled ZnSn nanocomposites. The diffraction peaks of SnO_2 are seen to be rather broad, indicating a small average crystallite size of 5 nm. Because of the sharp diffraction peaks in ZnO, the average crystallite size increased to 16.2 nm. The average ZnO crystallite size in ZnO/ SnO_2, however, decreases to 13.8 nm, which is less than that of pure ZnO. On the other hand, SnO_2 was found to have an average crystallite size of 5.1 nm, which is comparable to that of pure SnO_2. This suggests that SnO_2 inhibits ZnO nanocrystal growth in ZnO/ SnO_2. The distribution of the particles is uniform. The mean particle sizes were determined.

XRD for SnO_2/ Al_2O_3

The study analyzed the phase purity of SnO_2-Al_2O_3 nanocomposite using powder XRD patterns. By matching the Miller indices (hkl) of the diffraction peaks of SnO_2-Al2O_3 nanocomposites with JCPDS Card No. 41-1445 and 46-1212, the study confirmed the absence of any impurity peaks in the nanocomposite. The peak broadening observed in the XRD pattern of the SnO_2-Al_2O_3 nanocomposites indicated that the particles were nanosized, with a 12-16 nm size range, as calculated by the Debye-Scherrer formula. This finding is significant as it suggests that the nanocomposite is of high purity and has potential applications in various fields.

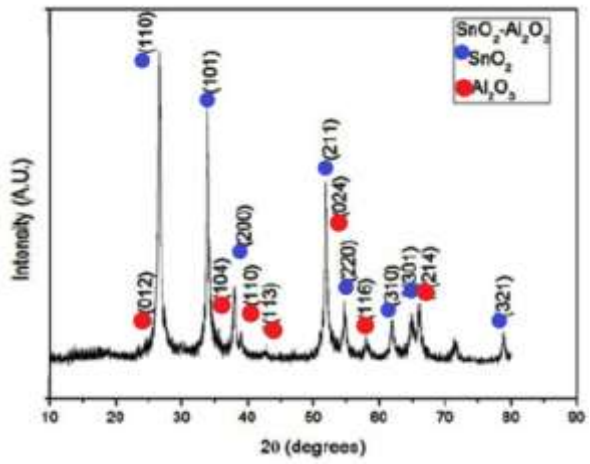

Fig 6 XRD pattern for SnO_2-Al_2O_3

Scanning electron microscope (SEM)

The SEM observations conducted for the ZnO-SnO_2 samples revealed some interesting findings. It was observed that all samples were composed of particle aggregates with average particle sizes similar to those calculated from the XRD patterns. The pure ZnO particles exhibited a hexagonal shape, while the SnO_2 particles took on a sphere-like morphology. The mixed ZnO- SnO_2 samples showed the presence of both particle shapes, Interwoven nanoclusters of small crystallites from different phases formed tightly bound nanocomposites. These observations could be instrumental in further research and development.

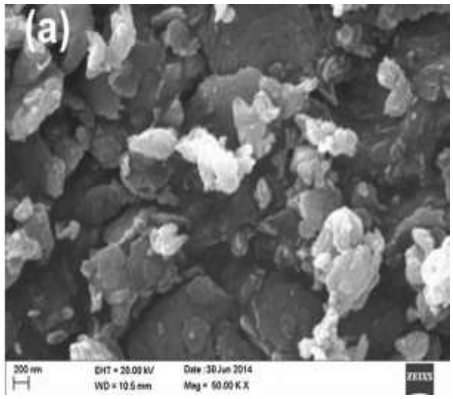

Fig 7(a) SEM image of SnO_2-ZnO nanocomposites

SEM of SnO_2-Al_2O_3 nanocomposite was captured at various magnifications in the 220 nm range. The micrographs reveal that clustering of particles has occurred on the surface of the nanocomposite, indicating some non-uniformity in the shapes of the nanoparticles and the existence of porosity, which can be advantageous in sensing applications. The particle size of the SnO_2-Al_2O_3 nanocomposite, determined from the SEM images, was nearly 65 nm, greater than the one calculated from powder XRD. This increase in particle size is attributed to sintering at 450°C, which results in particle binding and aggregation. Overall, these findings shed light on the unique properties of the SnO_2-Al_2O_3 nanocomposite and highlight its potential for various applications.

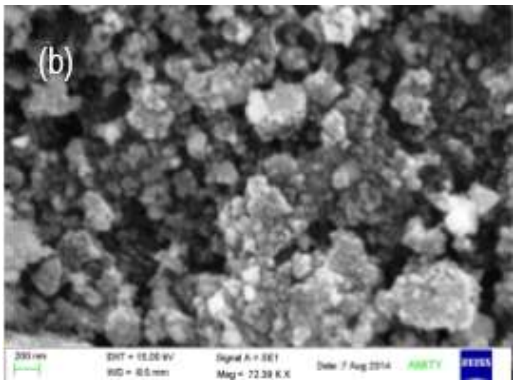

Fig 7(b) SEM micrograph of SnO_2–Al_2O_3 nanocomposite.

Photoluminescence for SnO_2/ZnO

Let's examine the photoluminescence (PL) spectrum of the SnO_2/ZnO nanocomposite we prepared. The Photoluminescence of ZnO nanoparticles is characterized by a narrow ultraviolet peak at 385 nm. When coupled with SnO_2, the nanocomposite exhibited a decrease in PL intensity.

In the case of ZnO and SnO_2, the conduction bands are located at different positions. This difference enables the electrons generated by the absorbed light to migrate from the conduction band of ZnO to that of SnO_2. As a result, the recombination of electrons on the surface of ZnO is reduced, which weakens the photoluminescence signal. This weakens the PL signal due to the migration of photogenerated electrons from ZnO to SnO_2, reducing electron recombination on the ZnO surface. We can further investigate ways to optimize the performance of our nanocomposite for potential applications in various fields.

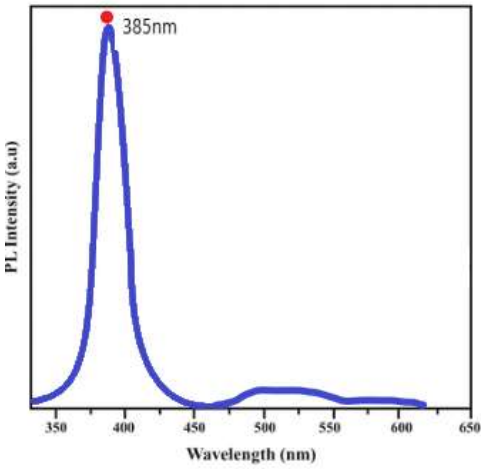

Fig 8(a)PL Spectra of SnO_2-ZnO nanocomposite

Photoluminescence for SnO_2/ Al_2O_3

Secondly, our research focused on the Sol-Gel method-prepared SnO_2–Al_2O_3 nanocomposites. We analyzed their room-temperature PL spectra, and observed a reduction in the emission from SnO_2, while the Al_2O_3 emission increased significantly. This phenomenon, where oxygen atoms migrate from the Al_2O_3 film to the oxygen vacancies on the SnO_2 surface, is explained by the mechanism we have proposed.

This results in a decrease in the SnO_2 emission and an increase in the emission from oxygen vacancies in Al_2O_3. Notably, the Al_2O_3 displayed a strong intensity of emission centred at 549nm at room temperature, which was easily visible to the naked eye. Based on the results, we conclude that our proposed principle works effectively with Al_2O_3 Insulator/semiconductor nanocomposites.

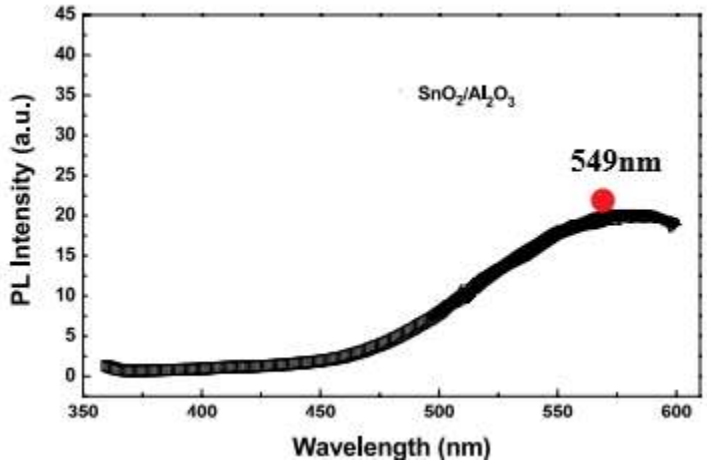

Fig 8(b) PL Spectra of SnO_2- Al_2O_3 nanocomposite

Photodecolorization of ZnO-SnO2

The ZnO- SnO_2 nanocomposites exhibit a higher photocatalytic activity than their pure oxide counterparts. This can be attributed to the presence of two semiconductors with different energy levels for their corresponding conduction and bands. When photogenerated holes and electrons have different potentials, there can be a vectorial transfer of charge carriers from one semiconductor to another, leading to more efficient electron-hole separation and increased photocatalytic activity. Both ZnO and SnO_2 are n-type semiconductors, which means that the valence band edge of each can be located by adding the band gap energy to the flat-band potential value, assuming the difference between flat band potential and conduction band edge is negligible.

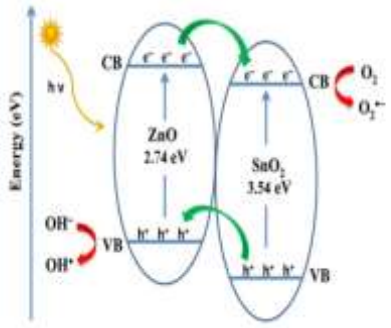

Fig 9 Schematic representation of photo-degradation of MB dye using ZnO-SnO_2 nanocomposites.

The radiated watt density was 0.4W/cm^2. The researchers then prepared suspensions by adding 50mg of the nanocomposite powder to a 100mL 20ppm MB aqueous solution at natural pH.

They stirred the suspensions in dark conditions for 15 minutes before exposing them to radiation. During irradiation, samples were taken at 15-minute intervals and centrifuged. The concentrations of the MB solutions were then calculated by measuring their absorbance at the maximum absorption peak of MB 672nm. Overall, the experimental setup and methodology allowed for precise and reliable measurements, which are essential for obtaining accurate results.

ZnO breaks down 59% of MB, while SnO_2 breaks down 85% of MB. SnO_2 has a higher degradation efficiency than ZnO, which is consistent with the findings of the previous report. ZnO/SnO_2 has the highest efficiency, degrading 95% of MB.

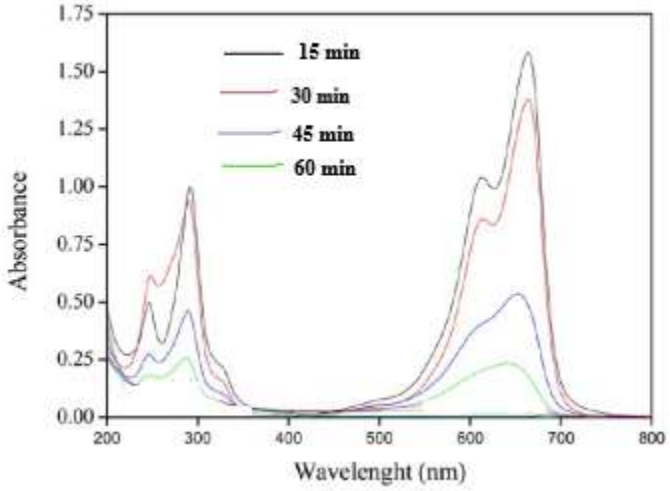

Fig 10 photocatalytic degradation MB using SnO_2–ZnO nanocomposite was shown.

Photodecolorization of SnO_2 - Al_2O_3

The study looked into how the chemical compound methylene blue (MB) deteriorated. with the formula C16H18-N3SCl, using the SnO_2-Al_2O_3 nanocomposite as a catalyst. The degradation process was measured using a UV-Vis spectrophotometer to determine the maximum absorption wavelength of MB at 663 nm. Blank tests were conducted without a catalyst at natural pH levels to determine the dye degradation rate.

In this result the degradation percentages were less than 5%, indicating that the SnO_2-Al_2O_3 nanocomposite was responsible for the high degradation percentage of the photocatalytic reaction. Initially, the photocatalytic degradation of MB was only 42.0% in the first 15 minutes, but it increased to 73.0% after 60 minutes. These findings suggest that the degradation percentage of MB was higher, demonstrating the effectiveness of the SnO_2-Al_2O_3 nanocomposite as a catalyst.

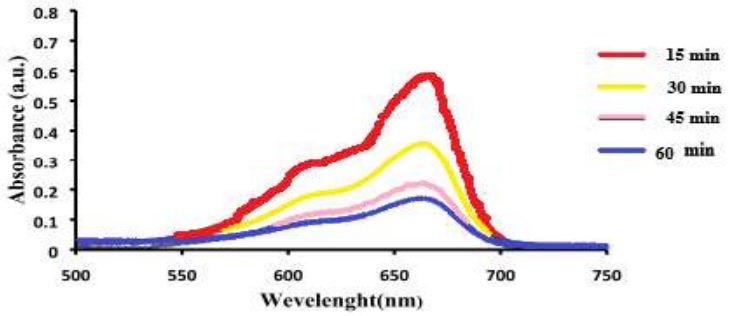

Fig 11 Photocatalytic degradation MB using SnO_2–Al_2O_3 nanocomposite was shown.

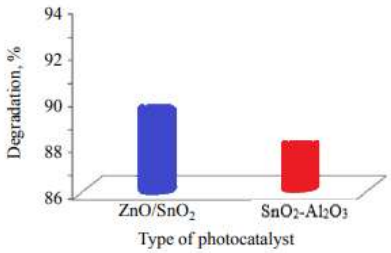

Fig 12 Comparison of the degradation activities of SnO_2/ZnO, SnO_2/Al_2O_3.

According to the experimental findings, SnO2/ZnO exhibited a higher photocatalytic efficiency and high photocatalytic activity. Then SnO_2/Al_2O_3 also showed higher degradation by gradually increasing time.

Biomedical Application

Antibacterial activity

For the SnO_2/ZnO and SnO_2/Al_2O_3 nanocomposites, the outcomes of the bactericidal activity performance studies are gathered. When comparing the illuminated SnO_2/ZnO nanocomposites both the substrate and the single component ZnO and SnO_2 nanocomposites, a sharp drop in the number of viable cells was seen. When SnO_2 is added to the ZnO surface, the antimicrobial efficacy is increased.

The antibacterial efficacy of these nanocomposites against common E. coli strains was assessed by measuring the cultures in LB broth both with two different concentrations of the nanocomposites. Throughout the 24-hour incubation period, the general strain of E. coli's growth was completely inhibited at a level of 10 microgram/ml of SnO_2 nanoparticles. At 10.0 mg/ml, limited inhibition was seen.

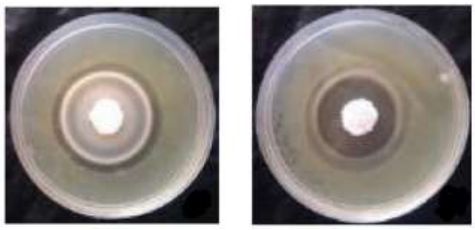

Fig 13 Zone of inhibition of SnO_2/ZnO on E.coli

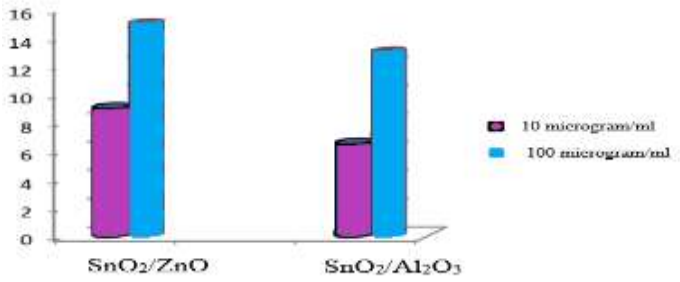

Fig14 Comparison of antibacterial sensitivity of SnO_2/ZnO and SnO_2/Al_2O_3 NCS in different concentrations.

The general E. Coli strain was inhibited from growing for up to six hours by SnO_2/ZnO and SnO_2/Al_2O_3 nanocomposites at a concentration of 10 mg/ml, but growth was completely prevented at 100 lg/ml for the entire 24-hour incubation period. As can be seen, in the control of 100 microgram/ml SnO_2/Al_2O_3, there was an initial excessive perturb caused by the nanoparticles, there was no apparent reduction over time that would have indicated inhibition of bacterial growth.

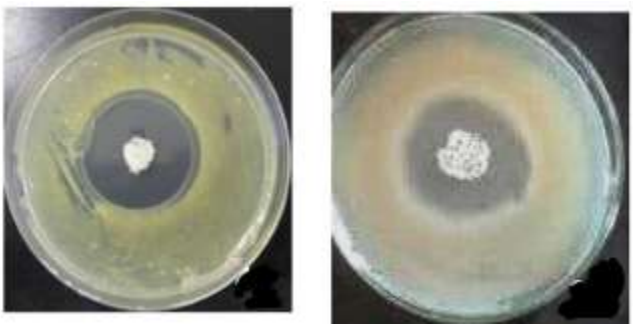

Fig 15 Zone of inhibition of SnO_2/Al_2O_3 on E.coli

CONCLUSION

In this experiment, we use the sol-gel method to create ZnO/SnO_2 and SnO_2/Al_2O_3 nanocomposites. X-ray diffraction (XRD), scanning electron microscopy (SEM), Photoluminescence (PL), and Photodecolorization were used to characterize the NCs. Additionally, Methylene blue was used as a model organic molecule to assess the photocatalytic activity. The experiment's findings demonstrated that ZnO/ SnO_2, both semiconductors, had strong photocatalytic activity and that SnO_2/Al_2O_3, which is also an insulator and semiconductor, also had high photocatalytic efficiency. The percentage of degradation was nearly identical in contrast. Al_2O_3-SnO_2 nanocomposite was created to overcome the original material's drawbacks and produce a more effective photocatalyst and we are done with it. Sol-gel research has produced a ZnO- SnO_2 nanocomposite with long-lasting antibacterial activity, even in the absence of light. The bacteria E. coli was used to test the antimicrobial susceptibility.

Conflicts of Interest: The authors declare that they have no conflicts of interest.

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