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SYNTHESIS AND CHARACTERIZATION STUDY OF ELECTROCHEMICAL PROPERTIES OF NANO MATERIALS

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Abstract

In current study for the first time, we were able to successfully synthesize single-crystalline Zinc Tin Oxide nanorods using a straightforward microwave irradiation technique. ZTO nanorods have a length of up to several micrometers and a diameter of 25-50 nm and are single-crystalline, structure obtained from XRD. The photoluminescence spectrum (PL) of the nanorods at room temperature shows stable broad blue-green emissions around the 400–600 nm wavelength range, with a maximum center at 490 nm and 520 nm. This is in good agreement with the reported values of 3.25 eV. ZTO nanorods have potential applications in high-performance supercapacitors, according to these findings. faradaic method of reaction

Keywords: XRD,CV,Tin oxide, etc.,

INTRODUCTION

Technology that makes use of phenomena and structures that can only be found at the nanoscale, which is the scale of a single atom and small molecules, is known as nanotechnology. Understanding and controlling matter at dimensions between one and one hundred nanometers, where unique phenomena enable novel applications, is the field of nanotechnology. The engineering discipline of nanotechnology, also known as molecular manufacturing, is concerned with the design and production of mechanical devices constructed at the molecular level of matter and extremely small electronic circuits. The creation, characterization, production, and application of nanoscale structures and devices is known as nanotechnology.A technology known as nanotechnology is one in which dimensions and tolerances as small as 0.1 to 100 nm (roughly equivalent to the wavelength of light) play a significant role. However, this definition is too broad to be useful because it could include everything from X-ray crystallography to atomic physics to microbial biology to the entirety of chemistry. Nanotechnology focuses on manipulating and machining objects within a predetermined dimensional range. Metal oxides have piqued material scientists' interest owing to the optical, electrical, thermal, magnetic, mechanical, and catalytic properties, which make them technologically important. Metal oxide nanostructures have recently received a lot of interest because of their potential use as functional components for nanoelectronics, optoelectronics, and sensing devices with an electronic structure. They may be metallic, semiconducting, or insulating in nature.Oxides can also be utilised to create micro-electronic circuits, sensors, piezo-electric devices, fuelcells, corrosion-resistant surface coatings with other devices. It is essential to understand the link connecting the configuration and properties (for both physical and chemical) of oxide materials as well as the applications. Many important applications for metal oxides such as iron, nickel, cobalt, manganese, copper, and zinc have been studied, including magnetic storage media, solar energy transformation, electronics, semiconductors, and catalysis

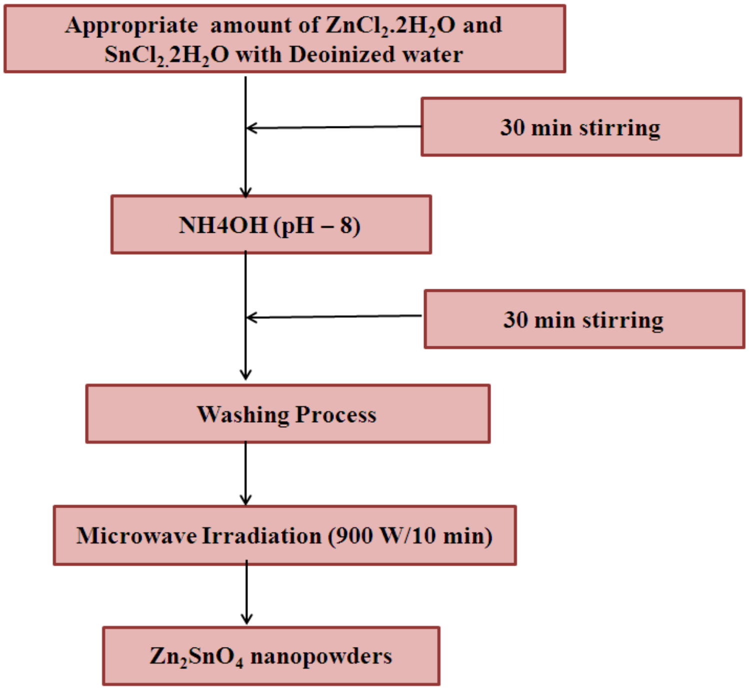
MATERIALS

SnCl2.2H2O and ZnCl2, the precursor for NH3.H2O the oxide source, Ethanol, Deionized Water were purchased from Merck. Because the chemicals were of analytical regent grade with 99 percent purity, they were utilised exactly as received.Simple chemical route was used to synthesize Zn_2SnO_4 nanorods. X-ray powder diffraction method PL and CV were used to characterize structural and optical with Electrical studies respectively

METHODS

Without further purification, all reagents were analytical reagent grade. are used in a typical experiment. 2H2O was dissolved in as little deionized water as possible in a ratio of 1:2 molar. After that, the NH3.H2O solution was added drop by drop while vigorously stirring the mixture until the pH reached 8. An azure precipitate was produced after the reaction was completed. More than ten times, this precipitate was washed with water until the silver nitrate test revealed no chlorine ions. NH4+ ions were removed from the precipitate by further washing it with ethanol. The resulting precipitate was irradiated for ten minutes in a teflon-lined household microwave oven (2.45 GHz) using up to 900W. At 80°C, the white precipitate was finally dried.

Proposed Method for Zn_2SnO_4 Synthesis



RESULTS AND DISCUSSION

XRD analysis

XRD was used to determine the as-synthesized SnO2 nanorods' structure and phase purity, as depicted in Fig.3.1. Face-centered spinel-structure ZTO can be used to precisely index all of the sharp diffraction peaks. With calculated lattice parameters of a=8.6533, the miller indices [220], [311], [222], [400], [422], [511], [440], [531], [533], [622], and [444] are in good agreement with the standard JCPDS data (#74-2184). ZnO, SnO2, and other impurity phases are not present. were depicted in Figure 3.1, indicating the products' high phase purity. The Debye-Scherrer formula was used to estimate the average size of the crystals.

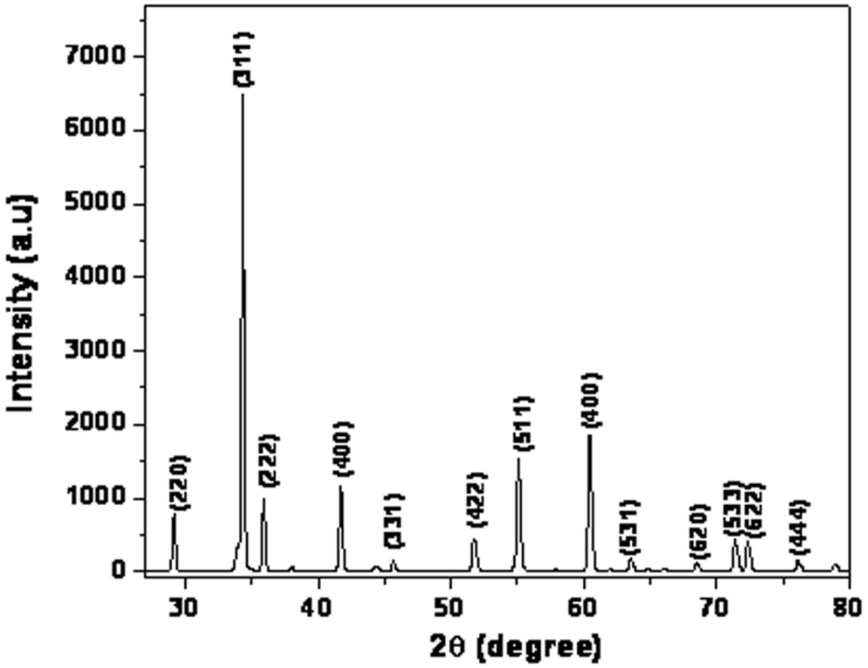


Figure 1 Powder XRD pattern of as-synthesized ZTO nanorods

Scherrer's equationormula was used to calculate the average nanoparticle grain size.Where d is the average size of the crystallite, K is the shape factor, the incident beam wavelength, the full width at half maximum, and the Bragg angle are all given.

Photoluminescence spectroscopy

Photoluminescence (PL) analysis is an effective method for determining the crystalline quality of nanocrystals and the presence of defect structure. Fig.2. demonstrates the ZTO nanorods' photoluminescence spectrum as they are synthesized. At room temperature, the ZTO nanorods' PL spectrum was measured, and the excitation wavelength was 325 nm. Around the 400–600 nm wavelength range, the ZTO nanorods emit a stable broad blue-green spectrum with a maximum center at 490 nm and 520 nm. Evidently, the 360nm band-to-band emission peak is not the broad blue-green peak we observed. The PL mechanisms have always been attributed to other luminescence centers in previous studies of semiconductor 1D nanostructures, such as oxygen deficiency and residual strain during growth.

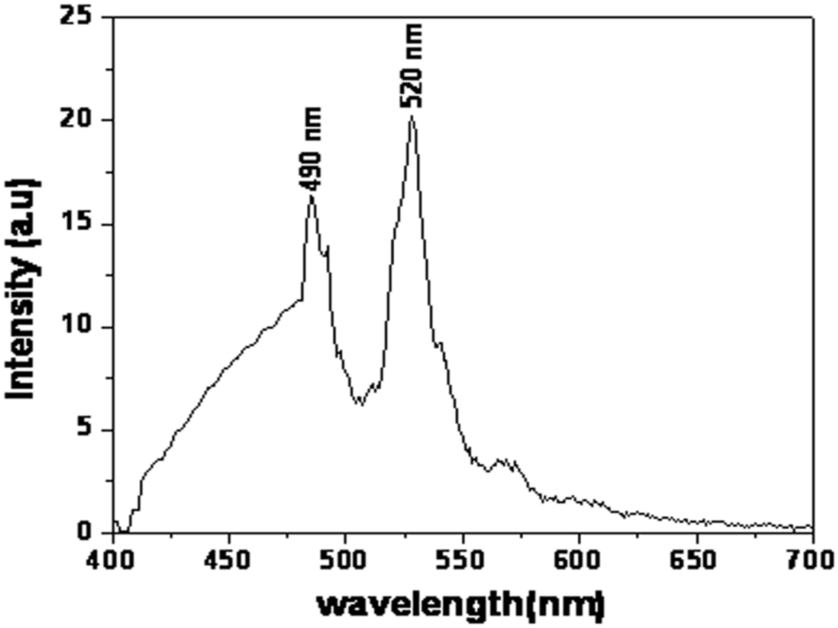


Figure2 Photoluminescence spectrum of as-synthesized ZTO nanorods

The ZTO nanorods were prepared through microwave irradiation in our experiment. During the microwave irradiation process, oxygen deficiency will unavoidably generate oxygen vacancies. ZTO nanorods have the potential to be used in opto-electronic nanodevices and nanoscale smart devices, despite the fact that research into their properties is still ongoing.

Electrochemical Studies

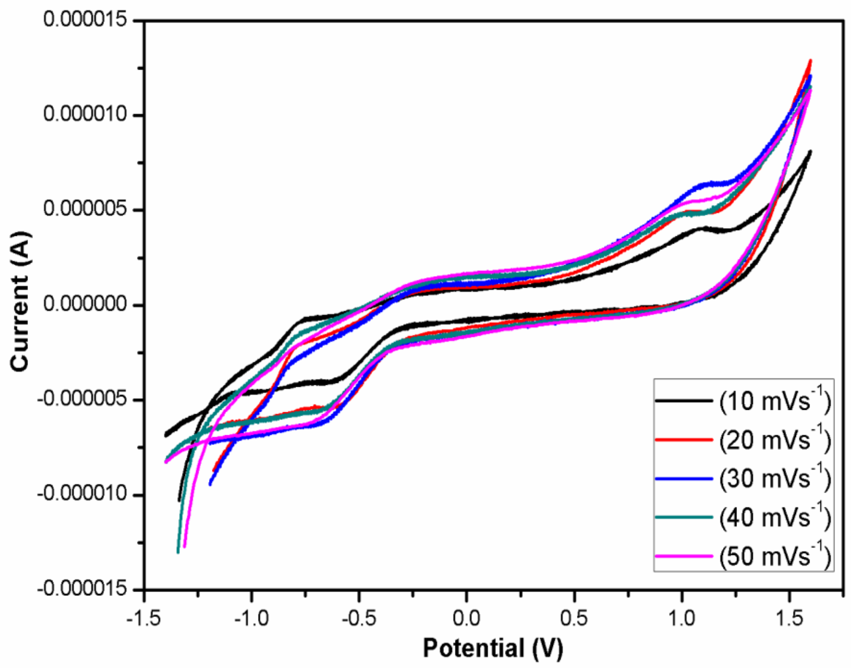


Figure 3. Cyclic voltagrams of ZTO sample at different scan rates

Cyclic voltammetry (CV) analysis was carried out so that the electrochemical properties of ZTO could be uncovered. The CV curves of ZTO at various scan rates (ten, twenty, thirty, forty, and fifty mVs-1) in the potential window of -1.5 V and +1.6 V are shown in Fig.3.3. It is evident from the figure that the shapes of the curves of the two samples were not rectangles, indicating that the samples lacked conventional electric double layer capacitance (EDLC). The synthesized nanoparticles' pseudo capacitive properties might be the cause of this deviation from the rectangle in the curve shape. Pseudo capacitance outperforms conventional EDLCs in terms of storage capacity thanks to its high energy transfer during the faradaic reaction . The equation a nanoscale smart device, was used to calculate the samples' specific capacitance (Cs). $Cs = \frac{Q}{\Delta v.m}$

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135, 98, 69, 43, and 28 Fg-1 are the calculated specific capacitance values for the MTO sample at 10, 20, 30, 40, and 50 mVs-1. The low faradaic reaction process could be the cause of the decreased specific capacitance value of the samples as the scan rate increases, as evidenced by the findings that a high value of specific capacitance was obtained at 10 mVs-1.

CONCLUSION

In this study , we were able to successfully synthesize single-crystalline ZTO nanorods using a straightforward microwave irradiation technique. ZTO nanorods have a length of up to several micrometers and a diameter of 25-50 nm. The photoluminescence spectrum (PL) of the nanorods at room temperature shows stable broad blue-green emissions around the 400–600 nm wavelength range, with a maximum center at 490 nm and 520 nm. This is in good agreement with the reported values of 3.25 eV. At a scan rate of 10 mVs-1, the ZTO nanorods achieved a specific capacitance of 135 Fg-1 and exhibit excellent electrochemical performance. ZTO nanorods have potential applications in high-performance super capacitors, according to these findings. faradaic method of reaction.

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