SIIC027

THE ANALYSIS OF TIN(IV) OXIDE PREPARED *VIA* HYDROTHERMAL TREATMENT AND ETHANOL GAS SENSING PROPERTIES

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Abstract:

Tin(IV) oxide SnO_2 is a semiconductor material with a wide bandgap energy (3.6 eV). It is particular interesting, because it has high a thermal and chemical stability and high surface to-volume ratio. Tin(IV) oxide nanostructure can be synthesis using various of techniques such as sol-gel, electrospinning, thermal evaporation, and co-precipitation. They produce nanostructure, however, they involve expensive instrumentation and high operational temperature. Among them, the hydrothermal synthesis is widely used nowadays because of its simplicity process. This study was carried out to analyze the data of SnO_2 nanostructures which was prepared via hydrothermal treatment at different heat treatment duration (6, 12, 18, and 24 hours) under constant temperature, 180 °C. The effect of different heat treatment duration on the structure, size and morphology was investigated by X-ray diffraction (XRD), Ultraviolet-visible spectroscopy (UV-vis), Field emission scanning electron microscope (FESEM), and Fourier-transform infrared spectroscopy (FTIR). It was found that the formation of SnO_2 nanorods for all sample grew into closely packed flower-like nanostructures. The diameter of the SnO_2 nanorods reduced from 43.30 to 24 .96 nm for heat treatment duration at 6 to 24 hours, respectively. For HRTEM analysis the diameter of SnO_2 nanorods for 24 hours was approximately 22.89 ± 4.84 nm. For UV-vis analysis, it was observed that, the band gap energy increased (3.52, 3.56, 3.57 and 3.6 eV). In second part of study, the best prepared SnO_2 sample was tested on ethanol gas at different operating temperature (200 °C - 450 °C). The highest sensor response (R_o/R_g ~ 1645.265) was obtained at temperature 450 °C. Therefore, the operating temperature with the highest sensor response was selected as the operating temperature.

***Keywords*:**

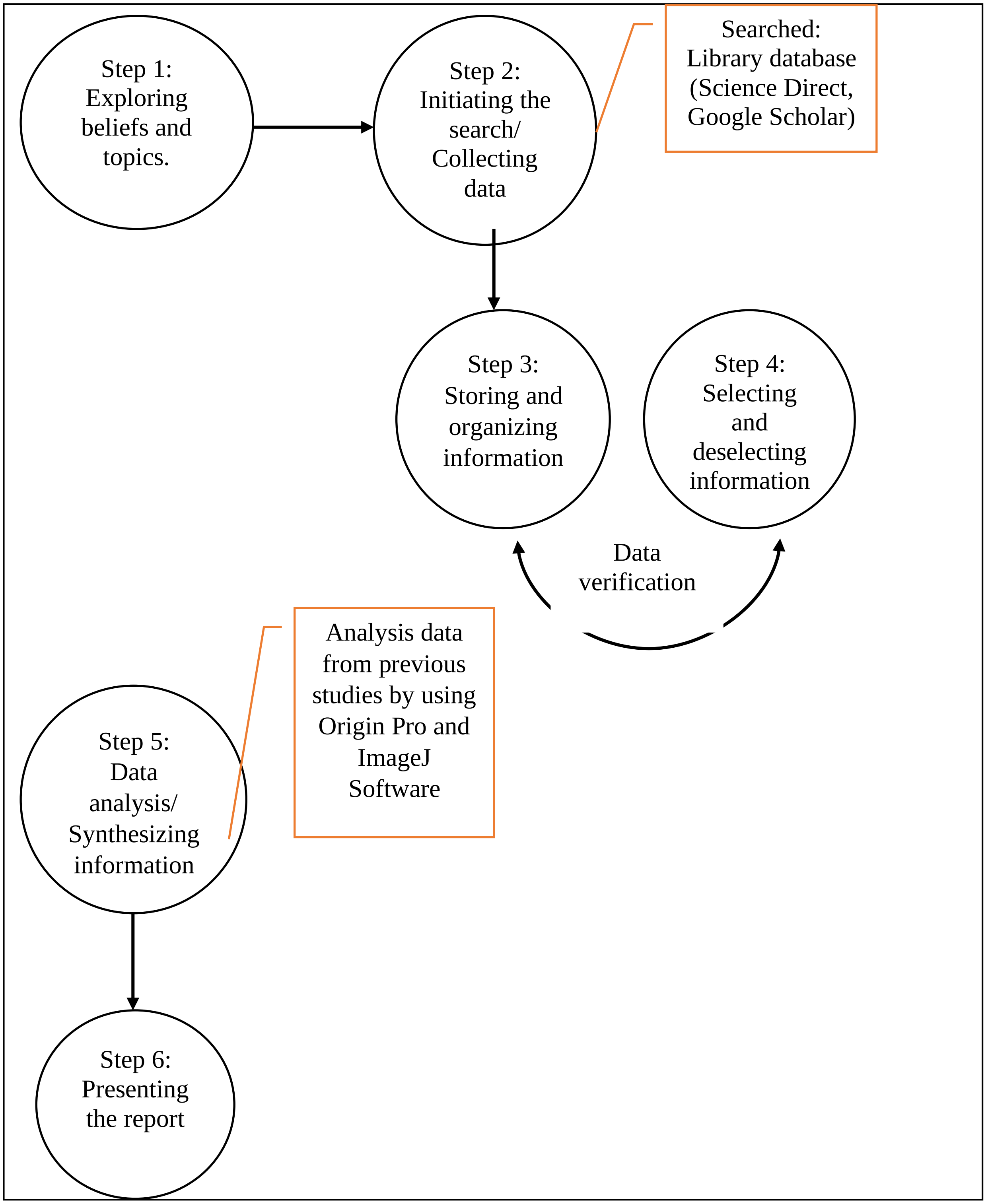
Hydrothermal, Tin(IV) oxide, Heat treatment duration; Ethanol gas sensor; Operating temperature

Objectives:

- To analyse the data of SnO_2 nanostructures prepared by hydrothermal method at different heat treatment duration and compare the data with previous studies.

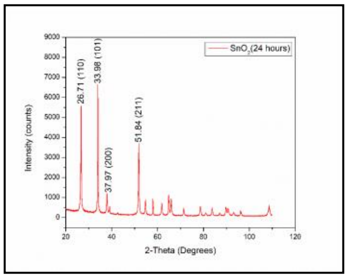
- To determine the performance of ethanol gas sensing at different operating temperatures and propose a plausible mechanism for ethanol gas sensing.

Methodology

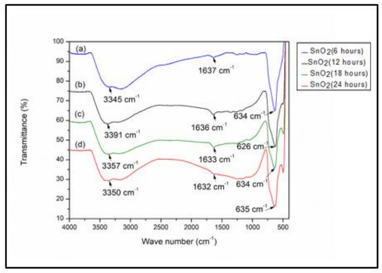


Results:

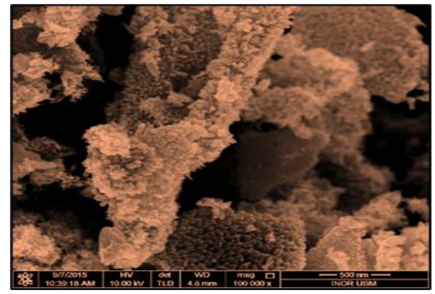
SnO_2 for 24 hours - XRD



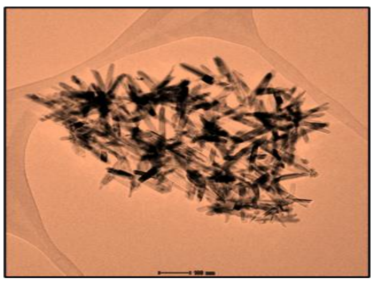
SnO_2 - FTIR



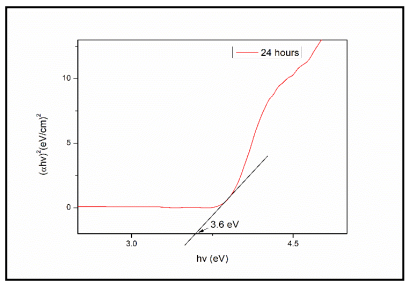
SnO2 for 24 hours - FESEM



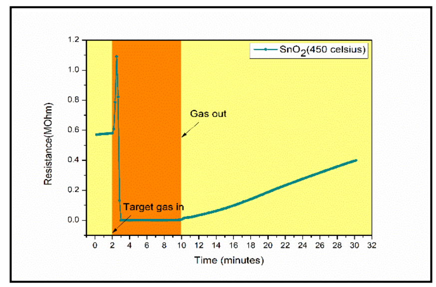
SnO_2 for 24 hours - HRTEM



SnO_2 for 24 hours – UV-vis



SnO_2 nanorods - 450 °C



Conclusion:

The XRD results show that all the diffraction peaks for SnO_2 can be assigned to rutile tetragonal structure and the dominant peaks were observed for all the samples (6, 12, 18, and 24 hours) at (110), (101), and (211). Based on the FTIR analysis, the functional group formed in the SnO_2 samples were O-H stretching, O-H bending, and O-Sn-O stretching. Next, the diameter of SnO_2 samples in FESEM analysis were decreased from 43.30 nm to 24.96 nm with increase in heat treatment duration (6-24 hours). For UV-vis analysis, it was observed that, the band gap energy increased (3.52, 3.56, 3.57, and 3.6 eV) as the size of SnO_2 nanostructures decreased. The ethanol gas sensors possess the best response performance at the operating temperature 450 °C with a response of ($R_o/R_g \sim 1.6 \times 10^3$) and response time 3 minutes. As the operating temperature increased to 450 °C, atomic ions species such as O^{2-} and O^- are dominated. Then, the oxygen ions absorbed on the surface of the SnO_2 leads to the structure of an electron-depleted surface layer, which results in the reduction in the electronic conductivity of SnO_2.