SIIC084

A COMPARATIVE STUDY ON THE EFFECT OF PALLADIUM DOPANT CONCENTRATION ON THE PHOTOCATALYTIC PROPERTIES OF TIN(IV) OXIDE

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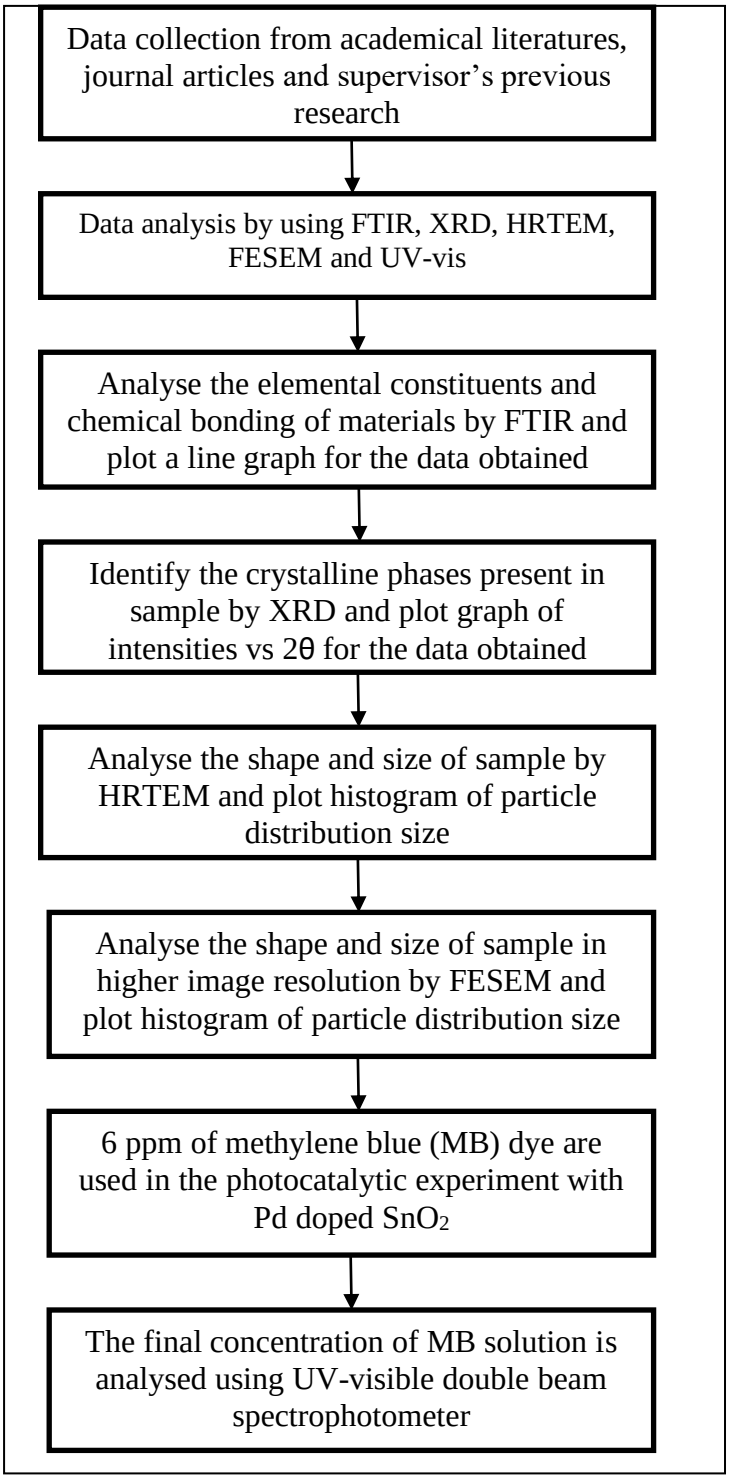
Abstract:
Several type of semiconductor photocatalysts such as TiO_2, ZnO and SnO_2 have been applied in treating dye containing wastewater. However, the application of SnO_2 metal oxides as photocatalysts still remain limited despite the potential of the material to oxidize and degrade pollutant materials in wastewater. SnO_2 can be modified with transition metal dopant such as palladium to improve its photocatalytic properties especially in the visible region of solar spectrum. In this work, SnO_2 with different concentration of palladium dopant (0.5, 1, 3 and 5 mol%) were successfully analysed. The characterization data from X-ray diffraction (XRD), Fourier-Transform infrared spectroscopy (FTIR), high-resolution transmission electron microscopy with selected area electron diffraction (HRTEM-SAED), field emission scanning electron microscopy (FESEM) and UV-vis spectroscopy were carefully analysed and compared with previous studies. From XRD analysis, the results showed strong evidence of SnO_2 nanoparticles formation. Whereas the FTIR peaks further confirmed the presence of the Sn-O bonds. The UV-vis result revealed the band gap of Sn-O considerably decreased from 3.75 eV to 3.66 eV with increasing Pd concentration. The selected 5 mol% Pd doped SnO_2 was tested on photocatalyst reaction with methylene blue. In addition, the image of Pd doped SnO_2 from HRTEM-SAED demonstrated the SnO_2 nanoparticles existed in short nanorods in a closely packed structure. The comparison with literature review shows that Pd doping improve the photocatalytic properties of SnO_2.

***Keywords*:**
SnO2, Pd doped, nanorods, photocatalyst, concentration

Objectives:

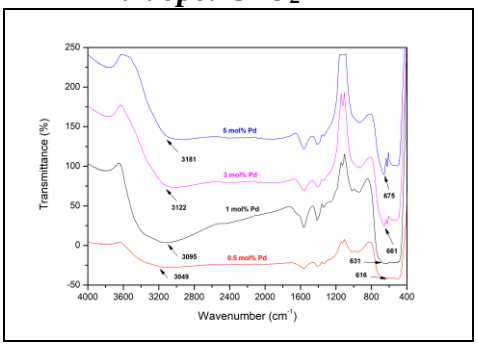
- To analyse the effect of Pd concentration on the chemical and structural properties of SnO_2.
- To compare the results of Pd-doped SnO2 characterization with previous data (XRD, FTIR, HRTEM-SAED, FESEM and UV-Vis).
- To propose a plausible mechanism for doped SnO2 photocatalyst based on the study.

Methodology:

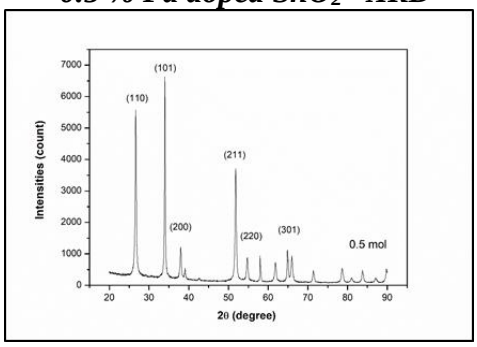

Data collection from academical literatures, journal articles and supervisor's previous research
Data analysis by using FTIR, XRD, HRTEM, FESEM and UV-vis
Analyse the elemental constituents and chemical bonding of materials by FTIR and plot a line graph for the data obtained
Identify the crystalline phases present in sample by XRD and plot graph of intensities vs 2θ for the data obtained
Analyse the shape and size of sample by HRTEM and plot histogram of particle distribution size
Analyse the shape and size of sample in higher image resolution by FESEM and plot histogram of particle distribution size
6 ppm of methylene blue (MB) dye are used in the photocatalytic experiment with Pd doped SnO_2
The final concentration of MB solution is analysed using UV-visible double beam spectrophotometer

Results:

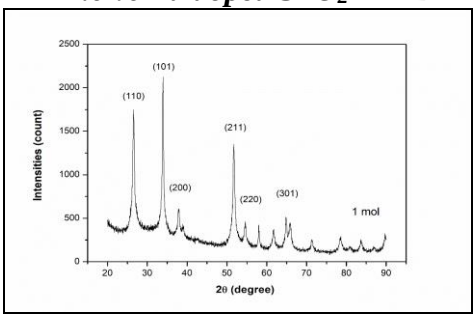
Pd doped SnO_2 - FTIR



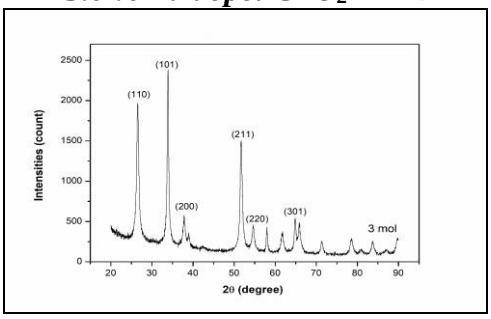
0.5 % Pd doped SnO_2 - XRD



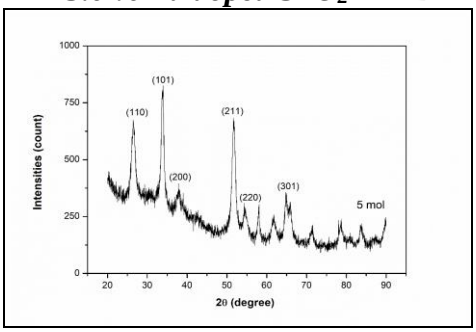
1.0 % Pd doped SnO_2 - XRD



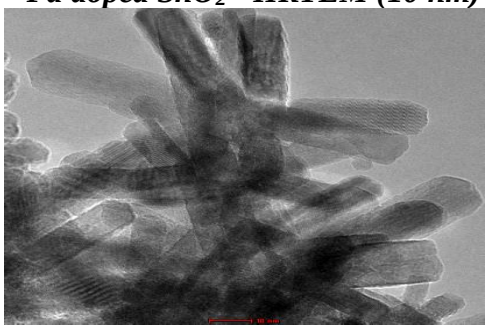
3.0 % Pd doped SnO_2 - XRD



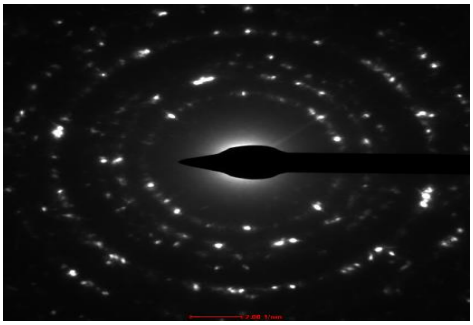
5.0 % Pd doped SnO_2 - XRD



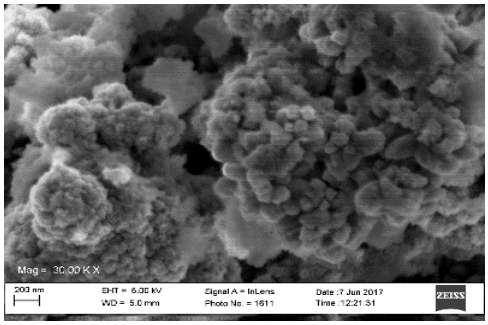
Pd doped SnO_2 - HRTEM (10 nm)



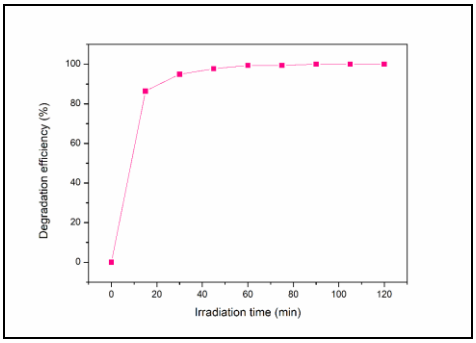
SAED pattern of Pd doped SnO_2 - HRTEM



Pd doped SnO_2 - FESEM (30.00 kx)



Photocatalytic experiment



Conclusion:

The properties of SnO_2 nanorods with different concentration of Pd dopant (0.5%, 1%, 3% and 5%) have successfully analyse in this study. The FTIR shown a significance results in the photocatalytic properties of SnO_2 material. From the FTIR results, the FTIR peaks produced were attributed mainly on the O-Sn-O, Sn-O and OH bonds. Whereas in XRD analysis, the results of XRD pattern showed strong evidence for the formation of SnO_2 nanoparticles. In addition the structure of SnO_2 nanoparticles were confirmed in tetragonal rutile structure with no other obvious characteristics impurity peaks observed from the XRD pattern. Moreover, intensity at major peaks (110,) (101) and (211) plane for the Pd doped SnO_2 seen to be reduce with higher concentration of Pd dopant. In this work it have been analysed that the Pd-SnO_2 has exhibited changes in the physical properties which produce an alterations on the crystal structure, morphology, energy band gap as well as the photocatalytic activity. The image of Pd doped SnO_2 from HRTEM-SAED demonstrated the as-prepared SnO_2 nanoparticles existed in polycrystalline nanorods structure with an average crystal size measured of 11.6 nm ± 1.8797 nm. In contrast, FESEM images analysed the samples are mostly short nanorods in closely packed structure and agglomerated with each other. The measured size of the particle is approximately in the range of 19.8 nm ± 2.3073 nm. It is clearly seen that doping SnO_2 with a moderate amount of Pd metal affects the shapes of SnO_2 slightly. The size of the particles is reduced upon increasing Pd concentration caused by Pd doping. On the other hand, the band gap of Sn-O is also reduced with increasing Pd concentration. The maximum degradation efficiency of methylene blue is 100% in 120 min. The narrowing of band gap of SnO_2 provide increase in absorption of visible light irradiation. The 5% concentration of Pd dopant suggested to be suitable concentration for the degradation of MB dye.