



UNIVERSITI PUTRA MALAYSIA

**PHOTOCATALYTIC REMOVAL OF METHYLENE BLUE BY
BISMUTH VANADATE PREPARED VIA POLYOL ROUTE**

MELANIE MOEY HUI JIA

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MELANIE MOEY HUI JIA

**MASTER OF SCIENCE
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**PHOTOCATALYTIC REMOVAL OF METHYLENE BLUE BY BISMUTH
VANADATE PREPARED VIA POLYOL ROUTE**

By

MELANIE MOEY HUI JIA

**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in
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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

PHOTOCATALYTIC REMOVAL OF METHYLENE BLUE BY BISMUTH VANADATE PREPARED VIA POLYOL ROUTE

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Chair : Associate Professor Abdul Halim Abdullah, PhD

Faculty : Science

In this study, visible-light driven photocatalyst BiVO_4 was synthesized via polyol route. The effect of calcination temperature and duration on the characteristics of the resulting BiVO_4 catalyst was studied by performing Thermogravimetric Analysis (TGA), X-ray Diffraction (XRD), Field Emission Scanning Electron Microscopy (FE-SEM), surface area measurement (BET method) and Diffuse Reflectance Spectroscopy (DRS). XRD analysis showed that monoclinic scheelite BiVO_4 can be obtained by calcining the sample at 450 °C for 3 hours. The BiVO_4 produced was olive-like in shape. The morphology of synthesized BiVO_4 retained the same upon increasing the calcination temperature and duration. However, its surface area decreased and showed increment in its particle size when calcination temperature and duration increased. Calcination temperature and duration did not affect the band gap energy of the BiVO_4 catalyst. The efficiency of resulted BiVO_4 as a visible-light driven photocatalyst was examined by removing Methylene Blue (MB) dye from aqueous solution. The effect of operational parameters such as catalyst dosage, initial concentration of dye and initial pH of solution

on the removal of MB was also studied. The removal percentage of MB increased with increasing mass up to an optimum mass of 0.6003 g. Rate of reaction increased with increasing initial concentration of MB. Highest removal percentage of MB was also achieved at its natural state of pH. Further, experimental design methodology was used for response surface modelling and optimisation of MB removal. A multivariate experimental design was employed to investigate its interaction relationship among catalyst loading, initial concentration of dye and initial pH of solution. The maximum removal percentage of MB approached 67.21 % under optimised conditions of 0.57 g BiVO_4 , 10.47 ppm of MB and at pH 4.7. A satisfactory goodness-of-fit was achieved between the predictive and the experimental results which indicates response surface methodology is a reliable tool for optimising removal percentage of MB.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

**PENYINGKIRAN METILENA BIRU DENGAN BISMUT VANADAT YANG
DISEDIAKAN MELALUI KAEDAH POLIOL**

Oleh

MELANIE MOEY HUI JIA

Disember 2012

Pengerusi : Profesor Madya Abdul Halim Abdullah, PhD

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Dalam kajian ini, fotomangkin cahaya tampak bismut vanadat BiVO_4 telah disintesis melalui kaedah poliol. Kesan suhu dan tempoh pengkalsinan terhadap ciri-ciri BiVO_4 yang dihasilkan dikaji dengan Analisis Termogravimetrik (TGA), Pembelauan Sinar-X (XRD), Pancaran Medan-Mikroskopi Pengimbasan Elektron (FE-SEM), Pengukuran Luas Permukaan (kaedah BET) dan Spektroskopi Penyerapan Pantulan (DRS). Daripada analisis XRD, bismut vanadat monoklinik telah diperolehi melalui pengkalsinan sampel pada suhu $450\text{ }^\circ\text{C}$ selama 3 jam. BiVO_4 yang dihasilkan berbentuk buah zaitun. Bentuk BiVO_4 yang disintesis kekal sama apabila suhu dan tempoh pengkalsinan meningkat. Tetapi, luas permukaan menurun dan menunjukkan peningkatan dalam saiz zarah apabila suhu dan tempoh pengkalsinan meningkat. Suhu dan tempoh pengkalsinan tidak mempengaruhi tenaga jurang jalur mangkin BiVO_4 . Kecekapan bismut vanadat yang dihasilkan sebagai fotomangkin cahaya tampak telah diuji dengan menyingkirkan Metilena Biru (MB) daripada larutan akueus. Kesan pelbagai parameter seperti dos mangkin, kepekatan pewarna dan pH awal larutan juga telah dikaji. Peratusan

penyingkiran pewarna MB meningkat dengan peningkatan dos mangkin sehingga ke tahap optimum sebanyak 0.6003 g. Kadar tindak balas meningkat dengan kepekatan MB. Penyingkiran tertinggi MB tercapai pada pH semula jadi. Kaedah reka bentuk ujikaji telah digunakan untuk permodelan respons permukaan dan mengoptimumkan peratusan penyingkiran MB. Kepelbagaian variasi reka bentuk ujikaji juga digunakan untuk mengkaji hubungan interaksi di antara dos mangkin, kepekatan pewarna dan pH awal larutan terhadap peratusan penyingkiran pewarna. Peratusan penyingkiran MB mencapai 67.21 % pada keadaan optimum. Keputusan eksperimen sejajar dengan keputusan ramalan dan ini menunjukkan bahawa kaedah respons permukaan ialah suatu kaedah yang boleh dipercayai untuk mengoptimumkan peratusan penyingkiran MB.



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I certify that an Examination Committee met on 20 December 2012 to conduct the final examination of Melanie Moey Hui Jia on her Master of Science thesis entitled “Photocatalytic Removal of Methylene Blue by Bismuth Vanadate Prepared via Polyol Route” in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institution.

MELANIE MOEY HUI JIA

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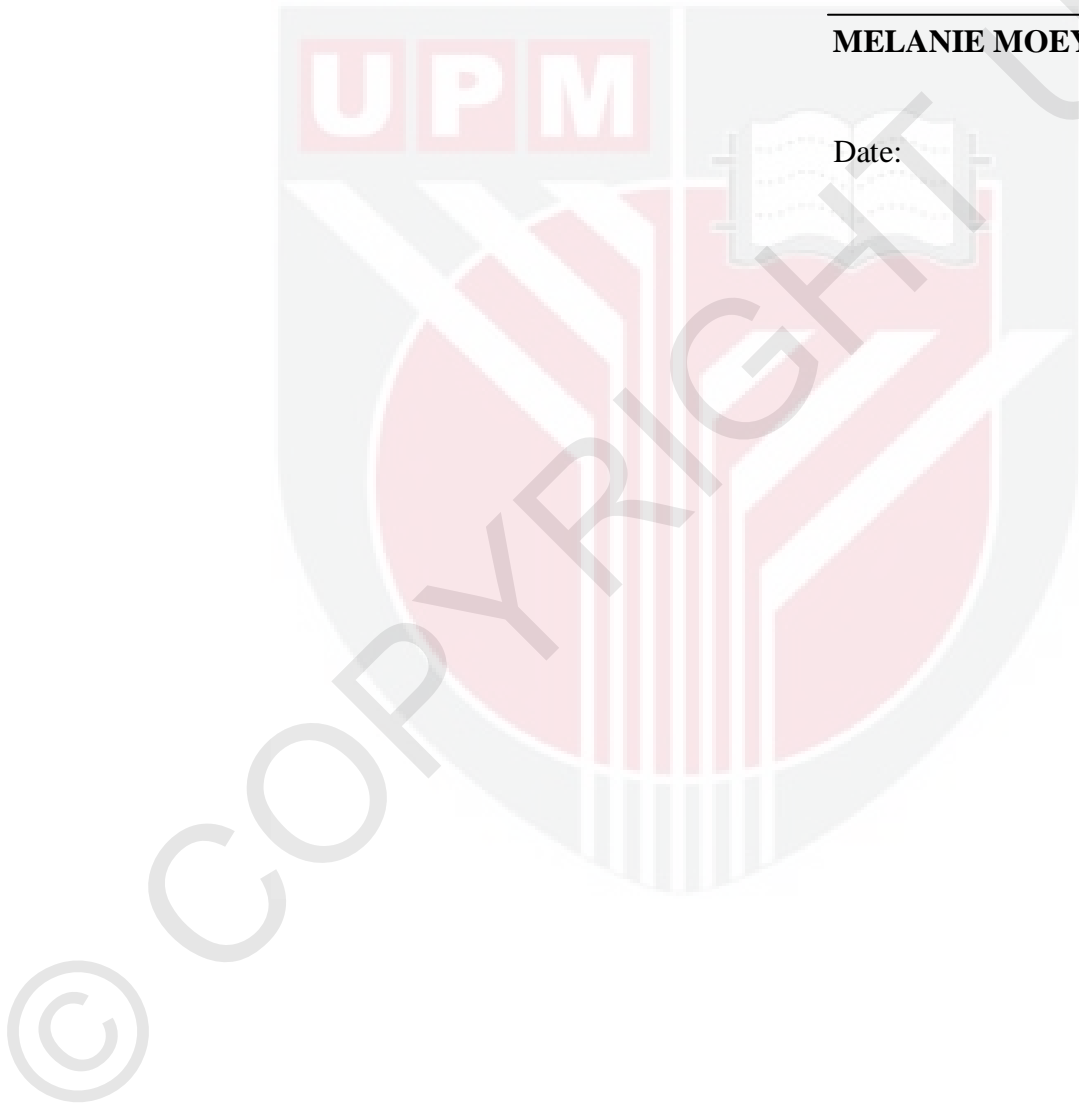


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