



UNIVERSITI PUTRA MALAYSIA

**SYNTHESIS AND PHOTOCATALYTIC ACTIVITY OF BiVO_4 , Ag-BiVO_4
AND Cu-BiVO_4 IN DEGRADATION OF METHYLENE BLUE**

JONG CHIN YUN

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AND Cu-BiVO_4 IN DEGRADATION OF METHYLENE BLUE**

By

JONG CHIN YUN

**Thesis Submitted to the School of Graduate Studies,
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Degree of Master of Science**

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June 2013

Chair : Associate Professor Abdul Halim bin Abdullah, PhD

Faculty : Science

In the past few decades, water contamination has been pointed out as one of the serious problem of modern society due to rapid growth of industrialization. Bismuth vanadate (BiVO_4) is a promising photocatalyst that works well in removing this highly coloured wastewater under visible light irradiation. Therefore, this study has focused on the synthesis and modification of BiVO_4 as well as their photocatalytic activities in degrading the methylene blue dye solution.

BiVO_4 photocatalysts were successfully synthesized by solution combustion method using two different bismuth precursors (bismuth nitrate and bismuth acetate), ammonium metavanadate and citric acid. A series of combustion temperature (500 – 700 °C) was used during BiVO_4 preparation step. Effects of

bismuth precursor and combustion temperature on the properties of BiVO₄ were studied.

The BiVO₄ formed were in monoclinic structure with nearly spherical shape. Acetate based BiVO₄ series exhibited better physical properties (small particle size and high surface area) than nitrate based BiVO₄. Increment in particle size, pore size, crystallinity and reduction in pore volume and surface area of prepared BiVO₄ were observed as combustion temperature increasing from 500 to 700 °C. Photocatalytic efficiency of BiVO₄ was found strongly influenced by its crystallinity and surface area. BiVO₄ (N600) possessed the highest photocatalytic activity with degradation rate, 3.4×10^{-2} ppm/min was chosen to be modified with Cu and Ag, respectively.

Ag-BiVO₄ exhibited higher photocatalytic activity in degradation of MB than Cu-BiVO₄. Ag loaded on the BiVO₄ was existed in Ag₂O form. Improvement in photocatalytic performances was ascribed to the efficient of charge separation in the Ag₂O-BiVO₄ interface. The optimal Ag loading was 5%, while excess Ag loading inhibited photocatalytic activity. 5% Ag-BiVO₄ was chosen as the best photocatalyst in this study and its ability to degrade MB were transpired by its photocatalytic activity in the effect of operational parameters.

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

**SINTESIS DAN AKTIVITI FOTOMANGKIN BiVO_4 , Ag-BiVO_4 DAN
 Cu-BiVO_4 DALAM DEGRADASI METILENA BIRU**

Oleh

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Dalam beberapa dekad yang lalu, pencemaran air telah muncul sebagai salah satu masalah yang serius dalam masyarakat moden ekoran daripada pertumbuhan perindustrian yang pesat. Bismut vanadate (BiVO_4) merupakan fotomangkin yang berkesan dalam menyingkir air sisa yang berwarna di bawah sinaran cahaya nampak. Oleh itu, kajian ini telah memberi tumpuan kepada sintesis dan pengubahsuaian BiVO_4 serta fotokatasis aktivitiya dalam mengurai larutan pewarna metilena biru

Fotomangkin bismut vanadat (BiVO_4) telah dihasilkan melalui kaedah pembakaran larutan menggunakan dua prekursor bismut yang berbeza (bismut nitrat dan bismut acetat), amonium metavanadat dan asid sitrik. Satu siri suhu

pembakaran (500 - 700 °C) telah digunakan semasa penyediaan BiVO₄. Kesan prekursor bismut dan suhu pembakaran ke atas sifat BiVO₄ telah dikaji.

BiVO₄ yang terhasil adalah dalam struktur monoklinik dengan bentuk hampir sfera. Siri BiVO₄ asas asetat memiliki sifat-sifat fizikal yang lebih baik (saiz zarah yang kecil and luas permukaan yang besar) berbanding BiVO₄ asas nitrat. Penambahan dalam saiz zarah, saiz liang, penghabluran dan pengurangan dalam isipadu liang dan luas permukaan BiVO₄ telah diperhatikan apabila suhu pembakaran meningkat dari 500 ke 700 °C. Kecekapan fotokatalisis BiVO₄ didapati pengaruhi oleh kristaliniti and luas permukaannya. BiVO₄ (N600) memiliki aktiviti fotokatalisis yang tinggi dengan kadar degradasi, 3.4×10^{-2} ppm/min telah dipilih untuk ubahsuai dengan Cu dan Ag secara berasingan.

Ag-BiVO₄ menunjukkan aktiviti fotokatalisis yang lebih tinggi daripada Cu-BiVO₄ dalam penguraian MB. Ag yang dimuat di atas BiVO₄ wujud dalam bentuk Ag₂O. Peningkatan dalam fotokatalisis berkait rapat dengan kecekapan pemisahan cas di antara Ag₂O-BiVO₄. Muatan optimum Ag adalah 5% berat, manakala muatan Ag yang berlebihan menghalang aktiviti fotokatalisis. 5% Ag-BiVO₄ telah dipilih sebagai fotomangkin yang terbaik dalam kajian ini dan kemampuannya untuk menguraikan MB telah dibuktikan dengan aktiviti fotokatalisisnya dalam kesan operasi parameter.

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I certify that a Thesis Examination Committee has met on 26 June 2013 conduct the final examination of Jong Chin Yun on her thesis entitled "Synthesis and Photocatalytic Activity of BiVO₄, Ag-BiVO₄ and Cu-BiVO₄ in Degradation of Methylene Blue" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

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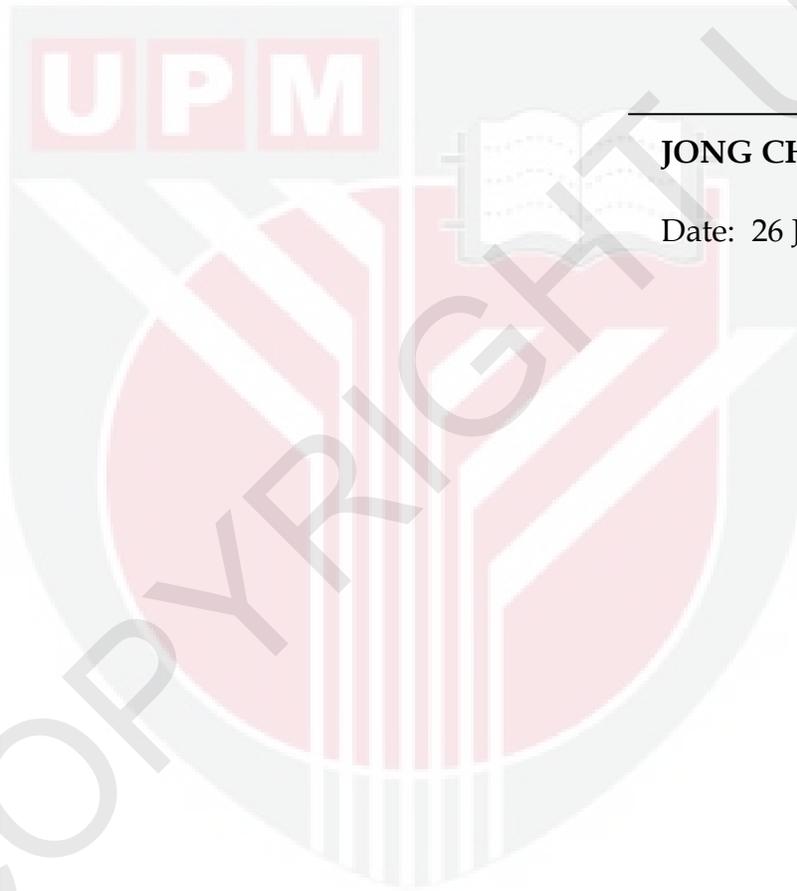
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DECLARATION

I declare that the thesis is my original work except for quotations and citations which has been duly acknowledgement. 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.



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Date: 26 June 2013

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