# 出國報告 (出國類別: 國際會議)

## Desalination for the Environment Clean Water and Energy

服務機關：國立高雄應用科技大學 化材系
姓名職稱：吳忠信教授
派赴國家：義大利
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# 目錄

## 摘要

In this work, $BiVO_4$ was synthesized using a one-step hydrothermal method. The precursors of Bi and V were $Bi(NO_3)_3 \cdot 5H_2O$ and $NH_4VO_3$, respectively. The photocatalytic activity of $BiVO_4$ was evaluated by using it to decolorize C.I. Reactive Red 2 (RR2) under ultraviolent (UV) or visible light (Vis.) irradiation. The surface characteristics of $BiVO_4$ were analyzed by X-ray diffraction (XRD), UV-Vis diffusion reflectance spectrophotometry (UV-Vis-DRS) and scanning electron microscopy (SEM). The mean diameter and band gap of $BiVO_4$ particles were 23 nm and 2.4 eV, respectively. After 180 min of reaction, the degrees of RR2 decolorization by $BiVO_4$ adsorption, Vis./$BiVO_4$ and UV/$BiVO_4$ were 10%, 46% and 85%, respectively. The photodegradation rate constants (k) of RR2 fitted pseudo-first-order kinetics and the k values of the Vis./$BiVO_4$ and UV/$BiVO_4$ systems were 0.0025 and 0.0096 $min^{-1}$, respectively.

## 目的

至 Desalination for the Environment Clean Water and Energy，發表"Decolorization of C.I. Reactive Red 2 by $BiVO_4$: adsorption and photodegradation"一文。

## 過程

本次會議於義大利羅馬舉行(05/22/2016-5/26/2016)，本人於 05/20/2016 出發，05/21/2016 於杜拜轉機，05/21/2016 抵達羅馬，05/22/2016 報到並於 05/23/2016 進行論文發表，05/28/2016 啟程返台，回程亦於杜拜轉機，05/29/2016 抵達台灣。本次 Desalination for the Environment Clean Water and Energy 論文以口頭及海報兩種型態進行，大會邀請專家及學者參與，針對 feedwater pretreatment for desalination, seawater desalination by reverse osmosis, brackish water desalination, nanofiltration, ultrafiltration, microfiltration in water treatment processes, forward osmosis, pressure retarded osmosis, removal of specific compounds, membrane performance and maintenance, membrane reuse, fouling, biofilms, SDI/MFI, pre-treatment and post-treatment of desalinated water, recent developments in desalination, advanced wastewater treatment, renewable energy for desalination, energy recovery technology, thermal seawater desalination, desalination and water in industries: oil and gas/mining/food and beverage, corrosion and scaling, material selection, low-cost water purification for remote and disaster areas, water scarcity and the environment, water resource management, desalination projects, financing schemes, cost of desalination and water treatment, environmental impact considerations, concentrate handling 和 science to business 等二十九個議題進行報告。此次受邀之專題講者為 Prof. Steven J. Duranceau (USA)，講題為"The expansion of membrane applications in the USA – past, present and future"及 Prof. Hans Vrouwenvelder (The Netherlands)，講題為"Advances in biofouling of spiral wound membrane research"，本次 Desalination for the Environment Clean Water and Energy 會議共有 244 篇論文口頭發表及 142 篇海報發表，參與人員來自台灣、韓國、馬來西亞、中國、印度、德國、日本、美國、巴基斯坦、阿爾及利亞、阿拉伯聯合大公國、伊朗、俄羅斯、葡萄牙、喬治亞、摩洛哥、沙烏地阿拉伯、南非、法國、突尼西亞、土耳其、義大利、西班牙、墨西哥、波蘭、匈牙利、羅馬尼亞、塞爾維亞、埃及、科威特、黎巴嫩、以色列、新加坡、挪威、巴西、阿曼、約旦、捷克及加拿大等四十一國，會議議程相當豐富。本人於此次大會發表"Decolorization of C.I. Reactive Red 2 by $BiVO_4$: adsorption and photodegradation"一文，會後並與多名學者進行意見交流。

**與會心得與建議事項**

這次出國參加的會議是Desalination for the Environment Clean Water and Energy，發表"Decolorization of C.I. Reactive Red 2 by $BiVO_4$: adsorption and photodegradation"一文。在會議的過程中不只聽到了一些與自己研究有相關的演講外，還可以聽到其他的研究以增加自己的知識。藉由參加這次研討會，不但增加了許多新知也得到許多的資訊，而這些資訊讓我可以了解各國實驗室的實驗進展，也可以督促自己研究之腳步。這次在本研討會同行出席之台灣人員為台大環工所林正芳教授，會中並與Prof. How-Yong Ng (National University of Singapore)及Dr. Kok Kwang Ng (National University of Singapore)交談討論，會議期間特別聽取他們的研究成果"Performance of membrane bioreactor systems operated at short SRTs"及"An innovative marine sediment coupled with membrane for the treatment of pharmaceutical wastewater"，他們分享了在新加坡研究之最新發展，特別是如何處理高鹽分之製藥廢水，他們利用海邊沿岸之海沙培養之微生物配合薄膜系統加以應用，成功發展出創新之水處理技術。最後要感謝校務基金(科技部計畫結餘款)補助我出國的經費，讓我能以較小的經濟壓力下出國參加會議學習。本次出席該會議與大會其他與會人員交換意見，獲益良多。在與新加坡學者交換意見後，建議我國應對學者之科研經費增加並放寬核銷之彈性。

**攜回資料名稱及內容**

本次攜回會議的議程書，其內容包括會議期間各演講者與題目。

**3** Defluoridation of post treated photovoltaic wastewater using aluminum electrodes: optimization of operating parameters and sludge characteristics
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**5** The efficacy of adsorptive removal of phenol from refinery wastewater using graphene
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**7** Application of nanofilter in removal of phosphate, fluoride and nitrite from groundwater
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**8** Freezing process – a new approach for nitrate removal
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**50** Optimization for dyeing wastewater treatment using modified sericite
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**55** Recovery of ferrite from iron(II)-rich mine water
*V. Akinwekomi, J.P. Maree, C. Zvinowanda, F. Carlsson, G.M. Wolfaardt, Vhahangwele Bologo (South Africa)*

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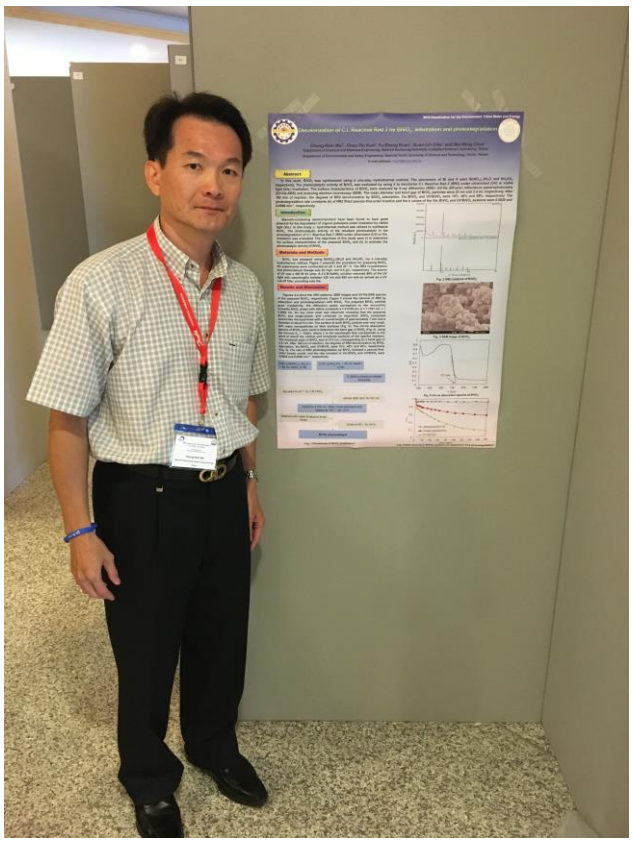
**參訪剪影**



圖一：筆者於研討會會場


圖二：筆者與台大林正芳教授於研討會會場合影

發表論文海報

2016 Desalination for the Environment: Clean Water and Energy

# Decolorization of C.I. Reactive Red 2 by $BiVO_4$: adsorption and photodegradation

**Chung-Hsin Wu[1*], Chao-Yin Kuo[2], Yu-Sheng Kuan[1], Kuan-Lin Chiu[1] and Wei-Ming Chen[1]**

[1]Department of Chemical and Materials Engineering, National Kaohsiung University of Applied Sciences, Kaohsiung, Taiwan

[2]Department of Environmental and Safety Engineering, National Yunlin University of Science and Technology, Yunlin, Taiwan

E-mail address: wuch@kuas.edu.tw

## Abstract

In this work, $BiVO_4$ was synthesized using a one-step hydrothermal method. The precursors of Bi and V were $Bi(NO_3)_3{\cdot}5H_2O$ and $NH_4VO_3$, respectively. The photocatalytic activity of $BiVO_4$ was evaluated by using it to decolorize C.I. Reactive Red 2 (RR2) under ultraviolent (UV) or visible light (Vis.) irradiation. The surface characteristics of $BiVO_4$ were analyzed by X-ray diffraction (XRD), UV-Vis diffusion reflectance spectrophotometry (UV-Vis-DRS) and scanning electron microscopy (SEM). The mean diameter and band gap of $BiVO_4$ particles were 23 nm and 2.4 eV, respectively. After 180 min of reaction, the degrees of RR2 decolorization by $BiVO_4$ adsorption, Vis./$BiVO_4$ and UV/$BiVO_4$ were 10%, 46% and 85%, respectively. The photodegradation rate constants (k) of RR2 fitted pseudo-first-order kinetics and the k values of the Vis./$BiVO_4$ and UV/$BiVO_4$ systems were 0.0025 and 0.0096 $min^{-1}$, respectively.

## Introduction

Bismuth-containing semiconductors have been found to have great potential for the degradation of organic pollutants under irradiation by visible light (Vis.). In this study a hydrothermal method was utilized to synthesize $BiVO_4$. The photocatalytic activity of the resultant photocatalyst in the photodegradation of C.I. Reactive Red 2 (RR2) under ultraviolent (UV) or Vis. irradiation was evaluated. The objectives of this study were (i) to determine the surface characteristics of the prepared $BiVO_4$ and (ii) to evaluate the photocatalytic activity of $BiVO_4$.

## Materials and Methods

$BiVO_4$ was prepared using $Bi(NO_3)_3{\cdot}5H_2O$ and $NH_4VO_3$ via a one-step hydrothermal method. Figure 1 presents the procedure for preparing $BiVO_4$. All experiments were conducted at pH 3 and 25° C. The RR2 concentration and photocatalyst dosage was 20 mg/L and 0.5 g/L, respectively. The source of UV was a 400 W Xe lamp. A 2.0 M $NaNO_2$ solution removed 99% of the UV light with wavelengths between 320 nm and 400 nm and so served as a UV cut-off filter, providing only Vis..

## Results and Discussion

Figures 2-4 show the XRD patterns, SEM images and UV-Vis-DRS spectra of the prepared $BiVO_4$, respectively. Figure 5 shows the removal of RR2 by adsorption and photodegradation with $BiVO_4$. The prepared $BiVO_4$ exhibits good crystallinity; the diffraction peaks correspond to the monoclinic scheelite $BiVO_4$ phase with lattice constants a = 0.5195 nm, b = 1.1701 nm, c = 0.5092 nm. No any other peak was observed, revealing that the prepared $BiVO_4$ was single-phase, and contained no impurities. $BiVO_4$ comprised peanut-like microparticles with an overall length of approximately 1 mm and a diameter of about 0.5 mm. The surface of each $BiVO_4$ particle was very rough, with many nanoparticles on their surfaces (Fig. 3). The UV-vis absorption spectra of $BiVO_4$ were used to determine the band gap of $BiVO_4$ (Fig. 4), using the formula $E_g = 1240/\lambda$, where $\lambda$ is the wavelength that corresponds to the point at which the vertical and horizontal sections of the spectra intersect. The threshold peak of $BiVO_4$ was at 515 nm, corresponding to a band gap of 2.41 eV. After 180 min of reaction, the degrees of RR2 decolorization by $BiVO_4$ adsorption, Vis./$BiVO_4$ and UV/$BiVO_4$ were 10%, 46% and 85%, respectively (Fig. 5). The rate of RR2 photodegradation by $BiVO_4$ followed a pseudo-first-order kinetic model, and the rate constant in Vis./$BiVO_4$ and UV/$BiVO_4$ were 0.0025 and 0.0096 $min^{-1}$, respectively.

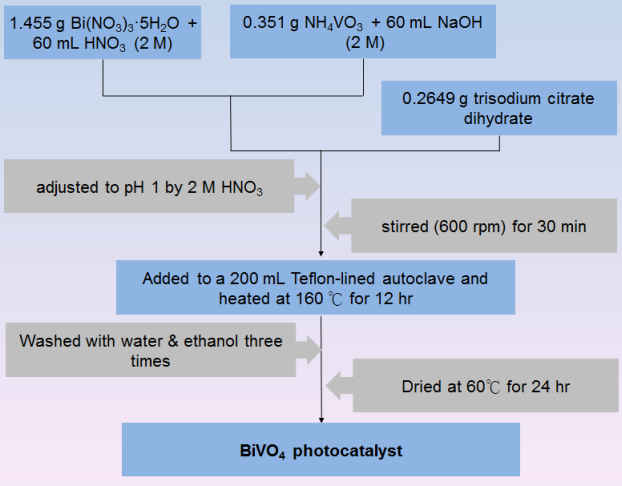



Fig. 1 Procedures of $BiVO_4$ preparation

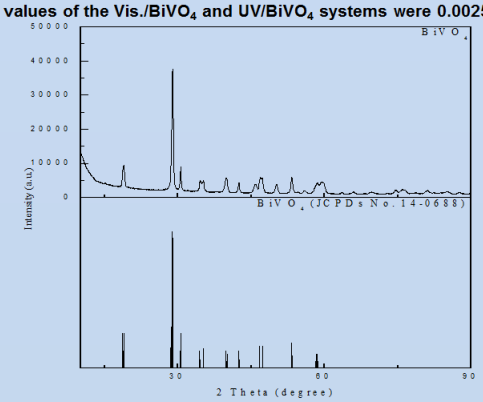



Fig. 2 XRD patterns of $BiVO_4$


Fig. 3 SEM image of $BiVO_4$

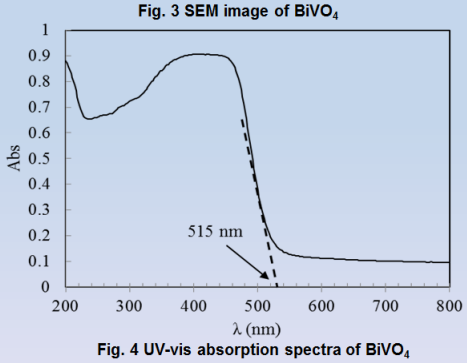



Fig. 4 UV-vis absorption spectra of $BiVO_4$

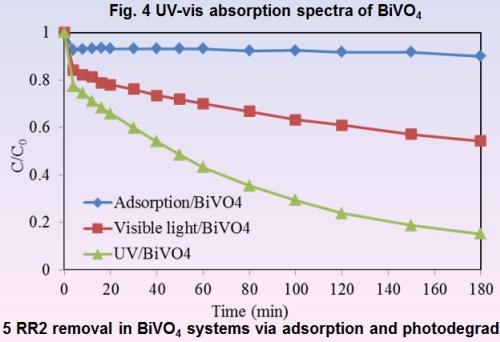



Fig. 5 RR2 removal in $BiVO_4$ systems via adsorption and photodegradation