出國報告（出國類別：出國參加學術研討會）

赴日本京都大學出席第二屆國際光催化與太陽能研討會：物質與奈米材料發展

(The Second International Conference on Photocatalysis and Solar Energy Conversion: Development of Materials and Nanomaterials)

服務機關：國立高雄第一科技大學
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派赴國家：日本 (京都市)
出國期間：民國 102 年 7 月 8 日~102 年 7 月 12 日
報告日期：102 年 7 月 18 日

摘　要

本人於 2013 年 7 月 8-12 日期間，赴日本京都「京都大學」，出席「第二屆國際光催化與太陽能研討會」，於會議中除了發表學術研究論文外，並與世界各地學術單位，專精於光觸媒議題研究的學者專家，進行學術交流，本報告彙整參加會議的經過與感想。此項會議係由加拿大氧化與還原學會主辦，日本京都大學等學術單位協辦，特別針對半導體光觸媒材料應用，所召開的研討會。對於二氧化鈦等半導體光觸媒材料之應用領域，所探討的核心主題主要有三，分別是污染物處理、氫能等潔淨能源開發、太陽光能的應用與材料發展等。基於此，此次會議深入探討的議題則包括：光催化反應基本原理探討、自然與人工光合作用、光催化有機物合成技術、光催化分解與太陽光能轉化材料開發、光敏太陽能電池染料與半導體材料研發、水裂解產氫、以及光伏特效應等先進研究議題。本人在此會議中，共發表了二篇論文，除了進行論文發表外，同時也與全世界相關之學術單位及學者，進行了廣泛地學術交流，對於國際間在半導體光觸媒方面的研究現況及未來發展，皆有深一層的認識與瞭解，獲益頗多。

目　次

報告本文

一、目的

本人於 2013 年 7 月 8-12 日期間，赴日本京都大學，出席由加拿大氧化與還原學會主辦、日本京都大學協辦的「第二屆國際光催化與太陽能研討會(The Second International Conference on Photocatalysis and Solar Energy Conversion: Development of Materials and Nanomaterials, PASEC-2)」，發表學術研究論文。此項會議係以二氧化鈦等半導體光觸媒為研究主題的學術性研討會，分別以污染物處理、氫能等潔淨能源開發、太陽光能的應用與材料發展等三大核心主題為研討的重點。與會期間，除了發表學術研究論文外，並與世界各地專精於研究議題的學術單位進行學術交流，獲益頗多。此外，此次會議特別深入探討的主題主要包括：光催化反應基本反應原理、人工光合作用系統、光催化有機物合成技術、光觸媒與太陽光能轉化材料、光敏太陽能電池染料與半導體材料、水裂解產氫、以及光伏特效應等先進研究議題。

本人在此會議中，共發表了二篇論文，論文題目分別是：“Photoelectrocatalysis of sulfadiazine by carbon-doped TiO_2/ITO composite thin-film photocatalysts irradiated with visible light” 和 “Photodegradation of BPA by hybrid nanocatalysts of CNT/TiO_2 under UV light source”。此次會議參與會議學者專家共約有 150 人，皆屬於與光觸媒材料和技術專門研究領域的研究學者，台灣地區與會的人士，包括學生共約有 6-8 位學者專家參與此項會議，相對於台灣目前有眾多學者也進行光觸媒或太陽能材料技術之研究，國內參加此會議之人數並不多。本人於此會議中，除了進行論文發表外，同時也與會的國際學者專家，進行了廣泛地學術交流。

整體而言，出席本次會議，獲致不錯的成果，除了與相關研究專業的學者進行學術交流外，也藉由研究成果發表的機會，瞭解彼此的研究領域專長重點，提供做為未來建立合作關係的管道機會。另外，此次會議中也特別邀請了 Akira Fujishima、C. Minero、Hiroshi Imahori、Michael R. Hoffmann 等在日本、歐洲、美國地區，專精於光觸媒技術或太陽能電池材料研發的重量級學者，發表專題演講，提供他們在光觸媒研究上的豐富

經驗與成果，同時也提示了一些未來研發重點方向。事實上，在日本東京大學任教的 Fujishima 教授即是相關於二氧化鈦研究的初始研究學者，其於 1970 年代在 Nature 期刊所發表的論文，已累積超過 6200 多次的引用次數；另外，於美國任教的 Hoffmann 教授則特別專精於將光觸媒技術應用於污染物的去除。因此，參與此研討會，對於國際間相關研究主題的發展情形，也有深一層的認知，收穫頗多。

二、出席會議過程說明

本人於 2013 年 7 月 8-12 日期間赴日本京都大學，出席第二屆國際光催化與太陽能研討會，發表學術研究論文。包括路程時間，出國參加會議的時間為年 2013 年 7 月 7-15 日期間，主要會議時間在 7 月 8-12 日，共計五天，其餘時間為路程或參訪行程。茲將詳細的會議行程經過，說明如下：

- 7 月 7 日下午飛機，從桃園國際機場出發，約 4 小時，先抵達大阪市，再經由日本鐵路接駁，到達京都市，晚上住宿，並預備於隔日起參與此項會議。
- 7 月 8~12 日為主要會議期間，會議的主要議程如附件一，本人與其他共同作者於此會議中，共發表兩篇研究論文，論文題目分別是：
    1. Photoelectrocatalysis of sulfadiazine by carbon-doped TiO_2/ITO composite thin-film photocatalysts irradiated with visible light
    2. Photodegradation of BPA by hybrid nanocatalysts of CNT/TiO_2 under UV light source

    相關之論文摘要，則如件二
- 7 月 13-15 日，則為日本參訪及回程，於 7 月 15 日晚間 9 點左右，回到高雄。

本人在此會議中所發表的論文主要重點在於光電催化技術(photoelectrocatalytic technology)多開發與應用，光電催化分解技術係一項從光催化(photocatalytic, PC)反應程序改良而來。事實上，光催化反應程序為近年來積極開發的新興技術，尤其是在結合奈米材料科學蓬勃發展下，使得此項程序的發展，更受到普遍的重視，同時也被視為一項綠色節能科技。

典型的光催化程序常以半導體氧化物為光觸媒，他們在適當光源的照射下，可產生系列的電子傳遞反應，亦即進行所謂的氧化還原反應。由於當光觸媒吸收適當的光能量時，其價電帶(valance band)上的電子，被提昇至導電帶(conduction band)，所形成的電子-電洞對(electron-hole pair)可快速地進行電子傳遞反應，這些電子傳遞反應，可能包括光觸媒半導體上的電洞端，與水分子反應生成氫氧自由基，以及其電子端與氧氣反應生成超氧自由基等反應。但由於大多數的電子-電洞對，與外界物質反應前，即進行了再結合反應(recombine reaction)，使得大多數光觸媒的量子效率並不高。因此，就高效能光催化反應程序的研發而言，其最好可將上述"光生電子"或"光生電洞"，更有效率地轉移給觸媒周遭的外界物質，或從外界獲得電子得補充，其對於整體光催化反應速率的提昇，才較具有明顯的助益。

基於此，本研究旨在以二氧化鈦(TiO_2)薄膜電極為光觸媒，嘗試利用外加電動勢的方式，引導出光生電子，藉以延緩光觸媒之電子與電洞再結合速率，期能加速液相光催化氧化反應的進行，並藉以研發液相光電催化分解反應系統(liquid-phase photo-electrocatalytic reaction processes)。本研究以磺胺嘧啶(sulfadiazine, SDZ)為目標污染物，進行外加電動勢下的光催化分解反應，磺胺嘧啶為一常見的抗生素用藥，本質上較不易被微生物所分解，故本研究嘗試應用光催化氧化高級氧化技術來去除之。本研究中特別探討外加電壓條件，對光觸媒活性之影響，同時也藉由不同電壓下氫氧自由基生成濃度的定量，分析比較兩者的關係，藉以深入探討相關的反應機制。

三、參訪心得與建議

本次赴日本進行研究論文發表與學術交流，期間除了和與會的專家學者交流彼此的研究經驗外，同時利用彼此交流的機會，與國際間致力於半導體氧化物應用的研究團隊，進行交流，藉以瞭解國際間對於此相關議題的最新研究趨勢方向。本人覺得此研究方向，仍值得大力的推廣，應可投入更多的研究資源。事實上，針對光催化反應程序的研究，本研究團隊已進行多年的探討，其對於光催化反應相關程序的研發、新型奈米光

觸媒材料製備技術的建置、有機污染物光催化反應分解路徑的解析、以及異相反應間輸送現象的模擬等方面，皆曾進行相關的研究，對於光催化反應的理論與機制，也曾進行深入的探討與分析。這些研究方向，也都與國際間的研究趨勢一致。

事實上，就光催化反應程序而言，其受到普遍的重視，為近二、三十年的事，但其發展相當快速。個人深感光催化反應技術能否持續發展的關鍵，除了需要繼續研發出更具活性的光觸媒之外，另一個關鍵之處，即在於需要將光觸媒改造成可直接以太陽光為光源的催化劑，才可能符合兼具永續環境與節能循環的理念。也基於此理念，本人在近年的研究中，除了持續新型光觸媒材料之開發外，更致力於將所製備可在可見光下進行反應的光觸媒。也基於此研發理念，乃積極地結合不同專長領域學者的研發能量，執行跨領域研究的團隊合作，希望能合作研發出新材質的觸媒或新的反應程序。事實上，本人在跨領域研究專長的結合方面，已初具成效，現已成功地結合環境保護、機械材料鍛鑄、光電材料科技、奈米材料製備、以及化工程序控制等專業領域的研發人才。

其次，雖然半導體氧化物光觸媒材料的應用性相當廣泛，但積極解決環境污染的問題，仍是本人相關研究最主要的研發目標，希望能將相關技術應用於污染防治的工作，更期望能夠將光催化程序發展成一低耗能的潔淨技術。因此，在基於建置永續循環環境的研發理念下，已將研究的觸角延伸至「新興污染物」之去除與「潔淨氫能源」之生成，也都是值得投入更多研究能量的研究議體。整體而言，針對光催化反應程序與新型半導體光觸媒的研發，個人認為有至少有下列的研究議題，值得投入更多的研發能量：

- 建立包含污染防治、材料科學、光電化學等跨領域團隊之合作機制及研發能量。
- 應用多種半導體材料薄膜製備技術，製備出物性與化性皆理想的薄膜型態光觸媒，並研發可吸收可見光光源的奈米光觸媒材料。
- 應用光催化反應技術於污染防治和潔淨新能源生成。
- 開發與模擬不同種型態的光催化反應器，以符合實際應用的需求。
- 建立完整的觸媒活性測模式，並建構半導體材料之表面特性分析方法。
- 建立觸媒表面自由基生成之檢測技術，資以作為探討光催化反應特性與機制之基礎。

整體而言，本人出席此次會議，獲致不錯的成果，也獲益良多。尤其是，此項會議結合多項研究領域，針對此一核心研究主體，發表其最新的研究成果，對於所有的與會人士，獲益也相當豐碩，應可以鼓勵更多的國內研究學者，參與此項國際會議。

附錄資料一：會議議程

The Second International Conference on

Photocatalysis and Solar Energy Conversion: Development of Materials and Nanomaterials (PASEC-2)

FINAL PROGRAM

Kyoto University, Japan
July 8-12, 2013

Conference Correspondence

Hussain Al-Ekabi, Ph.D.
President, Redox Technologies, Inc.,
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Plenary Lecture – 45 min
Invited Lecture – 25 min
Short Talk – 15 min

Tuesday, July 9, 2013

9:00 – 9:30am **Registration**

9:30 – 9:35am **Opening Remark**

Session 1: Photocatalysis - Fundamental Studies - I

9:30 – 9:55am **Opening of Photocatalysis International Research Center and its New Direction**
Akira Fujishima
Tokyo University of Science, Japan

9:55 – 10:20am **Investigation of Slurry and Gas/Solid Activity of Different TiO_2 Specimens**
C. Minero [1], A. Bedini [2], M. Minella [1,*]
[1]University of Torino, Italy
[2]Rodswood Italia S.p.a., Torino Italy

10:20 – 10:45am **Synergy Effect of Metal, Nitrogen Co-Modification of TiO_2 Photocatalyst**
D. Dolat [1], M. Janczarek [1], S. Mozia [1], H. Ohtani [2], A. W. Morawski [1]
[1]West Pomeranian University of Technology, Poland
[2]Hokkaido University, Japan

10:45 – 11:00am **Coffee Break**

11:00 – 11:25am **Coupling of Semiconductors for Efficient Photocatalytic Oxidation Reaction under Visible Light**
Sher Bahadur Kawal, Sandipan Bera, Kark Jin Kim, Seon Mi Yoo and Wan In Lee
Inha University, Korea

11:25 – 11:50am **Photocatalytic and Photochemical Decomposition of Perfluorooctanoic Acid (PFOA) and Perfluorooctane sulfonate (PFOS)**
Jiuyuan Zhang*, Ling Jin, Yian Shao, Zhenxin Li, Xiaoyun Li
Tsinghua University, Beijing, China

11:50am – 12:15pm **All-Oxide Photovoltaics: A Combinatorial Material Science Study**
Arie Zaban
Bar Ilan University, Israel

12:15 – 1:30pm **Lunch**

Session II: Natural and Artificial Photosynthesis

1:30 – 2:15pm **Structure and Function of $Mn_4CaO_5(H_2O)_4$ Cluster in Oxygen-Evolving Photosystem II**
Nobuo Kamiya
Osaka City University, Japan

2:15 – 2:40pm **Proton-Coupled Electron Transfer in Photosystem II**
Hiroshi Ishikita
Kyoto University, Japan

2:40 – 3:10pm **Photocatalysis and Artificial Photosynthesis, and Computational Modeling and Simulation**
Shozo Yanagida
Osaka University / University of Tokyo, Japan

3:10 – 3:30pm **Coffee Break**

3:30 – 3:55pm **From Natural to Artificial Photosynthesis- Chemistry for the Formation of Hydrogen from Solar Energy and Water**
Stenbjörn Styring and Anders Thapper
Uppsala University, Sweden

3:55 – 4:20pm **Solar CO_2 Reduction Conjugated with H_2O Oxidation Utilizing Semiconductor/Metal-Complex Hybrid Photocatalysts**
Takeshi Morikawa
Toyota Central R&D Labs., Inc., Japan

Session III: Photocatalysis in Organic Synthesis

4:20 – 4:45pm **"Novel Photocatalytic Organic Synthesis: Cyclization and N-Alkylation of Nitroaromatic Compounds"**
Anser Rakkil and Detlef Bahnemann
Leibniz Universitaet Hannover, Hannover, Germany

4:45 – 5:10pm **Photocatalytic Selective Organic Syntheses with Structured Titania and Non-titania Photocatalysts**
Ryuhei Ohtani
Hokkaido University, Japan

5:10 – 5:35pm **One-Pot Synthesis of Imino, Imidazole, and Quinoxaline over Semiconductor Photocatalyst**
Tetsuya Shishido[1,2], Yoshiro Ohno,[1] Kentaro Teramura,[1,2,3] Tsunehiro Tanaka[1,2]
[1]Department of Molecular Engineering, Kyoto University, Japan
[2]Elements Strategy Initiative for Catalysts & Batteries, Kyoto University, Japan
[3]Precursory Research for Embryonic Science and Technology (PRESTO), Japan

Wednesday, July 10, 2013

Session IV: Development of Materials and Nanomaterials for Photocatalysis and Solar Energy Conversion - I

9:00 – 9:45am **Tailoring Organic Materials for Solar Energy Conversion**
Hiroshi Imahori
Kyoto University, Japan

9:45 – 10:10am **Availability of Materials for the Global Energy Problem**
Peter C. K. Vesborg
Technical University of Denmark (DTU), Denmark

10:10 – 10:30am **Coffee Break**

10:30 – 10:55am **Design of Nanostructured Thin Film Photocatalysts with Enhanced Photofunctional Properties**
Takeshi Kawanishi[1,2] and Hitoshi Yamashita[1,2]
[1]Osaka University, Japan
[2]Kyoto University, Japan

10:55 – 11:20am **Development of Nanocarbon Materials for Solar Energy Conversion**
Yasuyuki Yamamoto[1,2]
[1]Kyoto University, Japan
[2]PRESTO, Japan Science and Technology Agency, Japan

11:20 – 11:45am **Charge Carrier Generation and Recombination in Bare and Dye-Sensitized TiO_2 Nanoparticles**
Ryuzi Katoh
Nihon University, Japan

11:45am – 12:10pm **Photocatalytic Activity of Low Dimensional Metal Co-Catalysts in Sub-Nanometer Size Range**
Alexander Orlov, Shen Zhao, Peichuan Shen, Yan Li and Dong Su
Stony Brook University, NY, USA

12:10 – 12:35pm **Carbon-Catalyzed Solar Hydrogen Production**
Kyusseong Park
Kyunggook National University, Korea

12:35 – 1:45pm **Lunch**

Session V: Dye and Semiconductor-sensitized Solar Cells

1:45 – 2:10pm **Present Status Future Prospects of Solar Cell R&D in Japan**
Masafumi Yamaguchi
Toyota Technological Institute, Japan

2:10 – 2:35pm **Lateral Charge Transport between Dye Molecules: Surface Hole Hopping at the Interface in Dye Sensitized Solar Cells**
Piers R. F. Barnes*, Davide Mola[1], Valerie Valander[1], Yanling Pang[1], Xiaoe Li[1], Brian C. O'Regan[2] and Jenny Nelson[1]
[1] Department of Physics, Imperial College London, United Kingdom
[2] Department of Chemistry, Imperial College London, United Kingdom

2:35 – 3:00pm **Dispersion Force as a Factor Controlling Charge Recombination Kinetics in Dye-sensitized Solar Cells**
Shogo Mori
Shinshu University, Japan

3:00 – 3:25pm **Transparent Conductive Oxide-Less Dye-Sensitized Solar Cells**
Jun Usagawa, Shyam S. Pandey, Yabel Ogomi, and Shuzi Hayase
Kyushu Institute of Technology, Japan

3:25 – 3:40pm **Coffee Break**

3:40 – 4:05pm **Advanced Materials and Process for Next Generation Dye-Sensitized Solar Cells**
Kyun Suk Jung
Sungkyunkwan University, Korea

4:05 – 4:30pm **Organic Semiconductors for Highly Efficient Dye-Sensitized Solar Cells**
Kang Duk Seo, Min Soo Kang, In Tack Choi, Sung Ho Kang, Sang Kyun Sung, Yeon Wook Kim, Myung Jong Ju and Hwan Kyu Kim*
Korea University, Korea

4:30 – 4:55pm **Highly Efficient Semiconductor-Sensitized Solar Cells**
Yuh-Lang Lee
National Cheng Kung University, Taiwan

4:55 – 5:20pm **Dye-sensitized Solar Cells from Fundamental Research to Application**
Tingli Ma*[1,2], Yantao Shi[1], Liang Wang[1], Huawei Zhou[1], Jiahao Guo[1]
[1]Dalian University of Technology, China
[2]Kyushu Institute of Technology, Japan

5:20 – 5:45pm **A Potential Strategy to Improve the Energy Conversion Efficiency of DSSCs**
Yan Feng, Shuhuai Huang, Meng Qi, Mingcai Fan
Nanjing University, Nanjing, P.R. China

Thursday, July 11, 2013

Session VI: Hydrogen Production

9:00 – 9:25am — **H_2 Production Using Multi-Composite Semiconductor Photoelectrodes**
Kazuhiro Sayama
National Institute of Advanced Industrial Science and Technology (AIST), Japan

9:25 – 9:50am — **Visible Light Responsive Photocatalysts for Solar Hydrogen Production**
Ryu Abe
Kyoto University, Kyoto, Japan

9:50– 10:15am — **Photoelectrochemical Overall Water Splitting Using Modified Cu-Based Chalcopyrite Thin Films**
Shigeru Ikeda
Osaka University, Japan

10:15 – 10:30am — **Coffee Break**

10:30 – 10:55am — **Photocatalysis of Pollutant Degradation and H_2 Production over TiO_2 Particles**
Debabrata Chatterjee
CSIR-Central Mechanical Engineering Research Institute, India

Session VII: Photovoltaics

10:55am – 11:20am — **Future Prospects of Electrochemical Photovoltaics**
Hiroshi Segawa
RCAST, The University of Tokyo, Japan

11:20 – 11:45am — **Development of a Self-Contained, PV-Powered Domestic Toilet and Wastewater Treatment System**
Michael R. Hoffmann
California Institute of Technology, USA

11:45am – 12:10pm — **Quantum-Dot-Sensitized Solar Cells: Effect of Nanostructured TiO_2 Morphologies on Photovoltaic Properties**
Taro Toyoda[1,2] and Qing Shen[1,2]
[1]The University of Electro-Communications, Japan
[2]JST CREST, Japan Science and Technology Agency (JST), Japan

12:10 – 1:30pm — **Lunch**

1:30 – 1:55pm — **Solution-Printable Solid-State Sensitized Solar Cells toward Next Generation Organic Photovoltaics**
Tsutomu Miyasaka
Toin University of Yokohama, Japan

1:55 – 2:20pm — **Novel Strategy for Highly Efficient Zn_2SnO_4 (Zinc Stannate) Based Light Harvesting Device**
Dongho Kim
Yonsei University, Korea

2:20 – 3:30pm — **Poster Session/Reception**

3:30 – 7:30pm — **Free Time**

7:30 – 9:30pm — **Banquet Dinner**

Friday, July 12, 2013

Session VIII: Development of Materials and Nanomaterials for Photocatalysis and Solar Energy Conversion - II

9:00 – 9:25am — **Plasmon-Enhanced Photocatalytic Activities of Visible-Light-Responsive ZnS-AgInS$_2$ Solid Solution Nanoparticles**
Toshiya Tachisuka[1], Takuya Takahashi[2], Akihiko Kudo[3], Tsutomu Kawabata[4,*] and Tatsuya Kameyama[1,*]
[1]Nagoya University, Japan
[2]Tokyo University of Science, Japan
[3]Osaka University, Japan
[4]Japan Science and Technology Agency, CREST, Japan

9:25 – 9:50am — **Preparation of Organic-Inorganic Porous Materials and Their Photocatalytic Activities**
Masaya Matsuoka[1,*], Takashi Toyao[1], Yu Horiuchi[1], Masatoshi Iwata[2] and Hideyuki Higashimura[2]
[1]Osaka Prefecture University, Japan
[2]Sumitomo Chemical Co., Ltd., Japan

9:50 – 10:15am — **Enhancement of Charge Transfer with Facet-controled Anatase Nanoporous TiO_2 in Dye-sensitized Solar Cells**
Masato M. Maitani, Eiji Wada
Tokyo Institute of Technology, Japan

10:15 – 10:30am — **Coffee Break**

10:30 – 10:55am — **Dye-sensitized Solar Cell with Anionic Nano-clay Electrolyte**
S. Ichikawa[1], T. Kubo[2] and H. Segawa[2]
[1]Komaba Organization for Educational Excellence College of Arts and Sciences (KOMEX), The University of Tokyo, Japan
[2]Research Center for Advanced Science and Technology (RCAST), The University of Tokyo, Japan

10:55 – 11:20am — **Effect of Nanomaterials' Properties on Transport and Recombination in the Dye-Sensitized Solar Cell**
Gecko Oskam[1], Juan Antonio Anta[2]
[1]CINVESTAV-IPN, Mérida, México
[2]Universidad Pablo de Olavide, Spain

11:20 – 11:45am — **Photonic Properties of Nanostructured Photocatalysts**
Mariano Curti, Alfonso Pepe, María Alejandra Grela, and Cecilia B. Mendive*
National University of Mar del, Argentina

11:45 – 12:00noon — **Effects of Temperature and Composition of Electrolyte on the Fabrication of TiO_2 Nanotube Prepared by Anodic Oxidation**
Bruno Su, Pei-Yu Lin and Wei-Ming Hou
National Taiwan University of Science and Technology, Taiwan

12:00noon – 12:15pm — **A Coordination Chemistry Approach for Shape Controlled Synthesis of Hematite Nanostructures and Their Photoelectrochemical Properties**
Pritesh V. Shinde and Sung-Hwan Han*
Hanyang University, Korea

12:15 – 1:30pm — **Lunch**

1:30 – 1:45pm — **Solvothermal Synthesis of (001) Faceted TiO_2 Submicron-sized Single Crystal Photocatalyst and Its Application for the Photocatalytic Decomposition of Gaseous Styrene**
Jiangyao Chen[1], Guiying Li[1], Xin Nie[1,2], Zhigui Su[1,2], Taicheng An[1,*]
[1]Guangzhou Institute of Geochemistry, Guangzhou, China
[2]University of Chinese Academy of Sciences, Beijing, China

1:45 – 2:00pm — **Nanofiber Titanium Dioxide Photoanodes for Dye-Sensitized Solar Cells**
Hana Krysova[1], Jana Trckova-Barakova[2], Michael Grätzel[3], Ladislav Kavan[1,*]
[1]J. Heyrovsky Institute of Physical Chemistry, Czech Republic
[2]Elmarco s.r.o., Liberec, Czech Republic
[3]EPFL, Lausanne, Switzerland

Session IV: Photocatalysis: Fundamental Studies - II

2:00 – 2:25pm **Photo-Induced Electron Transfer between a Reactant Molecule and Semiconductor Photocatalyst: In Situ Doping**
Yasuhiko Tanaka, Tetsuya Shishido, Kentaro Teramura
Kyoto University, Japan

2:25 – 2:50pm **Red photocatalysts**
Gang Liu*, Hui-Ming Cheng
Institute of Metal Research, Chinese Academy of Sciences, China

2:50 – 3:15pm **Charge Transport Characteristics of Graphene-Based Photocatalyst Composites: From Sensitization to Interfacial Charge Transfer**
Wey Yang Teoh
City University of Hong Kong, Hong Kong SAR

3:15 – 3:30pm **Coffee Break**

3:30 – 3:55pm **Surface Local Structure Dependence of Photooxidation Reaction of Water and its Competitive Side Reactions on TiO_2 Single Crystal Electrode**
Akihito Imanishi[a,b], Yoshinori Sakao[a], Atsushi Tsuji[a], Ken-ichi Fukui[b]
[a]Osaka University, Japan; [b]Hokkaido University, Japan

3:55 – 4:20pm **Properties of TiO_2 Photocatalysts Activated by HF Treatment**
K. Yagi, J. M. Arriola-Aguilar, Y. Harada, S. Ikeda, and M. Matsumura
Osaka University, Japan

4:20 – 4 :25pm **Photocatalytic Activity of Porous Chromium-Ion-Doped TiO_2 Photocatalyst under Visible Light Irradiation**
A. Yamazaki, Y. Fujiwara, and K. Adachi
Yamaguchi University, Japan

4:25 – 4:50pm **Combined Use of Recycled Glass and TiO_2 in Architectural Mortar for Enhancing Air-Purifying Properties**
Anibal Maury-Ramirez, Ming Zhi Guo, Tu Wing Kei, Chi Sun Poon
The Hong Kong Polytechnic University, Hong Kong

4:50 – 5:05pm **Visible Light-responsive Rhodium-modified Titania Photocatalysts: On the Controlling of Type of Modification, Mechanisms and Activity by Rhodium Concentration and Preparation Conditions**
Joanna Kurczewska[1,2] and Ryosho Ohtani[1]
[1]Hokkaido University, Japan; [2]Jagiellonian University, Poland

5:05 – 5:15pm **Concluding Remarks**

POSTERS

Photodegradation of IPA by hybrid nanocatalysts of CNT /TiO_2 under UV light source
C. Hung[1], R. C. Chuen[1], C. H. Hung[2]
[1]National University of Kaohsiung, Taiwan
[2]National Kaohsiung First University of Science and Technology, Taiwan

Role of Sacrificial Donors and Excited State Redox Properties of Dyes in Needle-Shaped Dye-Sensitized Solar Cells
Xiaoli Cai*, Mingxuan Sun
Fudan University, Shanghai, China

High Efficiency Zn_2SnO_4 Dye-Sensitized Solar Cells: Interfacial Engineering and Study of Electron Dynamics
Jhonsik Kwon and Dongho Kim*
Yonsei University, Seoul, Korea

Photoelectrocatalysis of Sulfadiazine by Carbon-doped TiO_2/ITO Composite Thin-film Photocatalysts Irradiated with Visible Light
Chang-Hsiung Hung[a,c], Y.-M. Lin[a], C. Yuan[b] and K.-R.Wu[a]
[a]National Kaohsiung First University of Science and Technology, Taiwan, R.O.C.
[b]National Kaohsiung University, Taiwan, R.O.C.
[c]National Kaohsiung Marine University, Taiwan, R.O.C.

Photocatalytic CO_2 Reduction for Methanol Formation using M-TiO_2/$CaFe_2O_4$ Composites under Visible-light
Hack Ho Kim, Sher Bahadur Rawal, Snadipan Bera, Seon Mi Yoo, Wan In Lee*
Inha University, Korea

Hydrothermal Synthesis of Nanocrystalline Titania Powder by the Aid of Ionic Liquid
Jana Maszkiková, Barbora Laskova, Hana Krysova and Ladislav Kavan
J. Heyrovsky Institute of Physical Chemistry of the AS CR, Czech Republic

Photocatalytic Activity of NO_x Removal on Mortar Contained Titania Produced from Ti-Salt Flocculated Sludge
Se Min Park[1], Jong Heon Kim[1], Hee-Ju Park[2], Ki Won Lee[2], Kwang Young Lee[2], Ho Kyong Shon[3], Tae Kyoon Kim[4], Phan Seok Kim[4], Jong-Ho Kim[1,4]*
[1] Chonnam National University, Gwangju, Korea
[2]Photo & Environmental Technology Co. Ltd, Gwangju, Korea
[3] University of Technology, Sydney, Australia
[4]Hwasung T&C Co. Ltd., Gyeonggnam, Korea

Photocatalytic-Oxidation of Chitosan's Derivatives and Phenol by Immobilized TiO_2 via Bilayer Assemblage Systems under Visible Light
Ali H. Jawad[a,b]and Mohd Asri Mohd. Nawi[b]
[a]Universiti Teknologi MARA, Malaysia
[b]Universiti Sains Malaysia, Malaysia

Synthesis of Chromium Oxide Nanoparticles in Flame and their Effect on the Efficiency of Solar Cells
A.R. Leshayev, M. Auyelkhankyzy, Z. A. Mansurov
Combustion Problems Institute, Kazakhstan

Solvent Effect on the Performance of Gel-State Dye-Sensitized Solar Cells
Jason Chuan Xu, I-Ping Liu, Ting-Wei Chang, Yuh-Lang Lee*
National Cheng Kung University, Taiwan, Taiwan

Electrochemically-Assisted Fabrication of CdSe-Sensitized Solar Cells
Chien-Wei Chang, I-Ping Liu, Ching-Fa Chi, Yuh-Lang Lee*
National Cheng Kung University, Taiwan, Taiwan

Preparation of High Performance Solid-State Dye-Sensitized Solar Cell by Using P(AN-VAC) Copolymer
Ching-Lun Chen, Ting-Wei Chang, Yuh-Lang Lee
Department of Chemical Engineering, National Cheng Kung University, Taiwan, Taiwan

Semiconductor-Sensitized Solar Cells Based on the Co-sensitization of $CuInS_2$/CdS Prepared by All SILAR Process
I-Ping Liu, Ching-Fa Chi, Chien-Wei Chang, Yuh-Lang Lee*
National Cheng Kung University, Taiwan, R.O.C.

附錄資料二：發表論文摘要

Photoelectrocatalysis of Sulfadiazine by Carbon-doped TiO_2/ITO Composite Thin-film Photocatalysts Irradiated with Visible Light

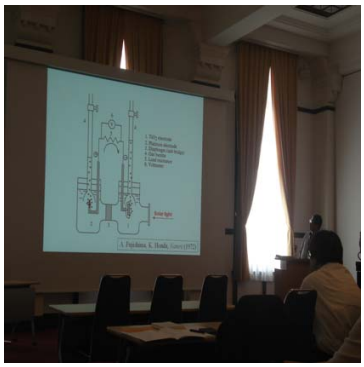
Chung-Hsuang Hung[1,*], Y.-W. Lin[1], C. Yuan[2] and K.-R.Wu [3]

This study aims to develop a photoelectrocatalytic (PEC) oxidation process to remove a typical antibiotic- sulfadiazine (SDZ) under illumination of visible light. SDZ is concerned as an emerging pollutant which has adverse effects on human health for long term exposure. The photoelectrocatalysis of SDZ was conducted in a batch photocatalytic reactor in which the titanium dioxide/indium tin oxide (TiO_2/ITO) composite thin film as its cathode and a Pt wire as its anode under illumination of LED blue light (main λ at 470 nm, irradiated intensity of 12.8 mW/cm^2). A 0.01-M Na_2SO_4 solution worked as the electrolyte for the reaction. For this study, two kinds of TiO_2/ITO composite thin-film photocatalysts, simple TiO_2 (ST-ITO) and carbon-doped TiO_2 (CT-ITO), were prepared by DC magnetron sputtering processes. Both effects of applied electric bias (0~0.8 V) and solution pH levels (3, 7, and 11) on SDZ degradation rate were particularly investigated in the study. Furthermore, based upon the information of hydroxyl radical formation concentrations and flat band potentials of the prepared samples, the photo-assisted degradation mechanisms of SDZ were discussed. For the degradation reaction of SDZ, the experimental results indicated the degradation of SDZ following the first-order reaction kinetics. It is also observed carbon-doped TiO_2 sample achieving higher SDZ degradation rate than the simple TiO_2 sample, which is consisting with the observations of forming Schottky barrier at the TiO_2/ITO interface and more negative flat band potential for CT-ITO. Both effects can promote the separation of photo-generated electron and hole pairs. Similar effects are also observed for the reactions provided with high external bias. The experimental results illustrate SDZ degradation rate proportional to the applied bias, typically. The SDZ degradation rate can be enhanced more than 4.8 folds than the reaction without providing any external bias. It is expected that the provided bias can reduce the recombination rate of photo-generated electron-hole pairs, resulting in more “photo-generated hole” reacting with its surrounding water molecule to form hydroxyl radical that can efficiently oxidize many recalcitrant pollutants. In addition, higher degradation rate was observed in more acid conditions due to more SDZ adsorbed by the probes, which might be due to more absorption of SDZ by the catalysts.

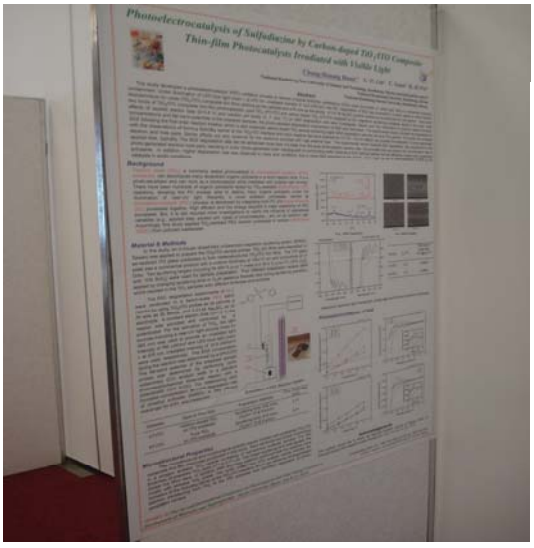
Keywords: sulfadiazine (SDZ); emerging pollutants; photoelectrocatalysis, TiO_2, visible light

附錄資料三：會議照片

(會議開幕情形)



(與會之美國學者專題報告，Akira Fujishima)



(海報發表)