# เอกสารอ้างอิง

[1] [1] L. A. Luck, M. J. Moravan, J. E. Garland, B. S. Sondi, D. Roy, “Chemisorptions of bacterial receptors for hydrophobic amino acids and sugars on gold for biosensor applications: a surface Plasmon resonance study of genetically engineered proteins”, Biosensors and Bioelectronics 19, 249-259 (2003)

[2] M. Losurdo, M. M. Giangregorio, G. V. Bianco, A. Sacchetti, P. Capezzuto, G. Bruno, “Enhanced absorption in Au nanoparitcles/a-Si:H/c-Si heterojunction solar cells exploiting Au surface Plasmon resonance”, Solar Energy Materials & Solar Cells 93, 1749-1754 (2009)

[3] L. A. Lyon, M. D. Musick, P. C. Smith, B. D. Reiss, D. J. Peña, M. J. Natan, “Surface Plasmon resonance of colloidal Au-modified gold films”, Sensor and Actuators B 54, 118-124 (1999)

[4] W.G. Xu, S.F. Liu, S.X. Lu, S.Y. Kang, Y. Zhou, H.F. Zhang, “Photocatalytic degradation in aqueous solution using quantum-sized ZnO particles supported on sepiolite”, Journal of Colloid and Interface Science 351, 210–216 (2010)

[5] I. Fatimah, S. Wang, D. Wulandari, “ZnO/montmorillonite for photocatalytic and photochemical degradation of methylene blue”, Applied Clay Science 53, 553–560 (2011)

[6] T. Ganesh, J. H. Kim, S. J. Yoon, B-H Kil, N.N. Maldar, J. W. Han, S-H Han, “Photoactive curcumin-derived dyes with surface anchoring moieties used in ZnO nanoparticle-based dye-sensitized solar cells”, Materials Chemistry and Physics 123, 62–66 (2010)

[7] A. E. Suliman, Y. Tang, L. Xu, “Preparation of ZnO nanoparticles and nanosheets and their application to dye-sensitized solar cells”, Solar Energy Materials & Solar Cells 91, 1658–1662 (2007)

[8] S. R. Ferreira, R. J. Davis, Y-J Lee , P. Lu, J. W.P. Hsu, “Effect of device architecture on hybrid zinc oxide nanoparticle:poly (3-hexylthiophene) blend solar cell performance and stability”, Organic Electronics 12, 1258–1263 (2011)

[9] I. M. Joni, A. Purwanto, F. Iskandar, M. Hazataa, K. Okuyama, “Intense UV-light absorption of ZnO nanoparticles prepared using a pulse combustion-spray pyrolysis method”, Chemical Engineering Journal 155, 433–441 (2009)

[10] N. Han, X. Wu, L. Chai, H. Liu, Y. Chen, “Counterintuitive sensing mechanism of ZnO nanoparticle based gas sensors”, Sensors and Actuators B 150, 230–238 (2010)

[11] J. H. Jun, J. Yun, K. Cho, I-S Hwang, J-H Lee, S. Kim, “Necked ZnO nanoparticle-based $NO_2$ sensors with high and fast response”, Sensors and Actuators B 140, 412–417 (2009)

[12] J. H. Jun, H. Seong, K. Cho, B-M Moon, S. Kim, “Ultraviolet photodetectors based on ZnO nanoparticles”, Ceramics International 35, 2797–2801 (2009)

[13] Y. Li, X. Dong, C. Cheng, X. Zhou, P. Zhang, J. Gao, H. Zhang, “Fabrication of ZnO nanorod array-based photodetector with high sensitivity to ultraviolet”, Physica B 404, 4282–4285 (2009)

[14] S.C. Liao, H.F. Lin, S.W. Hung, C.T. Hu, J. Vac, “Facile synthesis and photocatalytic activity of ZnO-CuO nanocomposite”, Sci. Technol. B, 24, 1332-1335 (2006)

[15] I. Y. Erdogan, “The alloying effects on the structural and optical properties of nanocrystalline copper zinc oxide thin films fabricated by spin coating and annealing method”, Journal of Alloys and Compounds., 502, 445-450 (2010)

[16] M.H. Mamat, M.Z. Sahdan, Z. Khusaimi, A. Zain Ahmed, S. Abdullah, M. Rusop, “Influence of doping concentrations on the aluminum doped zinc oxide thin films properties for ultraviolet photoconductive sensor applications”, Optical Materials, 32, 696-699, (2010)

[17] B. Li, Y. Wang, “Facile synthesis andphotocatalytic activity of ZnO-CuO nanocomposite”, Superlattices and Microstructures, 47, 615-623 (2010)

[18] K.L. Liu, S.L. Yuan, H.N Duan, S.Y. Yin, Z.M. Tian, X.F. Zheng, S.X. Huo, C.H. Wang, "A comparative study on the magnetic properties of Fe-doped CuO nanopowders prepared by sol-gel and co-precipitation method", Material Letters, 64, 192-194 (2010)

[19] F. Meng, J. Yin, Y.Q. Duan, Z.H. Yuan, and L.J. Bie, "Co-precipitation synthesis and gas-sensing properties of ZnO hollow sphere with porous shell", Sensors and Actuators B: Chemical, 156, 703-708, (2011)

[20] L. He, Y. Liu, A. Mustapha, M. Lin, "Antifungal activity of zinc oxide nanoparticles

against *Botrytis cinerea* and *Penicillium expansum"*, Microbiological Research, 166, 207-215, 2011

[21] M. H. Lai, M. W. Lee, Gou-Jen Wang and M. F. Tai. "Photovoltaic Performance of New-Structure ZnO–nanorod DyeSensitized Solar Cells". Int J Electrochem Sc.2011;6:2122–2130.

[22] Sonal Singhal, Japinder Kaur, Tsering Namgyal, Rimi Sharma. "Cu-doped ZnO nanoparticles: Synthesis, structural and electrical properties". Physica B. 2012;407:1223–1226.

# อัตชีวประวัติ

**รศ. ดร. วิษณุ เพชรภา**

Wisanu Pecharapa, Ph.D (Applied Physics)

E-mail: kpewisan@kmitl.ac.th, kpewisan@gmail.com

**ตำแหน่งทางวิชาการ:** รองศาสตราจารย์ ระดับ 9

สถานที่ทำงาน: วิทยาลัยนาโนเทคโนโลยีพระจอมเกล้าลาดกระบัง

สถาบันเทคโนโลยีพระจอมเกล้าเจ้าคุณทหารลาดกระบัง

ถนนฉลองกรุง แขวงลำปลาทิว เขตลาดกระบัง กรุงเทพฯ 10520

โทรศัพท์ 023298000 ต่อ 3117

**การศึกษา:**

| <u>คุณวุฒิ</u> | <u>ปี พ.ศ. ที่จบ</u> | <u>ชื่อสถานศึกษาและประเทศ</u> |
|---|---|---|
| วท. บ. (ฟิสิกส์ เกียรตินิยม) | 2535 | มหาวิทยาลัยเชียงใหม่ ประเทศไทย |
| M.Sc. ( Physics ) | 2540 | University of Central Florida, USA |
| ปร.ด. (ฟิสิกส์ประยุกต์) | 2550 | สถาบันเทคโนโลยีพระจอมเกล้า-เจ้าคุณทหารลาดกระบัง |

**ประวัติการรับราชการ**

| | |
|---|---|
| ได้รับแต่งตั้งให้ดำรงตำแหน่งอาจารย์ | เมื่อวันที่ 19 พฤษภาคม พ.ศ. 2536 |
| ได้รับแต่งตั้งให้ดำรงตำแหน่งผู้ช่วยศาสตราจารย์ | เมื่อวันที่ 24 เมษายน พ.ศ. 2545 |
| ได้รับแต่งตั้งให้ดำรงตำแหน่งรองศาสตราจารย์ | เมื่อวันที่ 31 สิงหาคม พ.ศ. 2548 |

**<u>ทุนและรางวัล</u>**

- พ.ศ. 2531-35 รับทุนโครงการพัฒนาและส่งเสริมผู้มีความสามารถพิเศษทางวิทยาศาสตร์และเทคโนโลยี (พสวท) ของ สสวท ในระดับปริญญาตรี สาขาฟิสิกส์ คณะวิทยาศาสตร์ มหาวิทยาลัยเชียงใหม่
- พ.ศ. 2532 เหรียญผลการเรียนดีเด่น คณะวิทยาศาสตร์ มหาวิทยาลัยเชียงใหม่
- พ.ศ. 2536-40 รับทุนกระทรวงวิทยาศาสตร์และเทคโนโลยี ในระดับปริญญาโท เพื่อศึกษาต่อในต่างประเทศ สาขาฟิสิกส์ Faculty of Art and Science, University of Central Florida, United State of America

**<u>ประสบการณ์การทำงาน:</u>**

- พ.ศ. 2536-52 อาจารย์ประจำ ภาควิชาฟิสิกส์ประยุกต์ คณะวิทยาศาสตร์ สถาบันเทคโนโลยีพระจอมเกล้าเจ้าคุณทหารลาดกระบัง
- พ.ศ. 2542-44 อาจารย์พิเศษ ภาควิชาฟิสิกส์ คณะวิทยาศาสตร์ มหาวิทยาลัยอุบลราชธานี
- พ.ศ. 2546 อาจารย์พิเศษ หลักสูตรปริญญาโท-เอก สาขาวิชาฟิสิกส์ คณะวิทยาศาสตร์ มหาวิทยาลัยมหิดล
- พ.ศ. 2546 อาจารย์พิเศษ หลักสูตรปริญญาโท-เอก สาขาวิชาฟิสิกส์ คณะวิทยาศาสตร์ มหาวิทยาลัยศิลปากร
- พ.ศ. 2552 รักษาการ รองคณบดีฝ่ายวิชาการ คณะวิทยาศาสตร์ สถาบันเทคโนโลยีพระจอมเกล้าเจ้าคุณทหาร ลาดกระบัง
- พ.ศ. 2552 รักษาการผู้อำนวยการสำนักบริหารงานทั่วไป คณะวิทยาศาสตร์ สถาบันเทคโนโลยีพระจอมเกล้าเจ้าคุณทหารลาดกระบัง
- พ.ศ. 2552 รักษาการผู้อำนวยการศูนย์เครื่องมือวิทยาศาสตร์ คณะวิทยาศาสตร์ สถาบันเทคโนโลยีพระจอมเกล้าเจ้าคุณทหารลาดกระบัง
- พ.ศ. 2552-ปัจจุบัน อาจารย์ประจำ สาขานาโนวิทยาและนาโนเทคโนโลยี คณะวิทยาศาสตร์ สถาบันเทคโนโลยีพระจอมเกล้าเจ้าคุณทหารลาดกระบัง

**หัวข้อวิจัยและพัฒนา :**

| ปี | ชื่องานวิจัย | แหล่งทุน |
|---|---|---|
| 2554-2556 | การสังเคราะห์สารประกอบออกไซด์เชิงซ้อนที่มีอนุภาคระดับนาโนเมตรด้วยกระบวนการใช้คลื่นเสียง | สถาบันเทคโนโลยีพระจอมเกล้าเจ้าคุณทหารลาดกระบัง |
| 2553 | เซ็นเซอร์จากวัสดุผสมไฮบริดนาโนสำหรับตรวจสารพิษโลหะหนักในสิ่งแวดล้อม | ศูนย์ความเป็นเลิศทางฟิสิกส์ |
| 2552 | การพัฒนาวัสดุคอมโพสิตของโลหะออกไซด์กับวัสดุโครงสร้างนาโนเพื่อใช้ในงานด้านอิเล็กทรอนิกส์ | ศูนย์ความเป็นเลิศทางฟิสิกส์ |
| 2549-2551 | การพัฒนาระบบการปลูกฟิล์มบางนำไฟฟ้าโปร่งใสและระบบวัดทางแสงเพื่อพิสูจน์เอกลักษณ์สมบัติฟิล์มบาง | สำนักวิจัยนาโนเทคโนโลยีลาดกระบัง |
| 2548-2549 | การพัฒนาระบบต้นแบบลอจิกเกททางแสงโดยใช้ฟิล์มบางสารอินทรีย์ | สจล. |

- **หัวข้องานวิจัยและพัฒนาที่สนใจ:** วัสดุพลังงาน, วัสดุทางแสง นาโนเทคโนโลยี เทคโนโลยีฟิล์มบาง

# ผลงานวิจัย (2005-2012)

## ผลงานวิจัยที่ตีพิมพ์ในวารสารระดับนานาชาติ

1. W. Pecharapa, A. Keawprajak, N. Kayunkid, S. Rahong, W. Yindeesuk, and J. Nukeaw, "Electroreflectance and Photocurrent measurement on ZnSe/Alq3/TPD heterostructure on Si-substrate", *Material Science and Engineering:B*, Vol. 123 (2005), pp. 163-166. (IF: 1.281)

2. W. Pecharapa, P. Potirak and W. Yindeesuk, "Temperature Dependent Photoluminescence of ZnSe/$Alq_3$ Hybrid Heterostructure", *Advanced Materials Research,* Vols. 55-57 (2008), pp. 493-496.

3. C. Saributr, W. Mekprasart, P. Thanomngam, and W. Pecharapa, "Investigation of Structural properties of CuPc/$TiO_2$ Nanocomposites", *Advanced Materials Research*, 93-94 (2010), pp. 687-690.

4. W. Mekprasart, W. Jareonboon, W. Pecharapa, "$TiO_2$/CuPc Hybrid Nanocomposites Prepared by Low-Energy Ball Milling for Dye-Sensitized Solar Cell Application", Material *Science and Engineering: B*, 172 (2010), pp. 231-236. (IF: 1.786)

5. K. Chongsri, S. Boonruang and W. Pecharapa, "N-doped MgZnO alloy thin film prepared by sol-gel method " *Material Letters*, 65 (2011), pp.1842-1845. (IF: 1.94)

6. Prayut Potirak, Chokchai Kahattha and Wisanu Pecharapa, "Microwave-Assisted Synthesis and Characterization of Carbon Nanotube/Zinc Oxide composites", *Journal of Nanoscience and Nanotechnology*, Vol.11,No. 9, (2011) pp. 11195-11199, (IF: 1.352)

7. Wanichaya Mekprasart, Russameeruk Noonuruk, Wirat Jareanboon and Wisanu Pecharapa "Quasi Solid-State Dye-Sensitized Solar Cells based on n-$TiO_2$/p-NiO Core-Shell Nanocomposites", *Journal of Nanoscience and Nanotechnology*, Vol.11, No. 7, (2011) pp. 6483-6489 (IF: 1.352)

8. R. Noonuruk, W. Techitdheera, W. Pecharapa, "Characterization and ozone-induced coloration of $Zn_xNi_{1-x}O$ thin films prepared by sol-gel method", *Thin Solid Films*, 520, (2012), pp. 2769-2775, (IF: 1.909)

9. K. Paipitak, T. Pornpra, P. Mongkontalang, W. Techitdheera and W. Pecharapa, "Characterization of PVA-Chitosan Nanofibers Prepared by Electrospinning", *Procedia Engineering*, 8 (2011), pp. 101-105.

10. R. Noonuruk, N. Wongpisutpaisan, P. Mukdacharoenchai, W. Techitdheera and W. Pecharapa, “Ozone-induced Optical Density Change of NiO Thin Films and Their Applicability as Neutral Optical Density Filter”, *Procedia Engineering*, 8 (2011), pp. 212-216.

11. O. Thanomkiat, C. Kahattha, W. Pecharapa and W. Techitdheera, “Sol-gel based Deposition of $Ti_xV_{1-x}O$ Films for Thermally Controlled Optical Switching Applications”, *Procedia Engineering*, 8, (2011), pp. 232-236.

12. W. Mekprasart and W. Pecharapa, “Synthesis and Characterization of Nitrogen-doped $TiO_2$ and its Photocatalytic Activity Enhancement under Visible Light”, *Energy Procedia*, 9, (2011), pp. 509-514.

13. B. Jandai, P. Woointranont, S. Chaiyasith, W. Pecharapa, “NiO/MWCNTs coated F-doped Tin Oxide Working Electrode for Hydrogen Peroxide Detection”, *Energy Procedia*, 9, (2011), pp. 575-580.

14. K. Paipitak, C. Kahattha, W. Techitdheera, S. Porntheeraphat, W. Pecharapa, “Characterization of Sol-gel Derived Ti-doped Tungsten Oxide Electrochromic Thin Films”, *Energy Procedia*, 9, (2011), pp. 446-451.

15. N. Wongpisutpaisan, P. Charoonsuk, N. Vittayakorn, W. Pecharapa, “Sonochemical Synthesis and Characterization of Copper Oxide Nanoparticles”, *Energy Procedia*, 9, (2011), pp. 404-409.

16. C. Bangbai,’ K. Chongsri, W. Pecharapa, and W. Techidheera, “ Effect of Al and N Doping on Structural and Optical Properties of Sol-gel Derived ZnO Thin Films”, Sains Malaysiana, Accepted and published in December 2012. (IF: 0.268)

17. Narongdet Wongpisutpaisan, Anucha Ruangphanit, Naratip Vittayakorn and Wisanu Pecharapa, “Cu-doped $TiO_2$ nanopowder synthesized by sonochemical-assisted process”, Sains Malaysiana, Accepted, and published in December 2012. (IF: 0.268)

18. W. Mekprasart, N. Vittayakorn and W. Pecharapa, “Ball-milled CuPc/$TiO_2$ hybrid nanocomposite and its photocatalytic degradation of aqueous Rhodamine B”, *Materials Research Bulletin*, 47, Issue 11, (2012), pp. 3114-3119 (IF: 2.105)

19. Athapon Simpraditpan, Thanakorn Wirunmongkol, Sorapong Pavasupree, Wisanu Pecharapa, “Simple hydrothermal preparation of nanofibers from a natural ilmenite mineral”, Ceramics International, Article in press, (IF: 1.751)

20. C. Kahattha, N. Wongpisutpaisan, N. Vittayakorn and W. Pecharapa, “Physical properties of V-doped $TiO_2$ nanoparticles synthesized by sonochemical-assisted process”, Ceramics International, Article in press, (IF: 1.751)

21. Thanit Tangcharoen, Anucha Ruangphanit, Wisanu Pecharapa, “Structural

and magnetic properties of nanocrystalline zinc-doped metal ferrites (metal = Ni; Mn; Cu) prepared by sol-gel combustion method" Ceramics International, Article in press, (IF: 1.751)

22. P. Mukdacharoenchai, W. Mekprasart, J. Sritharathikhun and W. Pecharapa, "Effect of $TiO_2$ compact layer on optical absorption and fluorescence performance of R6G/PMMA composite light-guided films", *Advanced Materials Research*, 528, pp. 245-248, 2012.

23. K. Paipitak, J. Rattanarak, D. Pakdeeyingyong, W. Techitdheera, S. Porntheeraphat and W. Pecharapa, "Enhanced electrochromic performance of sol-gel derived $WO_3$ thin films assisted by electrospun PVA nanofibers", *Advanced Materials Research*, 528, pp. 249-253, 2012.

## ผลงานวิจัยที่ตีพิมพ์ในวารสารระดับชาติ

1. W. Techitheera, P. Thanomngam, W. Pecharapa, and J. Nukeaw, "$Al_{0.3}Ga_{0.7}As$/GaAs single quantum well transition energy calculation",*KMITL SCIENCE JOURNAL*, Vol. 5, No. 1, pp. 445-449, 2005. (TJIF:0.045)

2. W. Pecharapa, A. Keawprajak, N. Kayunkid, S. Rahong, W. Yindeesuk, and J. Nukeaw, "Growth and characterization of novel optoelectronic materials based on II-VI inorganic/organic heterostructures", *ScienceAsia*, Vol. 32 No. 3, pp. 223-229 , 2006. (TJIF:0.058)

3. Chokchai Kahattha and Wisanu Pecharapa, "Effect of Temperature and Time on Etching Rate of Tin Oxide Thin Films", *CMU. J. Nat. Sci.*, Vol.7(1), pp. 7-12, 2007.

(TJIF: 0.019)

4. W. Pecharapa, W. Techitdheera and J. Nukeaw , "Quantum Confined Stark Effect of ErP Islands/InP Heterostructure", *Thai Journal of Physics*, Series 4, pp. 13-15, 2008.

5. Wisanu Pecharapa, Chokchai Kahattha, Papitchaya Woointranont, and Thanawee Chodjarusawand, "A study of acid-treated multiwall carbon nanotubes by electron microscopy and Raman Spectroscopy", *Journal of the Microscopy Society of Thailand,* 24 (2), pp.133-135, 2010.

6. W. Pecharapa, C. Kahattha, W. Techitdeera, “Optical Properties of MgZnO Alloyed Films Characterized by Transmission Spectroscopy”, *Thai Journal of Physics,* Series 5, pp. 393-395, 2010.

7. W. Techitdeera, K. Kulsirirat, W. Pecharapa and B. Tunhoo, “Temperature dependent photoabsorption of Copper Phthalocyanine (CuPc) Organic Semiconductor Thin Film”, *Thai Journal of Physics*, Series 5, pp. 390-392, 2010.

8. P. Potirak , K. Paipitak, P.Woointranont , C. Kahattha , W. Techitdheera , W. Pecharapa, “Effect of irradiation power on physical properties of ZnO/CNT nanocomposites synthesized via microwave-assisted technique”, *Thai Journal of Physics*, Series 6, pp. 341-343, 2010.

9. C. Kahattha and W. Pecharapa, “Physical Properties of Titanium Dioxide/Vanadium Oxide Composites Synthesized by Ball-milling Process”, *Journal of the Microscopy Society of Thailand,* 4 (1), pp. 53-55, 2011.

10. R. Noonuruk, W. Techitdheera, W. Pecharapa, “Study of Structural Properties of NiZnO Thin Films under UV/Ozone Treatment by Atomic Force Microscopy and Fourier Transform Infrared Spectroscopy”, *Journal of the Microscopy Society of Thailand,* 4 (1), pp. 28-31, 2011.

11. P. Woointranont and W. Pecharapa, “Effects of Surface Modification of Carbon Nanotubes on the Deposition of NiO/CNTs Nanocomposites”, *Journal of the Microscopy Society of Thailand,* 4 (2), pp. 116-119, 2011.

12. C. Bangbai, K. Chongsri, W.Pecharapa, W.Techitdheera, “Effect of Nitrogen doping on Structural and Optical Properties of ZnO Thin Films Prepared by Sol-Gel Technique”, *Thai Journal of Physics*, Series 7, pp. 108-110, 2011.

## ผลงานวิชาการอื่น ๆ (เช่น Proceeding ตำรา สิทธิบัตร ฯลฯ) ประชุมวิชาการ

1. K. Suwansukho, W. Pecharapa and J. Nukeaw, 2005, “Preparation of nanoporous silicon by electrochemical etching”, Proceeding of the International Symposium on Nanotechnology in Environmental Protection and Pollution, 2005, January 12-14, 2005, Bangkok.

2. Bunjong Jukgoljun, Wisanu Pecharapa, Wicharn Techitdheera, Prasert Kraisingdecha, Chawarat Siriwong,Chokehai Phuttharansa and Ekachai Chongserrcharoen, “Temperature depent-Photoluminescence of AlGaAs/GaAs Single Quantum Well Grown by

Molecular Beam Epitaxy", Proceeding of KMITL international Conference on science and applied science 2006, p138

3. Chewa Thassana, Wicharn Techitdheera, Wisanu Pecharapa and Jiti Nukeaw, "Growth of NiFeN Thin Films by Reactive Gas Timing RF Magnetron Sputtering", Laos Journal on Applied Science, Vol 1 No.1 2006, p 39-43.

4. Chokchai Kahattha and Wisanu Pecharapa, "Effect of Temperature and Time on Etching Rate of Tin Oxide Thin Films", Proceeding of The first Thailand National Nanotechnology Conference on Nanomaterials, Pharmaceutical, Devices and Applications, 2007, August 14-16 2007, Chiangmai.

5. Chokchai Kahattha and Wisanu Pecharapa, "Photoluminescence of InGaAs/GaAs Multiple Quantum Well Structure Grown by Molecular Beam Epitaxy", Proceeding of International Conference on Engineering, Applied Science and Technology, 2007, November 21-23, 2007, Bangkok.

6. W. Pecharapa, W. Techitheera, P. thanongam and J. Nukeaw, "Temperature-dependent photoluminescence investigation of narrow well-width InGaAs/InP single quantum well", International Workshop and Conference on Photonics and Nanotechnology, 2007, December 16-18, 2007, Pattaya.

7. W. Pecharapa, W. Techitdheera and J. Nukeaw , "Quantum Confined Stark Effect of ErP Islands/InP Heterostructure", Siam Physics Congress 2008, March 20-22, 2008, Khaoyai.

8. W. Pecharapa, P. Potirak and W. Yindeesuk, "Temperature Dependent Photoluminescence of ZnSe/$Alq_3$ Hybrid Heterostructure", SmartMat08 & IWOFM-2, 22-25 April 2008, Chiang Mai, THAILAND

9. W. Pecharapa, W. Techitheera, P. thanongam and J. Nukeaw, "Temperature-dependent photoluminescence investigation of narrow well-width InGaAs/InP single quantum well", Proc. SPIE, Vol. 6793, 667930C, March 2008.

10. W. Pecharapa and W. Mekprasart, "Optical absorption study on $TiO_2$-Nanostructure:CuPC Composite", NCOA 2008, August 2008, Bangkok, THAILAND.

11. C. Kahattha and W. Pecharapa, "Growth of Nanostructure-$TiO_2$ doped tin oxide films", Proceeding of The second Thailand National Nanotechnology Conference, 2008, August 13-15 2008, Phuket, THAILAND.

12. W. Mekprasart and W. Pecharapa, "Photocytalytic Degradation Study of Copper Phthalocyanines by $TiO_2$ Nanostructures", Commemorative International Conference

on Sustainable Development to Save the Earth 2008 (SDSE 2008), December 11-13, Bangkok, Thailand

13. Wisanu Pecharapa, Witoon Yindeesuk and Wicharn Techitdeera, “Determination of the Optical Properties of $Mg_xZn_{1-x}$ O thin films grown by MOCVD”, Proc. of I-SEEC2008, December 15-16, 2008, Nongkai, Thailand.

14. Chokchai Kahattha and Wisanu Pecharapa, ”Preparation and characterization of $SnO_2$ films by sol-gel dip coating technique”, Proc. of I-SEEC2008, December 15-16, 2008, Nongkai, Thailand.

15. Wanichaya Mekprasart and Wisanu Pecharapa, “Preparation of $TiO_2$/CuPc composite for photodegradation applications”, Proc. of I-SEEC2008, December 15-16, 2008, Nongkai, Thailand.

16. K.Kulsirirat, W. Pecharapa and W. Techitdheera, “Theoretical study on the influence of thermal expansion on transition energy of GaAs/AlGaAs single quantum well”, Proc. of I-SEEC2008, December 15-16, 2008, Nongkai, Thailand.

17. W. Pecharapa, C. Kahattha, and W. Techitdeera, “Optical properties of MgZnO alloyed films characterized by transmission spectroscopy”, Siam Physics Congress 2009, March 19-21, 2009, Cha-Am.

18. W. Techitdheera, K. Kulsirirat, W. Pecharapa, and B. Tunhoo, “Temperature dependent photoabsorption of Copper Phtahlocyanine(CuPc) organic semiconductor thin film”, Siam Physics Congress 2009, March 19-21, 2009, Cha-Am.

19. W. Mekprasart and W. Pecharapa, “Photodegradation of Dye Pollutant by Low-Dimensional Structure $TiO_2$/Metal Phthalocyanine Composites”, $1^{st}$ Nanotoday2009 Conference, August 2-5, 2009, Singapore.

20. W. Pecharapa and W. Mekprasart, “Structural and Optical Properties of Functional Hybrid Composites Based on $TiO_2$ Nanostructures and Metal Phthalocyanine”, $1^{st}$ Nanotoday2009 Conference, August 2-5, 2009, Singapore.

21. Chokchai Kahattha and Wisanu Pecharapa, “Sol-gel dip-coated CNT/ ZnO nanocomposite films for gas sensing applications”, The fourth international conference on sensors:Asiasense 2009, July 29-31, 2009, Bangkok.

22. Krisana Chongsri and Wisanu Pecharapa, “Optical properties of $Mg_xZn_{1-x}O$ alloy film by derived sol-gel method”, $35^{th}$ Congress on Science and Technology of Thailand, Oct 15-17, 2009, Bangsean, Thailand

23. Prayut Potirak, Chokchai Kahattha and Wisanu Pecharapa , “Effect of annealing temperature on physical properties of ZnO/CNT composites”, $35^{th}$ Congress on Science and Technology of Thailand, Oct 15-17, 2009, Bangsean, Thailand

24. W. Mekprasart, W. Jarernboon and W. Pecharapa, “Preparation of $TiO_2$/CuPc hybrid nanocomposite and their utilization as electrode materials of Dye-Sensitized Solar Cell” 7th Eco-Energy and Materials Science and Engineering Symposium, 19-22 Nov. 2009 Chiang Mai

25. R. Noonuruk , P. Potirak, W. Pecharapa and W. Techitdeera, “Synthesis and Characterization of Carbon Nanotubes / Nickel oxide Composites for Electrochemical Capacitor” 7th Eco-Energy and Materials Science and Engineering Symposium, 19-22 Nov. 2009 Chiang Mai, Thailand

26. T. Chodjarusawad, P. Potirak, W. Jareonboon, W. Pecharapa, “Flexible Conducting Electrodes from Carbon Nanotube-based Composites”, 7th Eco-Energy and Materials Science and Engineering Symposium, 19-22 Nov. 2009, Chiang Mai, Thailand

27. C. Saributr, W. Mekprasart, P. Thanomngam, and W. Pecharapa, “Investigation of Structural properties of CuPc/$TiO_2$ Nanocomposites” International Conference on Functionalized and Sensing Materials 2009” December 7-9, 2009, Bangkok, Thailand.

28. Prayut Potirak, Chokchai Kahattha and Wisanu Pecharapa, “Synthesis and Characterization of Carbon Nanotube/Zinc Oxide composites”, The $3^{rd}$ IEEE International Nanoelectronics Conference (IEEE INEC) 2010, 3-8 January, 2010, City University of Hong Kong, China

29. Wisanu Pecharapa, Chokchai Kahattha, Papitchaya Woointranont, and Thanawee Chodjarusawand, “A study of acid-treated multiwall carbon nanotubes by electron microscopy and Raman Spectroscopy”, The $27^{th}$ annual conference of microscopy society of Thailand (MST 27), 20-22 January 2010, Samui, Suratthani, Thailand

30. Thanawee Chodjarusawad, Wisanu Pecharapa, “The Investigation of Carbon Nanotubes Before and After UV/$O_3$ Treatments and Gamma-ray Irradiation Using Transmission Electron Microscopy”, The $27^{th}$ annual conference of microscopy society of Thailand (MST 27), 20-22 January 2010, Samui, Suratthani, Thailand.

31. P. Junlabhut, S. Phoojaruenchanachai, W. Pecharapa and S. Booruang, “Fabrication of holographic Lens as a Coupling Device in Surface Plasmon Resonance Biosensor”, The Fifth National Conference on Optics and Applications (NCOA-5), Febuary 5, 2010, Bangkok, THAILAND

32. K. Kulsirirat, W. Techitdheera and W. Pecharapa , “the critical themperature of transition energy of single quantum well, 14$^{th}$ International Annual Symposium on Computational Science and Engineering conference(ANSCSE), March 26-28 2010, Mae Fah Luang University, Chiangrai, Thailand.

33. P. Potirak , K. Paipitak, P.Woointranont , C. Kahattha , W. Techitdheera , W. Pecharapa, “Effect of irradiation power on physical properties of ZnO/CNT nanocomposites synthesized via microwave-assisted technique” Siam Physics Congress 2010, March 26-28 2010, Kanjanaburi

34. K. Paipitak, T. Pornpra, P. Mongkontalang, W.Techitdheera and W. Pecharapa, “Characterization of PVA-Chitosan Nanofibers Prepared by Electrospinning”, ISEEC 2010, Dec 15-17, 2010, Nakornpranom.

35. R. Noonuruk, N. Wongpisutpaisan, P.Mukdacharoenchai , W. Techitdheera and W. Pecharapa, “Ozone-Induced Optical Density Change of NiO Thin Films and Their Applicability as Neutral Optical Density Filter”, ISEEC 2010, Dec 15-17, 2010, Nakornpranom

36. P. Mukdacharoenchai, N. Wongpisutpaisan, W.Techitdheera and W. Pecharapa, “Characterization of Nickel Oxide Thin Films Prepared Spin-Coating Process” ISEEC 2010, Dec 15-17, 2010, Nakornpranom.

37. Russameeruk Noonuruk, Krisana Chongsri and Wisanu Pecharapa, ”Coloring and bleaching of spin-coated $Ni_{1-x}Zn_xO$ thin films controlled by simple treatment techniques”, Joint Symposium of IEEE Nano Korea, Aug17-20, 2010, South Korea

38. Wanichaya Mekprasart, Russameeruk Noonuruk, Wirat Jareanboon and Wisanu Pecharapa, “Quasi Solid-State Dye-Sensitized Solar Cells based on n-$TiO_2$/p-NiO Nanocomposites”, Joint Symposium of IEEE Nano Korea, Aug17-20, 2010, South Korea

39. K. Chongsri, P. Mukdacharoenchai , S. Boonruang and W. Pecharapa, “Spin-Coated $Mg_xZn_{1-x}O$ Metal-Semiconductor-Metal Structured Photoconductuive Detector with tunable Ultraviolet Response”, Micro Optics Conference, October 31- Nov 3, 2010, Taiwan

40. Papitchaya Woointranont , Russameeruk Noonuruk, Boonsong Jandai and Wisanu Pecharapa, “Microwave-Assisted Synthesis of NiO/CNTs Nanocomposites for functional electrochemical working electrode”, GMSTEC 2010; International Conference for a Sustainable Greater Mekong Subregion, 26-27 Aug, 2010, Bangkok, Thailand

41. Russameeruk Noonuruk, Wisanu Pecharapa, “Study of Structural Properties of NiZnO Thin Films under UV/Ozone Treatment by Atomic Force Microscopy and Fourier

Transform Infrared Spectroscopy", Proceedings of the 28th MST Annual Conference, 5-7 January 2011, Chiang Rai, Thailand

42. Papitchaya Woointranont, Wisanu Pecharapa, "Effects of Surface Modification of Carbon Nanotubes on the Deposition of NiO/CNTs Nanocomposites", Proceedings of the 28th MST Annual Conference, 5-7 January 2011, Chiang Rai, Thailand

43. Chokchai Kahattha, and Wisanu Pecharapa, "Physical Properties of Titanium dioxide/Vanadium oxide composites Synthesized by Ball-Milling Process, Proceedings of the 28th MST Annual Conference, 5-7 January 2011, Chiang Rai, Thailand

44. Boonsong Jandai , Suwan Chaiyasith, Papithaya Woointranont and Wisanu Pecharapa , "Synthesis and characterization of nickel oxide/multiwall carbon nanotube nanocomposites on Fluorine-doped tin oxide for hydrogen peroxide detection", PACCON 2011, Jan 5-7 2011, Bangkok, Thailand.

45. K. Chongsri, S. Boonruang, and W. Pecharapa, "Structural and Optical Properties of $Mg_xZn_{1-x}O$ Alloy Films Prepared by Sol-Gel Method", Proceedings of the 6$^{th}$ Annual Conference on the Thai Physics Society(SPC 2011), March 23-26, 2011, Pattaya, pp. 330-333.

46. C.Bangbai, K.Chongsri, W.Pecharapa, W.Techitdheera, "Effect of Nitrogen doping on Structural and Optical Properties of ZnO Thin Films Prepared by Sol-Gel Technique", SPC 2011, March 23-26, 2011, Pattaya.

47. K. Paipitak, C. Kahattha, W. Techitdheera, N. Porntheerapat, and W. Pecharapa, "Characterization of sol-gel derived Ti-doped Tungsten Oxide Electrochromic Thin Films", 9$^{th}$ Eco-Energy and Materials Science and Engineering Symposium (EMSES 2011) , May 25-28, 2011, Chiangrai.

48. R. Noonuruk and W. Pecharapa, "Effect of Zinc doping on electrochromic performance of sol-gel spin-coated NiO films", 9$^{th}$ Eco-Energy and Materials Science and Engineering Symposium (EMSES 2011) , May 25-28, 2011, Chiangrai.

49. W. Mekprasart and W. Pecharapa, "Synthesis and characterization of Nitrogen-doped $TiO_2$ and its photocatalytic activity enhancement under visible light", 9$^{th}$ Eco-Energy and Materials Science and Engineering Symposium (EMSES 2011) , May 25-28, 2011, Chiangrai.

50. C. Kahattha and W. Pecharapa, "Characterization of V-doped Titanium Dioxide Synthesized by Sol-gel Precipitation Process", 9$^{th}$ Eco-Energy and Materials Science and Engineering Symposium (EMSES 2011) , May 25-28, 2011, Chiangrai.

51. P. Mukdacharoenchai, W. Mekprasart, J. Sritharathikhun, N. Vittayakorn, P. Siriphannon, P. Kittidachachan and W. Pecharapa, “$TiO_2$/R6G hybrid optical composites synthesized by ball-milling process for light waveguide applications”, 9th Eco-Energy and Materials Science and Engineering Symposium (EMSES 2011) , May 25-28, 2011, Chiangrai.

52. N. Wongpisutpaisan, P. Charoonsuk, N. Vittayakorn and W. Pecharapa, “Sonochemical synthesis and characterization of Copper Oxide Nanoparticles”, 9th Eco-Energy and Materials Science and Engineering Symposium (EMSES 2011) , May 25-28, 2011, Chiangrai.

53. Papithaya Woointranont , Sirapat Pratontep and Wisanu Pecharapa, “Modification of Electrochemical Working Electrode using NiO/MWCNT Nanocomposites Synthesized by Microwave-Assisted Route, IEEE INEC 2011, Jun 21-24, 2011, Taiwan.

54. A. Simpraditpan, W. Pecharapa, T. Wirunmongkol, S. Pavasupree, “Preparation of Nanofibers from Natural Ilmenite Mineral by Simple Hydrothermal Method”, Industrial Engineering Network Conference 2011, Oct 20-21, 2011, Pattaya, Thailand.

55. A. Simpraditpan, T. Wirunmongkol, S. Pavasupree, W. Pecharapa, “Effect of Hydrothermal Temperature on Structure of Titanate Nanofibers Prepared from Low-Cost Natural Ilmenite Mineral”, ISTS 2011, Nov 23-26, 2011, Bangkok.

56. T. Tangcharoen, A. Ruangphanit, W. Pecharapa, “NiZn Ferrite nanopowders prepared by facile sol-gel combustion method”, ISTS 2011, Nov 23-26, 2011, Bangkok.

57. P. Junlabhut, S. Boonruang, W. Pecharapa, “Effect of Ag-doping on structural and optical properties of $SiO_2$/$TiO_2$ hybrid composite films”, ISTS 2011, Nov 23-26, 2011, Bangkok.

58. C. Bangbai,' K. Chongsri, W. Pecharapa, and W. Techidheera, “ Effect of Al and N Doping on Structural and Optical Properties of Sol-gel Derived ZnO Thin Films”, International Conference on Enabling Science and Nanotechnology 2012(ESci Nano 2012), 5-7 Jan, 2012, Johor Bahru, Malaysia.

59. N. Wongpisutpaisan, A. Ruangphanit, N. Vittayakorn and W. Pecharapa, “Cu-doped $TiO_2$ nanopowder synthesized by sonochemical-assisted process”, International Conference on Enabling Science and Nanotechnology 2012(ESci Nano 2012), 5-7 Jan, 2012, Johor Bahru, Malaysia.

60. P. Potiruk, W. Techitheera, W. Pecharapa, “Investigation of alcohol sensing property of ZnO/MWCNT hybrid nanocomposites synthesized by microwave-assisted route”, International Conference on Enabling Science and Nanotechnology 2012(ESci Nano 2012),

5-7 Jan, 2012, Johor Bahru, Malaysia.

61. Thanit Tangcharoen, Nuttapon Chomsin, Anucha Ruangphanit, Wichan Techitdheera, Wisanu Pecharapa, “Microwave-assisted combustion synthesis of nanocrystalline NiZn ferrite powders” , The 29th MST Annual Conference, 30 January - 1 February 2012, Cha-am, Thailand

62. Krisana Chongsri, Narongdet Wongpisutpaisan, Naratip Vittayakorn and Wisanu Pecharapa, “Al-doped ZnO Nanoparticles synthesized by sonochemical-assisted Method”, The 29th MST Annual Conference, 30 January - 1 February 2012, Cha-am, Thailand

63. Prasopporn Junlabhut, Sakoolkarn Boonruang, Wisanu Pecharapa, “FTIR and AFM studies of Ag-doped $SiO_2/TiO_2$ hybrid films prepared by sol-gel method” , The 29th MST Annual Conference, 30 January - 1 February 2012, Cha-am, Thailand

64. Khanokkorn Paipitak, Mati Horprathum, Wichan Techitdheera, Wisanu Pecharapa, “Influence of sputtering power on structural, optical and electrochromic properties of $WO_3$ thin films prepared by DC-sputtering”, The 29th MST Annual Conference, 30 January - 1 February 2012, Cha-am, Thailand

65. Orawan Tanomkiat, Kanokkorn paipitak , Wisanu Pecharapa and Wichan Techitdheera, “Effect of Nickel Dopant on Structural and Optical Properties of $WO_3$ Optical Thin Films Prepared by Sol-gel Spin Coating”, The Seventh National Conference on Optics and Applications (NCOA-7), March 16, 2012, Bangkok, Thailand.

66. Wicharn Techitdheera, Chatpong Bangbai and Wisanu Pecharapa, “Effect of Sn doping on Structural and Optical Properties of ZnO Thin Films Prepared by Sol-Gel Technique”, $7^{th}$ Siam Physics Congress, May 9-12, 2012, Ayutthaya, Thailand.

67. P. Mukdacharoenchai, P. Siriphannon, J. Sritharathikhun and W. Pecharapa, “Absorption and fluorescence studies of $TiO_2$/R6G/PMMA light-guided film”, $7^{th}$ Siam Physics Congress, May 9-12, 2012, Ayutthaya, Thailand.

68. T. Tangcharoen, A. Ruangphanit and W. Pecharapa, “Effect of Nickel Substitution on Structural and Magnetic Properties of MnZn and CuZn Ferrites Prepared by Sol-gel Combustion Method”, $7^{th}$ Siam Physics Congress, May 9-12, 2012, Ayutthaya, Thailand.

69. A. Simpraditpan, W. Pecharapa, T. Wirunmongkol, S. Pavasupree, “Synthesis and Optical Properties of Ilmenite Nanofibers Prepared via Hydrothermal Method”, $7^{th}$ Siam Physics Congress, May 9-12, 2012, Ayutthaya, Thailand.

70. K. Paipitak, W. Techitdheera, S. Porntheeraphat and W. Pecharapa, “Structural and optical characterization of sol-gel derived Zn-doped $WO_3$ thin films”, 7th Siam Physics Congress, May 9-12, 2012, Ayutthaya, Thailand.

71. O. Tanomkiat, K. Paipitak, W. Pecharapa and W. Techitdheera, “Structural, optical and electrochromic properties of Ni-doped $WO_3$ thin films prepared by sol-gel process”, 7th Siam Physics Congress, May 9-12, 2012, Ayutthaya, Thailand.

72. Narongdet Wongpisutpaisan, Chokchai Kahattha, Naratip Vittayakorn, Anucha Ruangphanit, and Wisanu Pecharapa, “Titanium dioxide nanostructures synthesized by sonochemical – hydrothermal process”, 7th International Conference on Materials and Technology (7th - MSAT), June 7-8, 2012, Bangkok, Thailand.

73. C. Kahattha, N. Wongpisutpaisan, N. Vittayakorn and W. Pecharapa, “Physical properties of V-doped $TiO_2$ nanoparticles synthesized by sonochemical-assisted process”, 8th Asian Meeting on Electroceramics, July 1-5, 2012, Penang, Malaysia.

74. Thanit Tangcharoen, Anucha Ruangphanit, Wisanu Pecharapa, “Structural and magnetic properties of nanocrystalline zinc-doped metal ferrites (metal = Ni; Mn; Cu) prepared by sol-gel combustion method”, 8th Asian Meeting on Electroceramics, July 1-5, 2012, Penang, Malaysia.

75. P. Mukdacharoenchai , W. Mekprasart, J. Sritharathikhun, W. Pecharapa, “Effect of $TiO_2$ compact layer on optical absorption and fluorescence performance of R6G/PMMA composite light-guided films”, 2nd International conference in Frontier in Nanoscience and Nanotechnology 2012, July 27-28, 2012, Hong Kong.

76. K. Paipitak, J. Rattanarak, D. Pakdeeyingyong, W. Tchitdheera, S. Porntheeraphat and W. Pecharapa, “Enhanced electrochromic performance of sol-gel derived $WO_3$ thin films assisted by electrospun PVA nanofibers”, 2nd International conference in Frontier in Nanoscience and Nanotechnology 2012, July 27-28, 2012, Hong Kong.

77. Napaporn Thaweesaeng, Sineenart Suphankij , Pattanapong Jumrusprasert, Wisanu Pecharapa , Wicharn Techitdheera, “ZnO nanopowders prepared by precipitation method using deferent precursors”, 38th Congress of Science and Technology of Thailand (38th STT), Oct 17-19, 2012, Chiangmai, Thailand

78. Sineenart Suphankij, Wanichaya Mekprasart ,Wisanu Pecharapa,

“Characterization of N-doped $TiO_2$ nanofibers prepared by electrospinning”, $38^{th}$ Congress of Science and Technology of Thailand ($38^{th}$ STT), Oct 17-19, 2012, Chiangmai, Thailand.

79. Kankanit Phiwdang*, Sininart Supanakit, Narongdet Wongpisutpaisan,Wanichaya Mekprasart, Wisanu Pecharapa, “Facile Synthesis of CuO Nanoparticles by Precipitation Method”, $38^{th}$ Congress of Science and Technology of Thailand ($38^{th}$ STT), Oct 17-19, 2012, Chiangmai, Thailand.

# ภาคผนวก

งานประชุมวิชาการวิทยาศาสตร์และเทคโนโลยีแห่งประเทศไทย ครั้งที่ 38 (วทท. 38)

ระหว่างวันที่ 17-19 ตุลาคม 2555

ณ จังหวัดเชียงใหม่

# Facile Synthesis of CuO Nanoparticles by Precipitation Method

K.Phiwdang[1*], S.Suphankij[1], N.Wongpisutpaisan[1], W. Mekprasart[1,2], W.Pecharapa[1,2]

[1]College of Nanotechnology, King Mongkut's Institute of Technology Ladkrabang, Chalongkrung Rd., Ladkrabang Bangkok 10520, Thailand.

[2]ThEP Center, CHE,328 Siayuthtaya Rd.,Bangkok 10400,Thailand

## Abstract

CuO nanoparticles were synthesized by precipitation method using copper nitrate $Cu(NO_3)_2$ as starting precursor combination with post-heating. Relevant properties of as-synthesized nanoparticles were investigated by X-ray diffraction, Scanning electron microscope and Fourier transform infrared spectroscopy. XRD result suggests that CuO nanoparticles in cubic structure are obtained by this synthesized process. Meanwhile, SEM result reveals that surface morphologies and structure of as-prepared CuO are in short nanorod-like structure with average size of few hundred nanometer range. FTIR results suggest that the formation of CuO nanostructure and Cu-O bonding were obtained by this simple process.

## Introduction

**CuO**

### Properties

- Molecular weight 79.545 g/mol
- P-type semiconductor
- Narrow band gap

### Application

- Photocathalyst
- Dye-sensitized solar cells
- Antifungi

## Experiment

- 2.416 grams of $Cu(NO_3)_2$ at concentration 0.1 mol/l
- + DI water 100 ml
- ↓ Under stirring, Drop NaOH 25 ml
- Stirring for 20 min.
- ← Wash with DI water and absolute ethanol (pH=7)
- ↓ Dried at 80 °C for 16 h
- → Annealed at 500 °c for 4 h
- ↓ CuO nanoparticle (Black precipitate)

## Results & Discussion

### XRD , SEM and FTIR Characterization

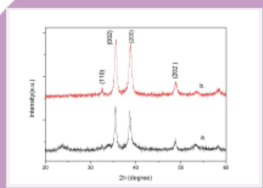


Fig. 1. XRD pattern of CuO nanostructure from $Cu(NO_3)_2$ (a) as-synthesized and (b) after calcination of CuO.

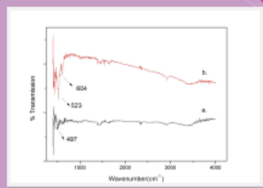


Fig. 2. FTIR spectra of CuO nanostructure from $Cu(NO_3)_2$ (a) as-synthesized and (b) after calcination of CuO.

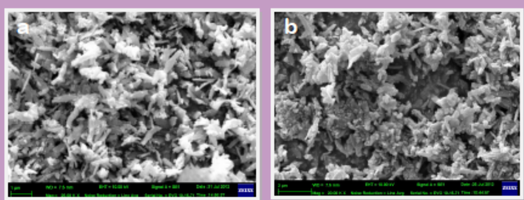


Fig. 3 SEM images of CuO nanostructure from $Cu(NO_3)_2$ (a) as-synthesized and (b) after calcination of CuO.

## Conclusion

- CuO nanostructures were successfully synthesized by precipitation method
- XRD peaks confirm that the formation of CuO from $Cu(NO_3)_2$ is in monoclinic phase
- SEM results show that good dispersion in short nanorod-like structure are found in as-synthesized CuO whilst the aggregation of CuO is formed by annealing process.
- FTIR result suggests that the formation of copper oxide compound is obtained after annealing process in this method accompanying the presence of Cu–O bonds in stretch-

## Acknowledgements

This work has been financially supported by the National Nanotechnology Center (NANOTEC), NSTDA, Ministry of Science and Technology Thailand, through its program of Center of Excellence Network and Nation Research Council of Thailand (NRCT).

## References

1. Junwu Z, Dan L, Haiqun Ch, Xujie Y, Lude L, Xin W, Mater.Lett. 2004;58:3324– 3327.
2. Rujun W, Zhenye M, Zhenggui G, Yan Y, J.Alloy.Compd. 2010;504:45–49.
3. Sonal Singhal n, Japinder K, Tsering N, Rimi S, Physica B 2012;407:1223–1226.

Dear Miss. Sineenart Suphankij

We are pleased to inform you that your paper with paper code : NM72 entitled

Photocatalytic of N-doped TiO2 Nanofibers prepared by electrospinning

has been ACCEPTED for presentation at the 10th EMSES 2012, which will be held at Sunee Grand Hotel, Ubon-Ratchathani, Thailand, on December 5-8, 2012.

With this letter, we cordially invite you to attend 10thEMSES2012 to present your paper.

Reviewers' comments are listed at the end of this message. It is strongly recommended to the author to revise the paper following reviewer's comments in camera-ready submission.

To include your paper in the conference proceedings, you MUST strictly adhere to the following requirements:

1. At least one of the authors must register to attend the conference by November 12, 2012, which is the deadline for camera-ready submission. The registration rates are as follows: http://www.emses.org/index.php/registration.

2. Your paper may have been accepted with a condition that the paper must be revised according to the reviewer comments. Failing to do so may exclude your paper from the program and proceeding.

3. A final camera-ready copy of your revised paper in PDF format (NO MORE THAN 6 PAGES) must be resubmitted electronically (uploaded) for publication NO LATER THAN November 5, 2012.

4. For selected paper to publish in Energy Procedia, the committee and editor in chief will range the score and send the acceptance letter to you on December 5, 2012

http://paper4submission.com/emses2012/login.asp

Please also check if your paper follows the EMSES manuscript format available on www.emses.org. For more information about how to submit camera-ready version, please go to www.emses.org.

Please note that NO TIME EXTENSION will be granted.

Please accept our thanks for submitting your paper to the conference.
We look forward to seeing you at 10th EMSES2012 on December 5-8, 2012.

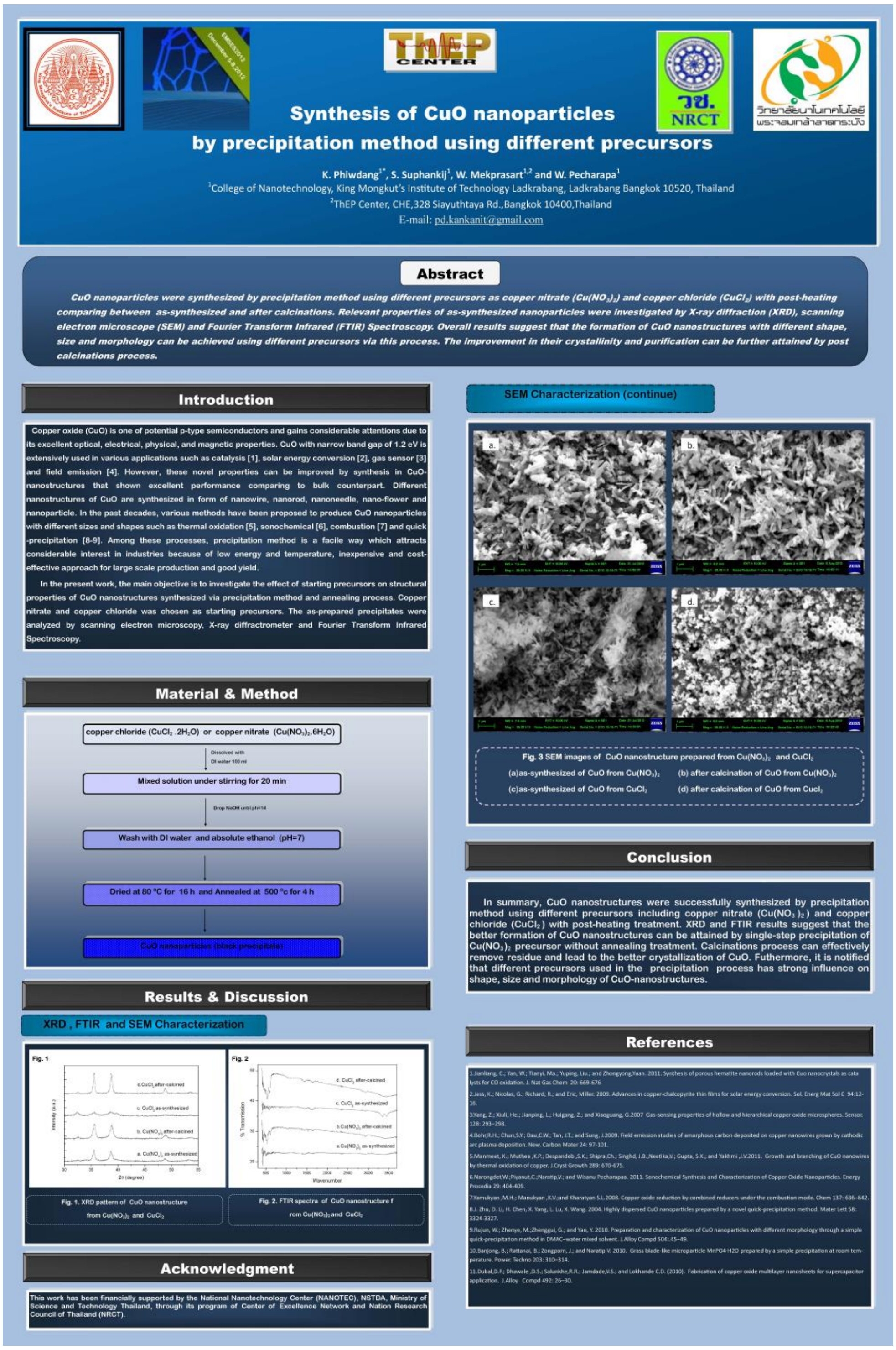
Sincerely,
Asst.Prof.Dr.Krischonme Bhumkittipich
Dr.Sumonman Niamlang

10th EMSES2012 Secretary (On the behalf of technical programme committee)
E-mail: emses@en.rmutt.ac.th,
Website: http://www.emses.org/

**เข้าร่วมงานประชุมวิชาการระดับนานาชาติ Eco-Energy and Materials Science and Engineering ครั้งที่ 10 ระหว่างวันที่ 5-8 ธันวาคม 2555**

**ณ จังหวัดอุบลราชธานี**

**ได้รับการตีพิมพ์ในวารสารวิชาการ Energy Procedia (Special issue; 10th Eco-Energy and Materials Science and Engineering Symposium**



Dear Kankanit Phiwdang, (pd.kankanit@gmail.com)

We would like to inform you that your paper entitled

**"Synthesis of CuO nanoparticles by precipitation method using different precursors"**

has been selected to be published in Energy Procedia (Special issue; 10th Eco-Energy and Materials Science and Engineering Symposium).

The authors are **Kankanit Phiwdang, Sininart Suphankij, Wanichaya Mekprasart, and Wisanu Pecharapa**
Please submit the final version in the Energy Procedia template and the copy right transfer forms before **January 19, 2013** via emses@en.rmutt.ac.th.

The author guideline, paper template and copy right transfer forms are attached here with this letter.

Please find the attached fee form of your manuscript to be filled and signed in for advance procedures. Please fill the attached form and send it via email attachment at your earliest convenience.

As soon as we receive filled and signed fee form, your manuscript will be processed for publication.

If you decide not to publish your paper in Energy Procedia, please inform us as soon as possible via emses@en.rmutt.ac.th.

Yours Sincerely,

Sommai Pivsa-Art, Ph.D.
Co-Editor in Chief of Energy Procedia (Special issue; 10th Eco-Energy and Materials Science and Engineering Symposium)

**เข้าร่วมงานการประกวดนวัตกรรมนาโนฯ ครั้งที่ 4 ประจำปี 2556**

**28-29 มีนาคม 2556 ณ หอประชุมใหญ่ สถาบันเทคโนโลยีพระจอมเกล้าเจ้าคุณทหาร ลาดกระบัง กรุงเทพมหานคร**

**เข้าร่วมงานประชุมวิชาการระดับนานาชาติ International Conference on Engineering, Applied Sciences, and Technology (ICEAST) ครั้งที่ 3**

**ระหว่างวันที่ 21-24 สิงหาคม 2556 ณ กรุงเทพมหานคร**

**ได้รับการตีพิมพ์ในวารสารวิชาการ Advanced Materials Research Vol. 802 in 2013 with the title Advances in Material Science and Technology.**

*Advanced Materials Research Vol. 802 (2013) pp 89-93*
*Online available since 2013/Sep/10 at www.scientific.net*
*© (2013) Trans Tech Publications, Switzerland*
*doi:10.4028/www.scientific.net/AMR.802.89*

# Study of Antifungal Activities of CuO/ZnO Nanocomposites Synthesized by Co-precipitation Method

Kankanit Phiwdang[1, a], Mongkol Phensaijai[2,b] and Wisanu Pecharapa[1,c]

[1]College of Nanotechnology, King Mongkut's Institute of Technology Ladkrabang, Ladkrabang, Bangkok, 10520 Thailand

[2]Department of biology, Faculty of Science, King Mongkut's Institute of Technology Ladkrabang, Ladkrabang , Bangkok, 10520 Thailand

[a]pd.kankanit@gmail.com, [b]kpmongko@kmitl.ac.th, [c]kpewisan@gmail.com

**Keywords:** CuO/ZnO, nanocomposites, co-precipitation method, antifungal activities

**Abstract.** In this work, series of CuO/ZnO functional nanocomposites were synthesized through co-precipitation method using $CuCl_2 \cdot H_2O$ and $ZnCl_2$ as starting materials with various molar ratio of copper:zinc, followed by annealing process at 600 °C for 2 hours to obtain CuO/ZnO nanocomposites. The structures of the composites were analyzed using X-ray diffraction and field emission scanning electron microscopy. For XRD result, diffraction peaks of the composites reveal the well-crystalline characteristic indicating the mixture phase of CuO and ZnO. SEM results show different morphologies of CuO, ZnO and Cu-Zn oxide nanocomposites appearing in quasi spherical structure.The composites were used for antifungal activity via agar disk diffusion method. It is found that the composite with certain ratio of Cu:Zn exhibits superiority in partial inhibition of strain *AspergillusflavusTrichoderma* comparing to either pure CuO or ZnO.

## Introduction

At the present time, nanoparticles inward to the size range of 100 nm have attracted great interest due to their rather high surface to volume ratio with unique morphologies, leading to practical utilizations in various potential applications of science and technology. Among them, metal oxide nanoparticles such as CuO, ZnO, $TiO_2$ and MgO are well recognized because of their good physical properties suitable for widespread applications including optoelectronic, semiconductor technology and fungal inhibition [1-4]. Copper oxide has been extensively utilized as antifungal agent accompanying low cost, abundant resource, simple preparation [5].However, some fungi strain cannot be inhibited by CuO. Therefore, composite form with compatible elements or compounds is one of effective method for improving CuO functionality. It is known that ZnO has been comprehensively advertent owing to its fascinating properties such as high exciton binding energy of 60 meV, strong chemical-thermal stability and most of all, its ablility for resisting microbial activity[6].In consequence, the advantage of CuO coupled with ZnO is easy incorparation,improvement of antifungi properties and similar physical-chemical properties comparing to other metal oxide materials[7]. Moreover, both material are rather cheap and environmental friendly. CuO/ZnO composites with different sizes and shapes can be synthesized various methods such as electrodeposition [8], hydrothermal process [9], electrospinning [10] and co-precipitation [11]. Among these mentioned processes, precipitation method is a facile way which attracts considerable interest because of low temperature process, inexpensive and cost-effective approach for large scale production. The practical applications of CuO-ZnO composite in solar energy conversion applications, photocatalysis and gas-sensing have been recently reported [12-14]. Nevertheless, few literature has been so far focused on the study of antifungal properties of CuO-ZnO nanocomposite. In this study, we reports antifungal property(*Aspergillus flavus Trichoderma agents)*of CuO-ZnO nanocomposite synthesized by co-precipitation method with various molar ratio.

Dear Dr. Kankanit Phiwdang,

Your paper(s) will be published in our Periodical of Advanced Materials Research Vol. 802 in 2013 with the title Advances in Material Science and Technology.

You may access (free of charge) your paper(s) online and download a PDF version fromhttp://www.scientific.net

Login pd.kankanit@gmail.com
Password DHrZGdBJ
Go to 'Author' (upper left corner), then go to 'Papers' and click on the PDF icon next to your paper.

Thank you for supporting our Periodical.

Kind regards,

Anne Wohlbier
Trans Tech Publications