REFERENCES

Alejandre, A., Medina, F., Fortuny, A., Salagre, P., and Sueiras, J.E. Characterisation of copper catalysts and activity for the oxidation of phenol aqueous solutions. Applied Catalysis B: Environmental 16 (1998): 53-67.

Bekkouche, S., Bouhelassa, M., Salah, N. H., and Meghlaoui, F. Z. Study of adsorption of Phenol on Titanium Oxide (TiO_2). Desalination 166 (2004): 355-362.

Bessekhouad, Y., Robert, D., and Weber, J.V. Synthesis of photocatalytic TiO_2 nanoparticles: optimization of the preparation conditions. Journal of Photochemistry and Photobiology A: Chemistry 157 (2003): 47-53.

Bhatkhande, D. S., Pangarkar, V. G., and Beenackers, A ACM. Photocatalytic Degradation for Environmental Applications-A Review. Journal of chemicalTechnology and Biotechnology 77 (2001): 102-116.

Brand-Williams, W., Culier, M.E. and Berest, C. Use of a tree radical method to evaluate antioxidant activity. Lebensmittel-Wissenschaft Und-Technology 28 (1995); 25-30.

Brinker, C.J. and Scherer, G.W. Sol-Gel Science. New York: Academic Press, 1990.

Carp, O., Huisman, C.L., and Reller, A. Photoinduced reactivity of titanium dioxide. Progress in Solid State Chemistry 32 (2004): 33-177.

Chen, L.,Graham, M.E., Li, G., and Gray, K.A. Fabricating highly active mixed phase TiO_2 photocatalysts by reactive DC magnetron sputter deposition. Thin Solid Films 515 (2006): 1176-1181.

Chen, P. H. and Jenq, C. H. Kinetics of photocatalytic oxidation of trace organic compounds over titanium dioxide. Environment International 24 (1998): 871-879.

Chichina, M. and Tichi, M. A study of the barrier torch discharge applied for the thin film deposition. WDS'05 Proceedings of Contributed Papers Part II (2005): 325-331. Cited in Stall, D. JANAF Thermochemical Tables Joint Army-Navy-Air Force-ARPA-NASA, Thermochemical working group, 1996.

Devipriya, A. and Yesodharan, S. Photocatalytic degradation of pesticide contaminations in water. Solar Energy Materials & Solar cells 86 (2005): 309-348.

Devlin, H. and Levec, J. Mechanism of the oxidation of aqueous phenol with dissolved oxygen. Industrial & Engineering Chemistry Fundamentals 23 (1984): 387-392.

Diebold, U. The surface science of titanium dioxide. Surface Science Reports 48 (2003): 53-229.

Ding, Z.Y., Aki, S., and Abraham, M.A. Catalytic supercritical water oxidation: phenol conversion and product selectivity. Environmental Science & Technology 29 (1995):2748-2753.

Duprez, D., Delanoë, F., Barbier, J., Barbier, P., and Blanchard, G. Catalytic oxidation of organic compounds in aqueous media. Catalysis Today 29 (1996): 317-322.

Fox. M.A. and Dulay, M.T. Heterogeneous Photocatalysis. Chemical Reviews 93 (1993): 341-357.

Hench, L.L. and West, J.K. The Sol-Gel Process. Chemical Reviews 90 (1990): 33-72.

Hoffmann, M. R., Martin, S. T., Choi, W., and Bahnemann, D. W. (1995). Environmental Applications of Semiconductor Photocatalysis. Chemical Reviews 95 (1995): 69-96.

Hurum, D. C., Agrios, A. G., Crist, S. E., Gray, K. A., Rajh, T., and Thurnauer, M. C. Probing reaction mechanisms in mixed phase TiO_2 by EPR. Journal of Electron Spectroscopy and Related Phenomena 150 (2006): 155-163.

Hurum, D.C., Agrios, A.G., Gray, K.A., Rajh, T, and Thurnauer, M.C. Explaining the Enhanced Photocatalytic Activity of Degussa P25 Mixed-Phase TiO_2 Using EPR. Journal of Physical Chemistry B 107(2003): 4545 – 4549.

Janez, L. and Albin, P. Catalytic oxidation of aqueous solutions of organics. An effective method for removal of toxic pollutants from waste waters. Catalysis Today 24 (1995): 51-58.

Jung, K.Y., Park, S.B., and Anpo, M. Photoluminescence and photoactivity of titania particles prepared by the sol–gel technique: effect of calcination temperature. Journal of Photochemistry and Photobiology A: Chemistry 170 (2005): 247-252.

Klein, L.C. Sol gel Formation and Deposition. Goldstein, A.N. Handbook of Nanophase Materials, p.43. New York: Marcel Dekker, 1997.

Kosanic, M. M. Photocatalytic degradation of oxalic acid over TiO_2 power Journal of Photochemistry and Photobiology A: Chemistry 119 (1998): 119-122.

Ksibi, M., Zemzemi, A., and Boukchina, R. Photocatalytic Degradability of Substituted Phenols Over UV Irradiated TiO_2. Journal of Photochemistry and Photobiology A: Chemistry 159 (2003): 61-70.

Kumar, K. N. P. Growth of rutile crystallites during the initial stage of anatase-to-rutile transformation in pure titania and in titania-alumina nanocomposites. Scripta Metallurgica et Materialia 32 (1995): 873-877.

Li, B., Wang, X., Yan, M., and Li, L. Preparation and characterization of nano-TiO_2 powder. Materials Chemistry and Physics 78 (2003): 184-188.

Linsebigler, A.L., Lu, G., and Yates, J.T.Jr. Photocatalysis on TiO_2 Surfaces: Principles, Mechanisms, and Selected Results. Chemical Reviews 95 (1995): 735-758.

Litter, M.I. Heterogeneous photocatalysis transition metal ions in photocatalytic systems. Applied Catalysis B: Environmental 23 (1999): 89-114.

Mills., A. and Hunte, S. L. An Overview of Semiconductor Photocatalysis. Journal of Photochemistry and Photobiology A: Chemistry 108 (1997): 1-35.

Music, S., Gotic, M., Ivanda, Popovic, S., Turkovic, A., Trojko, R., Sekulic, A., and Furic, K. Chemical and microstructural properties of TiO_2 synthesized by sol-gel procedure. Materials Science & Engineering B 47 (1997): 33-40.

Nagaveni, K., Sivalingam, G., Hegde, M. S., and Madras, G. Photocatalytic Degradation of Organic Compounds over Combustion-Synthesized Nano-TiO_2. Environmental Science & Technology 38 (2004): 1600-1604.

Navrotsky, A. and Kleppa, O.J. Enthalpy of the Anatase-Rutile Transformation. Journal of the American Ceramic Society-Discussions and Notes 50 (1967): 626.

Ni. M., Leung, M.K.H., Leung, D.Y.C., and Sumathy, K. A review and recent developments in photocatalytic water-splitting using TiO_2 for hydrogen production. Renewable & Sustainable Energy Reviews 11 (2007): 401-425.

Nuansing, W., Ninmuang, S., Jarernboon, W., Maensiri, S., and Seraphin, S. Structural characterization and morphology of electrospun TiO_2 nanofibers. Materials Science and Engineering: B 131 (2006): 147-155.

Ohta, H., Goto, S., and Teshima, H. Liquid –phase oxidation of phenol in rotating catalytic basket reactor. Industrial & Engineering Chemistry Fundamentals 19 (1980): 180-185.

Oppenländer, T. Photochemical Purification of Water and Air, Principles, Reaction Mechanisms and Reactor Concepts. Weinheim: Wiley-VCH, 2003.

Pilken, S. and Raftery, D. Solid-state NMR studies of the adsorption and photooxidation of ethanol on mixed TiO_2-SnO_2 photocatalysts. Solid State Nuclear Magnetic Resonance 24 (2003): 236-253.

Pissololatto, T. M., Caramao, E. B., and Martins, A. F. Solid phase extraction of chlorinated phenolics in aqueous solution. Journal of Microcolumn Separations 8(1996): 5-12.

Richards, B.S. Novel Uses of Titanium Dioxide for Silicon Solar Cell Docteral dissertation, Center of Photovoltaic Engineering and the School of Electric Engineering, University of New South Wales, 2002.

Santos, A., Yustos, P., Quintanilla, A., García-Ochoa, F., Casas, J.A., and Rodríguez, J.J. Evolution of Toxicity upon Wet Catalytic Oxidation of Phenol. Environmental science and technology 38 (2004): 133-138.

Sawyer, C. N., McCarty, P. L., and Parkin G.F. Chemistry for Environmental Engineering. 4th ed. New York: McGraw-Hill, Inc, 1994.

Shang, J., Yao, W., Zhu, Y., and Wu, N. Structure and photocatalytic performances of glass/SnO_2/TiO_2 interface composite film. Applied Catalysis A: General 257 (2004): 25-32.

Shannon, R.D. and Pask, J.A. Kinetic of the Anatase-Rutile Transformation. Journal of the American Ceramic Society 48 (1965): 391-398.

Su, C., Hong, B. Y., and Tseng, C.M. Sol-Gel Preparation and Photocatalysis of Titanium Dioxide. Catalyst Today 96 (2004): 119-126.

Sumita, T., Yamaki, T., Yamamoto, S., and Miyashita, A. Photo-induced surface charge separation of highly oriented TiO_2 anatase and rutile thin film. Applied Surface Science 200 (2002): 21-26.

Sumita, T., Yamaki, T., Yamamoto, S., and Miyashita, A. Photo-induced surface charge separation of highly oriented TiO_2 anatase and rutile thin films. Applied Surface Science 200 (2002): 21-16.

Suzuki, H., Cao, J., Jin, F., Kishita, A., and Enomoto, H. Wet oxidation of lignin model compounds and acetic acid production. Journal of Material Science 41 (2006): 1591-1597.

Tryk, D.A., Fugishima, A., and Honda, K. Recent topics in photochemistry: achievements and future prospects. Electrochimica Acta 45 (2000): 2326-2376.

Vinodgopal, K. and Kamat, P.V. Enhanced rate of photocatalytic degradation of an azo dye using SnO_2/TiO_2 coupled semiconductor thin film. Environmental Science & Technology 29 (1995): 841-845.

Watanabe T., Nakajima, A., Wang, R., Minabe, M., Koizumi, S., Fujishima A., and Hashimoto, K. Photocatalytic activity and photoinduced hydrophilicity of titanium dioxide coated glass. Thin Solid Films 351 (1999): 260-263.

Yu, J., Zhao, X., and Zhao, Q. Effect of surface structure on photocatalytic activity of TiO_2 thin film prepared by sol-gel method. Thin Solid Films 379 (2002): 7-14.

Zheng, M.P., Gu, M.Y., Jin, Y.P., Wang, H.H., Zu, P.F., Tao, P., and He, J.B. Effects of PVP on structure of TiO_2 prepared by the sol-gel process. Materials Science and Engineering B 87 (2001): 197-201.

APPENDIX

APPENDIX

Radical scavenging power (RSP)

The DPPH method was used because this technique is easily applicable and widely used. DPPH is a synthetic free radical that accepts an electron or hydrogen to be converted to a DPPHH stable molecule. The disappearance of DPPH radical is monitored by the decrease in absorbance of solution at 517 nm. Estimation of RSP was carried out by four milliliters of 25 mg/l 1,1-diphenyl-2-picrylhydrazyl radical (DPPH) solution were well mixed with 1 ml of phenol, guaiacol, and syringol, the concentration of each solution was 10 mg/l in ethanol. Then mixed solutions were transferred to spectrophotometer cuvettes. In the blank, ethanol was used in place of the sample. Remaining purple color of DPPH was measured by using spectrophotometer (GENESYS 20 Thermo Spectronic) at 517 nm after 15 min incubation in darkness. RSP was calculated by the following equation:

$$RSP = \left[1 - \left(\frac{As}{Ab}\right)\right] \times 100$$

Where As is absorbance of samples and Ab is absorbance of blank

BIOGRAPHY

Miss Kulyakorn Khuanmar was born on April 25, 1973 in Sakolnakorn, Thailand. She obtained her B.Eng (Agricultural Engineering) in 1997 and M.Eng (Environmental Engineering) in 2002 from Khon Kaen University. Kulyakorn is the officer of the Ministry of Natural Resources and Environment. Her major responsibility relates to the national environmental plan and policy. In October 2003, she had got permission to leave for her Ph.D study in the International program in Environmental Management at Chulalongkorn University. She has completed her study by April 2007. Her interest is in application of new technology, such as nanotechnology, for hazardous waste treatment.