

REFERENCES

1. Carp, O., Huisman, C.L., and Reller, A., Photoinduced reactivity of titanium dioxide, *Prog. Solid State Chem.*, 2004, **32**, 42-90.
2. Li, X.Z., and Liu, H., Photocatalytic oxidation using a new catalyst-TiO₂ microsphere-for water and wastewater treatment, *Environ. Sci. Technol.*, 2003, **37**(17), 3989-3994.
3. Li, Y., White, T., and Lim, S.H., Structure control and its influence on photoactivity and phase transformation of TiO₂ nano-particles, *Adv. Mater. Sci.*, 2003, **5**, 211-215.
4. Hu, Y., Tsai, H.-L., and Huang C.-L., Effect of brookite phase on the anatase-rutile transition in titania nanoparticles, *J. Eur. Ceram. Soc.*, 2000, **23**, 691-696.
5. Samuel, V., Pasricha, R., and Ravi, V., Synthesis of nanocrystalline rutile, *Ceram. Int.*, 2005, **4**, 555-557.
6. Watson, S.S., Beydoun, D., Scott, J.A., and Amal, R., The effect of preparation method on the photoactivity of crystalline titanium dioxide particles, *Chem. Eng. J.*, 2003, **95**, 213-220.
7. Bessekhouad, Y.; Robert, D.; and Weber, J.V. Synthesis of photocatalytic TiO₂ nanoparticles: optimization of the preparation conditions, *J. Photoch. Photobio. A.*, 2003, **157**, 47–53.

8. Zhang, R.; Gao, L.; and Zhang, Q. Photodegradation of surfactants on the nanosized TiO₂ prepared by hydrolysis of the alkoxide titanium, *Chemosphere* 2004, **54**, 405-411.
9. Eiden-Assmann, S.; Widoniak, J.; and Maret, G. Synthesis and characterization of porous and nonporous monodisperse colloidal TiO₂ particles, *Chem. Mater.* 2004, **16**, 6-11.
10. Almquist, C.B.; and Biswas, P. Role of synthesis method and particle size of nanostructured TiO₂ on its photoactivity, *J. Catal.* 2002, **212**, 145-156.
11. Khalil, K.M.S.; and Zaki, M.I. Synthesis of high surface area titania powders via basic hydrolysis of titanium(IV) isopropoxide, *Powder Technol.*, 1997, **92**, 233-239.
12. Zaban, A.; Arona, S.T.; Tirosh, S.; Greeg, B.A.; and Mastal, Y. The effect of the preparation condition of TiO₂ colloids on their surface structures, *J. Phys. Chem. B.*, 2000, **104**(17), 4130-4133.
13. Kolen'ko, Y.V.; Maximov, V.D.; Garshev, A.V.; Meskin, P.E.; Oleynikov, N.N.; and Churagulov B.R. Hydrothermal synthesis of nanocrystalline and mesoporous titania from aqueous complex titanyl oxalate acid solutions, *Chem. Phys. Lett.* 2004, **388**, 411-415.
14. Paola, A. D., García-López, E., Ikedab, S., Marcía, G., Ohtanib, B., and Palmisano, L., Photocatalytic degradation of organic compounds in aqueous systems by transition metal doped polycrystalline TiO₂, *Catal. Today*, 2002, **75**, 87-93.

15. Wu, J. C.-S., and Chen, C. H., A visible-light response vanadium-doped titania nanocatalyst by sol-gel method, *J. Photoch. Photobio. A.*, 2004, **163**, 509–515.
16. Colmenares, J.C., Aramendi'a, M.A., Marinas, A., Marinas, J.M., and Urbano, F.J., Synthesis, characterization and photocatalytic activity of different metal-doped titania systems, *Appl. Catal., A-Gen*, 2006, **306**, 120–127.
17. Harada, M., Sasaki, T., Ebina, Y., and Watanabe, M., Preparation and characterizations of Fe- or Ni-substituted titania nanosheets as photocatalysts, *J. Photoch. Photobio. A.*, 2002, **148**, 273–276.
18. Slamet, H.. Nasution, W., Purnama, E., Kosela, S., and Gunlazuardi, J., Photocatalytic reduction of CO₂ on copper-doped titania catalysts prepared by improved impregnation method, *Catal. Commun.*, 2005, **6**, 313-319.
19. Colmenares, J.C., Aramendia, M.A., Marinas, A., Marinas, J.M., and Urbano, F.J., Synthesis, characterization and photocatalytic activity of different metal-doped titania systems, *Appl. Catal. A-Gen*, 2006, **306**, 120–127.
20. Zhang, R., Gao, L., and Zhang, Q., Photodegradation of surfactants on the nanosized TiO₂ prepared by hydrolysis of the alkoxide titanium, *Chemosphere* 2004, **54**, 405–411.
21. Anpo, M., Use of visible light second-generation titanium oxide photocatalysts prepared by the application of an advanced metal ion-implantation method, *Pure Appl. Chem.*, 2000, **72**, 1787–1792.

22. Romero, M., Blanco, J., Sanchez, B., Vidal A., Malato, S., Cardona, A.I., and Garcia, E., Solar photocatalytic degradation of water and air pollutants: challenges and perspectives, *Sol. Energy*, 1999, **66**, 169–182.
23. Karvinen, S., and Lamminmäki, R.-J., Preparation and characterization of mesoporous visible-light-active anatase, *Solid State Sci.*, 2003, **5**, 1159-1166.
24. Bahnemann, D., Photocatalytic water treatment: solar energy applications, *Sol. Energy*, 2004, **77**, 445–459.
25. *staff.aist.go.jp/.../english/itscgallery-e.htm* (1 August 2007).
26. Gai, P.L., and Boyes, E.D., “Electron Microscopy in Heterogeneous Catalysis”, DuPont, Central Research and Development, Wilmington, DE, USA, Institute of Physics Publishing Bristol and Philadelphia, 2003.
27. *http://ruby.colorado.edu/~smyth/min/tio2.html* (1 August 2007).
28. *http://en.wikipedia.org/wiki/Titanium* (1 November 2007).
29. Niccholls, D., Complexs and First-Row Transition Elements, The Macmillan Press, New York, 1974.
30. *http://en.wikipedia.org/wiki/Vanadium* (1 November 2007).
31. *http://ceramic-materials.com/cermat/oxide/feo.html* (1 November 2007).
32. *http://en.wikipedia.org/wiki/Iron* (1 November 2007)..
33. *http://en.wikipedia.org/wiki/Copper* (1 November 2007).
34. Schiavello, M., “Heterogeneous Photocatalysis”, Wiley series in photoscience and photoengineering Vol. 3, Wiley, New York, 1997.

35. Mills, A., and Hunte, S.L., An overview of semiconductor photocatalysis, *J. Photoch. Photobio. A.*, 1997, **108**, 1-35.
36. <http://hyperphysics.phy-astr.gsu.edu/hbase/solids/band.html> (1 August 2007).
37. Herrmann, J.-M., Heterogeneous photocatalysis: fundamentals and applications to the removal of various types of aqueous pollutants, *Catal. Today*, 1999, **53**, 115–129.
38. McKelvey, J.P., Solid State and Semiconductor Physics, Happer and Row, New York, 1996.
39. Mori, K., Photo-functionalized materials using nanoparticles: photocatalysis, surface finishing R&D center central research laboratories nihon parkerizing. *KONA*, 2005, **23**, 205-214.
40. Hodnett, B.K., “Heterogeneous Catalytic Oxidation: Fundamental and Technological Aspects of the Selective and Total Oxidation of Organic Compounds”, Department of Chemical and Environmental Sciences and The Materials and Surface Science Institute University of Limerick, Ireland, 2000.
41. Teoh, W.Y., Madler, L., Beydoun, D., Pratsinis, S. E., and Amal, Rose, Direct (one-step) synthesis of TiO_2 and Pt/TiO_2 nanoparticles for photocatalytic mineralisation of sucrose, *Chem. Eng. Sci.*, 2005, **60**, 5852 – 5861.
42. Viswanathan, B., Catalysis Principles and Applications (Photocatalysis), India, 289-301.

43. Teoh, W.Y., Amal, R., Mädler, L., and Pratsinis, S.E., Flame sprayed visible light-active Fe-TiO₂ for photomineralisation of oxalic acid, *Catal. Today*, 2007, **120**, 203–213.
44. Crittenden, J.C., Liu, J., Hand, D.W., and Perram, D.L., Photocatalytic oxidation of chlorinated hydrocarbons in water, *Water Res.*, 1997, **31**(3), 429-438.
45. Fujii, H., Inata, K., Ohtaki, M., Eguchi, K., and Arai, H., Synthesis of TiO₂/CdS nanocomposite via TiO₂ coating on CdS nanoparticles by compartmentalized hydrolysis of Ti alkoxide, *J. Mater. Sci.*, 2001, **36**, 527-532.
46. Anpo, M., Preparation, characterization, and reactivities of highly functional titanium dioxide-based photocatalysts able to operate under UV-Visible light irradiation: approaches in realizing high efficiency in the use of visible light, *Bull. Chem. Soc. Jpn.*, 2004, **77**, 1427-1442.
47. Herrmann, J.-M., The electronic factor and related redox processes in oxidation catalysis, *Catal. Today*, 2006, **112**, 73–77.
48. Augugliaro, V., Loddo, V., Palmisano, L., and Schiavello, M., Performance of heterogeneous photocatalytic systems: influence of operational variables on photoactivity of aqueous suspension of TiO₂, *J. Catal.*, 1995, **153**, 32-40.
49. Zhao, J., and Yang, X., Photocatalytic oxidation for indoor air purification: a literature review, *Build. Environ.*, 2003, **38**, 645-654.

50. Chen, D., and Ray, A. K., Photocatalytic kinetics of phenol and its derivatives over UV irradiated TiO₂, *Appl. Catal. B-Environ.*, 1999, **23**, 143–157.
51. Baleka, V., Li, D., Šubrt, J., Večerníková, E., Hishita, S., Mitsuhashi, T., and Haneda, H., Characterization of nitrogen and fluorine co-doped titania photocatalyst: Effect of temperature on microstructure and surface activity properties, *J. Phys. Chem. Solids*, 2007, **68**, 770–774.
52. Getoff, N., Factors influencing the efficiency of radiation-induced degradation of water pollutants, *Radiat. Phys. Chem.*, 2002, **65**, 437–446.
53. Dyk, A. C., and Heyns, A. M., Dispersion stability and photo-activity of rutile (TiO₂) powders, *J. Colloid Interf. Sci.*, 1998, **206**, 381–391.
54. Palmisano, L., Augugliaro, V., Schiavello, M., and Sclafani, A., Influence of acid-base properties on photocatalytic and phtochemical processes, *J. Mol. Catal. A-Chem.*, 1989, **56**, 284-295.
55. Mao, L., Li, Q., Dang, H., and Zhang, Z., Synthesis of nanocrystalline TiO₂ with high photoactivity and large specific surface area by sol–gel method, *Mater. Res. Bull.*, 2005, **40**, 201–208.
56. Liu, A.R., Wang, S.M., Zhao, Y.R., and Zheng, Z., Low-temperature preparation of nanocrystalline TiO₂ photocatalyst with a very large specific surface area, *Mater. Chem. Phys.*, 2006, **99**, 131–134.
57. Yeung, K.L., Yau, S.T., Maira, A.J., Coronado, J.M., Soria, J., and Yue, P.L., The influence of surface properties on the photocatalytic activity of nanostructured TiO₂, *J. Catal.*, 2003, **219**, 107–116.

58. Calza, P., Pelizzetti, E., Mogyorósi, K., Kun, R., and Dékány, I., Size dependent photocatalytic activity of hydrothermally crystallized titania nanoparticles on poorly adsorbing phenol in absence and presence of fluoride ion, *Appl. Catal. B-Environ.*, 2007, **72**, 314–321.
59. Venkatachalam, N., Palanichamy, M., and Murugesan, V., Sol-gel preparation and characterization of nanosize TiO₂: Its photocatalytic performance, *Mater. Chem. Phys.*, 2007, **104**, 454–459.
60. Bouras, P., Stathatos, E., and Lianos, P., Pure versus metal-ion-doped nanocrystalline titania for photocatalysis, *Appl. Catal. B-Environ.*, 2007, **73**, 51-59.
61. Baolong, Z., Baishun, C., Keyu, S., Shangjin, H., Xiaodong, L., Zongjie, D., and Kelian, Y., Preparation and characterization of nanocrystal grain TiO₂ porous microspheres, *Appl. Catal. B-Environ.*, 2003, **40**, 253–258.
62. Bacsa, R.R. and Kiwi, J., Effect of rutile phase on the photocatalytic properties of nanocrystalline titania during the degradation of *p*-coumaric acid, *Appl. Catal. B-Environ.*, 1998, **16**, 19-29.
63. Fujishima, A., Rao, T.N., and Tryk, D.A., Titanium dioxide photocatalysis, *J. Photoch. Photobio. C.*, 2000, **1**, 1–21.
64. Fujishima, A., and Zhang, X., Titanium dioxide photocatalysis: present situation and future approaches, *C.R. Chim.*, 2006, **9**, 750–760.
65. Liao, D.L., and Liao, B.Q., Shape, size and photocatalytic activity control of TiO₂ nanoparticles with surfactants, *J. Photochem. Photobiol. A.*, 2007, **187**, 363–369.

66. Sonawane, R.S., and Dongare, M.K., Sol-gel synthesis of Au/TiO₂ thin films for photocatalytic degradation of phenol in sunlight, *J. Mol. Catal. A-Chem.*, 2006, **243**, 68–76.
67. Yang, H., Zhang, K., Shi, R., Li, X., Dong, X., and Yu Y., Sol-gel synthesis of TiO₂ nanoparticles and photocatalytic degradation of methyl orange in aqueous TiO₂ suspensions, *J. Alloy Compd.*, 2006, **413**, 302–306.
68. Zhang, R., Gao, L., and Zhang, Q., Photodegradation of surfactants on the nanosized TiO₂ prepared by hydrolysis of the alkoxide titanium, *Chemosphere*, 2004, **54**, 405–411.
69. Zhou, X.F., Chu, D.B., Wang, S.W., Lin, C.J., and Tian, Z.Q., New route to prepare nanocrystalline TiO₂ and its reaction mechanism, *Mater. Res. Bull.*, 2002, **37**, 1851–1857.
70. Chhor, K., Bocquet, J.F., and Justin, C. C., Comparative studies of phenol and salicylic acid photocatalytic degradation: influence of adsorbed oxygen, *Mater. Chem. Phys.*, 2004, **86**, 123–131.
71. Sonawane, R.S., and Dongare, M.K., Sol-gel synthesis of Au/TiO₂ thin films for photocatalytic degradation of phenol in sunlight, *J. Mol. Catal. A-Chem.*, 2006, **243**, 68–76.
72. Liqiang, J., Xiaojun, S., Baifu, X., Baiqi, W., Weimin, C., and Honggang, F., The preparation and characterization of La doped TiO₂ nanoparticles and their photocatalytic activity, *J. Solid State Chem.*, 2004, **177**, 3375–3382.

73. Colón, G., Maicu, M., Hidalgo, M.C., and Navío, J.A., Cu-doped TiO₂ systems with improved photocatalytic activity, *Appl. Catal. B-Environ.*, 2006, **67**, 41–51.
74. Krýsa, J., Keppert, M., Jirkovský, J., Štengl, V., and Šubrt, J., The effect of thermal treatment on the properties of TiO₂ photocatalyst, *Mater. Chem. Phys.*, 2004, **86**, 333–339.
75. Lee, J.H., and Yang, Y.S., Effect of hydrolysis conditions on morphology and phase content in the crystalline TiO₂ nanoparticles synthesized from aqueous TiCl₄ solution by precipitation, *Mater. Chem. Phys.*, 2005, **93**, 237–242.
76. Li, W.-C., Comotti, M., and Schüth, F., Highly reproducible syntheses of active Au/TiO₂ catalysts for CO oxidation by deposition–precipitation or impregnation, *J. Catal.*, 2006, **237**, 190–196.
77. Kongsuebchart, W., Praserthdam, P., Panpranot, J., Sirisuk, A., Supphasirongjaroen, P., and Satayaprasert, C., Effect of crystallite size on the surface defect of nano-TiO₂ prepared via solvothermal synthesis, *J. Cryst. Growth*, 2006, **297**, 234–238.
78. Wu, L., Yu, J.C., Wang, X., Zhang, L., and Yu, J., Characterization of mesoporous nanocrystalline TiO₂ photocatalysts synthesized via a solid-solvothermal process at a low temperature, *J. Solid State Chem.*, 2005, **178**, 321–328.
79. Falcomera, D., Daldossoa, M., Cannasb, C., Musinub, A., Lasioc, B., Enzoc, S., Speghinia, A., and Bettinellia, M., A one-step solvothermal route

for the synthesis of nanocrystalline anatase TiO₂ doped with lanthanide ions, *J. Solid State Chem.*, 2006, **179**, 2452–2457.

80. Li, G.L., and Wang, G.H., Synthesis of nanometer-sized TiO₂ particles by a microemulsion method, *NanoStructured Materials*, 1999, **11**(5), 663–668.
81. Wang, J., Sunb, J., and Bian, X., Preparation of oriented TiO₂ nanobelts by microemulsion technique, *Mat. Sci. Eng. A-struct.*, 2004, **379**, 7–10.
82. Kitamura, Y., Okinaka, N., Shibayama, T., Mahaney, O.O.P., Kusano, D., Ohtani, B., and Akiyama, T., Combustion synthesis of TiO₂ nanoparticles as photocatalyst, *Powder Technol.*, 2007, **176**, 93–98.
83. Priya, M.H., and Madras, G., Photocatalytic degradation of nitrobenzenes with combustion synthesized nano-TiO₂, *J. Photoch. Photobio. A.*, 2006, **178**, 1–7.
84. Sakthivel, S., Shankar, M.V., Palanichamy, M., Arabindoo, B., Bahnemann, and D.W., Murugesan, V., Enhancement of photocatalytic activity by metal deposition: characterisation and photonic efficiency of Pt, Au and Pd deposited on TiO₂ catalyst, *Water Res.*, 2004, **38**, 3001–3008.
85. Satterfield, C.N., *Heterogeneous Catalysis in Industrial Practice*, McGraw-Hill, New York, 1991.
86. Kontos, A.I., Arabatzis, I.M., Tsoukleris, D.S., Kontos, A.G., Bernard, M.C., Petrakis, D.E., and Falaras, P., Efficient photocatalysts by hydrothermal treatment of TiO₂, *Catal. Today*, 2005, **101**, 275–281.

87. Kim, D.S., and Kwak, S.-Y., The hydrothermal synthesis of mesoporous TiO₂ with high crystallinity, thermal stability, large surface area, and enhanced photocatalytic activity, *Appl. Catal. A-Gen.*, 2007, **323**, 110–118.
88. Zhang, F.-B., and Li, H.-L., Hydrothermal synthesis of TiO₂ nanofibres, *Mater. Sci. Eng. C*, 2007, **27**, 80–82.
89. Kolen'ko, Y.V., Churagulov, B.R., Kunst, M., Mazerolles, L., and Justin, C.C., Photocatalytic properties of titania powders prepared by hydrothermal method, *Appl. Catal. B-Environ.*, 2004, **54**, 51–58.
90. Watt, I.M., *The Principles and practice of Electron Microscopy*, Cambridge University Press, Cambridge, 1997.
91. Egerton, R.F., *Physical Principles of Electron Microscopy; An Introduction to TEM, SEM, and AEM*, University of Alberta, Alberta, 2005.
92. Venezia, A.M., X-ray photoelectron spectroscopy (XPS) for catalysts characterization, *Catal. Today*, 2003, **77**, 359–370.
93. <http://www.wcaslab.com/tech/tbftir.htm> (1 August 2007).
94. Richey, H.G., *Fundamentals of Organic Chemistry*, Prentice-Hall, Upper Saddle River, 1983.
95. Martin, S.T., Morrison, C.L., and Hoffmann, R., Photochemical mechanism of size-quantized vanadium-doped TiO₂ Particles, *J. Phys. Chem.*, 1994, **98**, 13695-13704.
96. Navío, J.A., Colh, G., Litter, M.I., and Bianco, G.N., Synthesis, characterization and photocatalytic properties of iron-doped titania

- semiconductors prepared from TiO₂, and iron(III) acetylacetone, *J. Mol. Catal. A-Chem.*, 1996, **106**, 267-276.
97. Navío, J.A., Colon, G., Macias, M., Real, C., and Litter, M.I., Iron-doped titania semiconductor powders prepared by sol-gel method. Part I: synthesis and characterization. *Appl. Catal. A-Gen.*, 1999, **177**, 111-120.
98. Dhananjeyan, M.R., Kandavelu, V., and Renganathan, R., A study on the photocatalytic reactions of TiO₂ with certain pyrimidine bases: effects of dopants (Fe³⁺) and calcinations, *J. Mol. Catal. A-Chem.*, 2000, **151**, 217-223.
99. Anpo, M., and Takeuchi, M., Design and development of second-generation titanium oxide photocatalysts to better our environment-approaches in realizing the use of visible light, *Int. J. Photoenergy*, 2001, **3**, 89-94.
100. Paola, D., Lopez, E.G., Ikeda, S., Marci, G., Ohtani, B., and Palmisano, L., Photocatalytic degradation of organic compounds in aqueous systems by transition metal doped polycrystalline TiO₂. *Catal. Today*, 2002, **75**, 87-93.
101. Beydoun, D., Tse, H., Amal, R., Low, G., and McEvoy, S., Effect of copper (II) on the photocatalytic degradation of sucrose, *J. Mol. Catal. A-Chem.*, 2002, **177**, 265-272.
102. Li, B., Wang, X., Yan, M., and Li, L., Preparation and characterization of nano-TiO₂ powder, *Mater. Chem. Phys.*, 2002, **78**, 184–188.

103. Yamashita, H., Harada, M., Misaka, J., Takeuchi, M., Neppolian, B., and Anpo, M., Photocatalytic degradation of organic compounds diluted in water using visible light-responsive metal ion-implanted TiO₂ catalyst: Fe ion-implanted TiO₂, *Catal. Today*, 2003, **84**, 191-196.
104. Kang, M., Choung, S.-J., and Park, J.Y., Photocatalytic performance of nanometer-sized Fe_xO_y/TiO₂ particle synthesized by hydrothermal method, *Catal. Today*, 2003, **87**, 87-97.
105. Park, H., Ahn, J.P., Cho, Y.S., Sieger, H., Hahn, H., and Park, J.K., Chemical band structure of V-doped TiO₂ nanopowder synthesized by aerosol-assisted chemical vapor synthesis, *Proceeding to the International Congress of Nanotechnology*, November 7-10, San Francisco, 2004.
106. Su, C., Hong, B.-Y., and Tseng, C.-M., Sol-gel preparation and photocatalysis of titanium dioxide, *Catal. Today*, 2004, **96**, 119–126.
107. Wu, J. C.-S., and Chen, C.-H., A visible-light response vanadium-doped titania nanocatalyst by sol-gel method, *J. Photoch. Photobio. A.*, 2004, **163**, 509-515.
108. Zhu, J., Chen, F., Zhang, J., Chen, H., and Anpo, M., Fe³⁺-TiO₂ photocatalysts prepared by combining sol-gel method with hydrothermal treatment and their characterization, *J. Photoch. Photobio. A.*, 2005, **130**, 35–47.
109. Zhou, M., Yu, J., Cheng, B., and Yu, H., Preparation and photocatalytic activity of Fe-doped mesoporous titanium dioxide nanocrystalline photocatalysts, *Mater. Chem. Phys.*, 2005, **93**, 159-163.

110. Araña, J., Díaz, O.G., Rodríguez, J.M.D., Melián, J.A.H., Cabo, C.G., Peña, J.P., Hidalgo, M.C., and Navío-Santos, J.A., Role of $\text{Fe}^{3+}/\text{Fe}^{2+}$ as TiO_2 dopant ions in photocatalytic degradation of carboxylic acid, *J. Mol. Catal. A-Chem.*, 2003, **197**, 157-171.
111. Grosvenor, A.P., Kobe, B.A., and Biesinger, M.C., McIntyre, N.S., Investigation of multiplet splitting of Fe 2p XPS spectra and bonding in iron compounds, *Surf. Interface Anal.* 2004, **36**, 1564–1574.
112. Franch, M.I., Ayllón, J.A., Peral, J., and Domènech, X., Fe(III) photocatalyzed degradation of low chain carboxylic acids, implications of the iron salt, *Appl. Catal. B-Environ.*, 2004, **50**, 89–99.
113. Jeong J., and Yoon, J., pH effect on OH radical production in photo/ferrioxalate system, *Water Res.*, 2005, **39**, 2893–2900.
114. Colthup, N.B., Daly, L.H., and Wiberley, S.E., Introduction to Infrared and Raman Spectroscopy, Academic Press, London, 1975.
115. Axe, K., Vejgarden, M., and Perrson, P., An ATR-FTIR spectroscopic study of the competitive adsorption between oxalate and malonate at the water-goethite interface, *J. Colloid Interf. Sci.*, 2006, **294**, 31-37.
116. Hug, S.J., and Bahnemann, D., Infrared spectra of oxalate, malonate and succinate adsorbed on the aqueous surface of rutile, anatase and lepidocrocite measured with in situ ATR-FTIR, *J. Electron Spectrosc.*, 2006, **150**, 208-219.
117. Araña, J., Díaz, O.G., Saracho, M.M., Rodríguez, J.M.D., Melián, J.A.H., and Peña, J.P., Photocatalytic degradation of formic acid using Fe/TiO_2

catalysts: the role of $\text{Fe}^{3+}/\text{Fe}^{2+}$ ions in the degradation mechanism,
Appl. Catal. B-Environ., 2001, **32**, 49–61.

118. Stuart, B., Infrared Spectroscopy: Fundamentals and Applications, John Wiley&Sons, Sydney, 2004, 77-79.
119. Wu, K., Xie, Y., Zhao, J., and Hidaka, H., Photo-Fenton degradation of a dye under visible light irradiation, *J. Mol. Catal. A- Chem.*, 1999, **144**, 77–84.
120. Mazellier, P., and Sulzberger, B., Diuron Degradation in irradiated, heterogeneous iron/oxalate systems; the rate-determining step, *Environ. Sci. Technol.* 2001, **35**, 3314-3320.
121. Balmer, M.E.; and Sulzberger, B. Atrazine degradation in irradiated iron/oxalate system: effects of pH and oxalate, *Environ. Sci. Technol.* 1999, **33**, 2418-2424.
122. Dhananjeyan, M.R., Kandavelu, V., and Renganathan, R. A study on the photocatalytic reactions of TiO_2 with certain pyrimidine bases: effects of dopants (Fe^{3+}) and calcinations, *J. Mol. Catal. A-Chem.* 2000, **151**, 217–223.
123. Quici, N.; Morgada, M.E.; Piperata, G.; Babay, P.; Gettar, R.T.; and Litter, M.I. Oxalic acid destruction at high concentrations by combined heterogeneous photocatalysis and photo-Fenton processes, *Catal. Today*, 2005, **101**, 253-260.

124. Andreozzi, R.; Caprio, V.; Insola, A.; and Marotta, R. Advanced oxidation processes (AOP) for water purification and recovery, *Catal. Today*, 1999, **53**, 51-59.
125. Litter, M.I., Heterogeneous photocatalysis transition metal ion in photocatalytic systems, *Appl. Catal B-Environ.*, 1999, **177**, 111-120.

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