REFERENCES

[1] Patnaik, P. *A comprehensive guide to the hazardous properties of chemical substances*, 3rd edition, Wiley, 2007.

[2] Fine, G.F.; Cavanagh, L.M.; Afonja, A.; and Binions, R. Metal oxide semiconductor gas sensors in environmental monitoring, *Sensors* 10 (2010): 5469-5502.

[3] Ding, B.; Wang, M.; Yu, J.; and Sun, G. Gas sensors based on electrospun nanofibers, *Sensors* 9 (2009): 1609-1624.

[4] Arafat, M. M.; Dinan , B.; Akbar, S. A.; and Haseeb, A. S. M. A. Gas sensors based on one dimensional nanostructured metal-oxides: A Review, *Sensors* 12 (2012): 7207-7258.

[5] Wang, C.; Yin, L.; Zhang, L.; Xiang, D.; and Gao, R. Metal oxide gas sensors: Sensitivity and influencing factors, *Sensors* 10 (2010): 2088-2106.

[6] Rickerby, D. G., and Serventi, A. M. Nanostructured metal oxide gas sensors for air-quality monitoring, In *Environanotechnology*, pp. 99-136, Elsavier, 2010.

[7] Herrán, J.; Mandayo, G. G.; and Castaño, E. Physical behaviour of $BaTiO_3$–CuO thin-film under carbon dioxide atmospheres, *Sensor and Actuator B* 127 (2007): 370-375.

[8] Kim, I.-D.; Jeon, E.-K.; Choi, S.-H.; Choi, D.-K.; and Tuller, H. L. Electrospun SnO_2 nanofiber mats with thermo-compression step for gas sensing applications, *Journal of Electroceramics* 25 (2010): 159–167.

[9] Vaishampayan, M. V.; Deshmukh, R. G.; Walke, P.; and Mulla, I.S. Fe-doped SnO_2 nanomaterial: A low temperature hydrogen sulfide gas sensor, *Materials Chemistry and Physics* 109 (2008): 230–234.

[10] Leng, J.-y.; Xu, X.-j.; Lv, N.; Fan, H.-t.; and Zhang, T. Synthesis and gas-sensing characteristics of WO_3 nanofibers via electrospinning, *Journal of Colloid and Interface Science* 356 (2011): 54–57.

[11] Khorami, H. A.; Keyanpour-Rad, M.; and Vaezi, M. R. Synthesis of SnO_2/ZnO composite nanofibers by electrospinning method and study of its ethanol sensing properties, *Applied Surface Science* 257 (2011): 7988–7992.

[12] Ruiz, A. M.; Sakai, G.; Cornet, A.; Shimanoe, K.; Morante, J. R.; and Yamazoe, N. Cr-doped TiO_2 gas sensor for exhaust NO_2 monitoring, *Sensors and Actuators B* 93 (2003): 509–518.

[13] de Lacy Costello, B.P.J.; Ewen, R.J.; Ratcliffe, N.M.; and Richards, N.M. Highly sensitive room temperature sensors based on the UV-LED activation of zinc oxide nanoparticles, *Sensors and Actuators B* 134 (2008): 945–952.

[14] Gong, J.; Li, Y.; Chai, X.; Hu, Z.; and Deng, Y. UV-Light-Activated ZnO fibers for organic gas sensing at room temperature, *Journal of Physical Chemistry C* 114 (2010): 1293-1298.

[15] Chen, H.; Liu, Y.; Xie, C.; Wu, J.; Zeng, D.; and Liao, Y. A comparative study on UV light activated porous TiO_2 and ZnO film sensors for gas sensing at room temperature, *Ceramics International* 38 (2012): 503-509.

[16] Sun, J.; Xu, J.; Yu, Y.; Sun, P.; Liu, F.; and Lu, G. UV-activated room temperature metal oxide based gas sensor attached with reflector, *Sensors and Actuators B* 169 (2012): 291– 296.

[17] Peng, L.; Zhao, Q.; Wang, D.; Zhai, J.; Wang, P.; Pang, S.; and Xie, T. Ultraviolet-assisted gas sensing: A potential formaldehyde detection approach at room temperature based on zinc oxide nanorods, *Sensors and Actuators B* 136 (2009): 80–85.

[18] Wang, W.; Li, Z.; Zheng, W.; Huang, H.; Wang, C.; and Sun, J. Cr_2O_3-sensitized ZnO electrospun nanofibers based ethanol detectors, *Sensors and Actuators B* 143 (2010): 754–758.

[19] Choi, J. K.; Hwang, I.-S.; Kim, S.J.; Park, J.-S.; Park, S.-S.; Jeong, U.; Kang, Y. C.; and Lee, J.-H. Design of selective gas sensors using electrospun Pd-doped SnO_2 hollow nanofibers, *Sensors and Actuators B* 150 (2010): 191-199.

[20] Zhang, Y.; He, X.; Li, J.; Miao, Z.; and Huang, F. Fabrication and ethanol-sensing properties of micro gas sensor based on electrospun SnO_2 nanofibers, *Sensors and Actuators B* 132 (2008): 67–73.

[21] Liu, L.; Li, S.; Zhuang, J.; Wang, L.; Zhang, J.; Li, H.; Liu, Z.; Han, Y.; Jiang, X.; and Zhang, P. Improved selective acetone sensing properties of Co-doped ZnO nanofibers by electrospinning, *Sensors and Actuators B* 155 (2011): 782–788.

[22] Fan, S.-W.; Srivastava, A. K.; and Dravid, V. P. Nanopatterned polycrystalline ZnO for room temperature gas sensing, *Sensors and Actuators B* 144 (2010): 159–163.

[23] Kim, I.-D.; Rothschild, A.; Lee, B. H.; Kim, D.Y.; Jo, S. M.; and Tuller, H. L. Ultrasensitive chemiresistors based on electrospun TiO_2 nanofibers, *Nano Letters* 6 (2006): 2009-2013.

[24] Zhang, J.; Choi, S.-W.; and Kim, S. S. Micro- and nano-scale hollow TiO_2 fibers by coaxial electrospinning: Preparation and gas sensing, *Journal of Solid State Chemistry* 184 (2011): 3008–3013.

[25] Biao, W.; YuDong, Z.; LiMing, H.; JunSheng, C.; FengLi, G.; Yun, L.; and LiJun, W. Improved and excellent CO sensing properties of Cu-doped TiO_2 nanofibers, *Electronics Physics* 55 (2010): 228-232.

[26] Naranjo, E., and Neethling, G. A. Diversified technologies for fixed gas detection. [Online]. Available from:

http://s7d9.scene7.com/is/content/minesafetyappliances/Gas%20Detection %20Technologies%20White%20Paper [2011, October 11].

[27] Inductiveload Semiconductor/What is a semiconductor. [Online]. Available from:
http://upload.wikimedia.org/wikipedia/commons/thumb/0/0b/Band_gap_comparison.svg/350px-Band_gap_comparison.svg.png [2013, August 22].

[28] Chou. S. M.; Teoh, L. G.; Lai, W. H.; Su, Y. H.; and Hon, M. H. ZnO:Al thin film gas sensor for detection of ethanol vapor, *Sensors* 6 (2006): 1420-1427.

[29] Wei, S.; Yu, Y.; and Zhou, M. CO gas sensing of Pd-doped ZnO nanofibers synthesized by electrospinning method, *Materials Letters* 64 (2010): 2284–2286.

[30] Park, J.-A.; Moon, J.; Lee, S.-J.; Kim, S. H.; Zyung, T.; and Chu, H. Y. Structure and CO gas sensing properties of electrospun TiO_2 nanofibers, *Materials Letters* 64 (2010): 255–257.

[31] Comini, E.; Cristalli, A.; Faglia, G.; and Sberveglieri, G. Light enhanced gas sensing properties of indium oxide and tin dioxide sensors, *Sensors and Actuators B* 65 (2000): 260–263.

[32] Kim, Y.-S.; Hwang, I.-S.; Kim, S.-J.; Lee, C.Y.; and Lee, J.-H. CuO nanowire gas sensors for air quality control in automotive cabin, *Sensors and Actuators B* 135 (2008): 298-303.

[33] Moon, J.; Park, J.-A.; Lee, S.-J.; Zyung, T.; and Kim, I.-D. Pd-doped TiO_2 nanofiber networks for gas sensor applications, *Sensors and Actuators B* 149 (2010): 301–305.

[34] Kaur, M.; Jain, N.; Sharma, K.; Bhattacharya, S.; Roy, M.; Tyagi, A.K.; Gupta, S.K.; and Yakhmi, J.V. Room-temperature H_2S gas sensing at ppb level by single crystal In_2O_3 whiskers, *Sensors and Actuators B* 133 (2008): 456-461.

[35] Alessandri, I.; Comini, E.; Bontempi, E.; Faglia, G.; Depero, L. E.; and Sberveglieri, G. Cr-inserted TiO_2 thin films for chemical gas sensors, *Sensors and Actuators B* 128 (2007): 312–319.

[36] Wang, B.; Zhu, L.F.; Yang, Y.H.; Xu, N.S.; and Yang, G.W. Fabrication of a SnO_2 nanowire gas sensor and sensor performance for hydrogen, *Journal of Physical Chemistry C* 112 (2008): 6643–6647.

[37] Xiangfeng, C.; Caihong, W.; Dongli, J.; and Chenmou, Z. Ethanol sensor based on indium oxide nanowires prepared by carbothermal reduction reaction, *Chemical Physics Letters* 399 (2004): 461-464.

[38] Gou, X.; Wang, G.; Yang, J.; Park, J.; and Wexler, D. Chemical synthesis, characterization and gas sensing performance of copper oxide nanoribbons, *Journal of Materials Chemistry* 18 (2008): 965-969.

[39] Zeng, Y.; Lou, Z.; Wang, L.; Zou, B.; Zhang, T.; Zheng, W.; and Zou, G. Enhanced ammonia sensing performances of Pd-sensitized flowerlike ZnO nanostructure, *Sensors and Actuators B* 156 (2011): 395–400.

[40] Pawar, S.G.; Chougule, M. A.; Patil, S. L.; Raut, B. T.; Godse, P. R.; Sen, S.; and Patil, V. B. Room temperature ammonia gas sensor based on polyaniline-TiO_2 nanocomposite, *IEEE Sensors Journal* 11 (2011): 3417-3423.

[41] Thong, L. V.; Hoa, N. D.; Le, D. T. T.; Viet, D. T.; Tam, P. D.; Le, A.-T.; and Hieu, N. V. On-chip fabrication of SnO_2-nanowire gas sensor: The effect of growth time on sensor performance, *Sensors and Actuators B: Chemical* 146 (2010): 361–367.

[42] Zhao, M.; Wang, X.; Ning, L.; Jia, J.; Li, X.; and Cao, L. Electrospun Cu-doped ZnO nanofibers for H_2S sensing, *Sensors and Actuators B* 156 (2011): 588–592.

[43] Lin, H.-M.; Hsu, T.-Y.; Tung, C.-Y.; and Hsu, C.-M. Hydrogen sulfide detection by nanocrytal Pt doped TiO_2-based gas sensors, *Nanostructure Materials* 6 (1995): 1001-1004.

[44] Rout, C. S.; Hedge, M.; and Rao, C.N.R. H_2S sensors based on tungsten oxide nanostructures, *Sensors and Actuators B* 128 (2008): 488-493.

[45] Vaishampayan, M.V.; Deshmukh, R.G.; Walke, P.; and Mulla, I.S. Fe-doped SnO_2 nanomaterial: A low temperature hydrogen sulfide gas sensor, *Materials Chemistry and Physics* 109 (2008): 230–234.

[46] Zheng, W.; Lu, X.; Wang, W.; Li, Z.; Zhang, H.; Wang, Z.; Xu, X.; Li, S.; and Wang, C. Assembly of Pt nanoparticles on electrospun In_2O_3 nanofibers for H_2S detection, *Journal of Colloid and Interface Science* 338 (2009): 366–370.

[47] Iyama, T.; Kato, A.; Fujiishi, K.; and Nagatani, M. A new detector for gaseous components using semiconductive thin films, *Analytical Chemistry* 34 (1962): 1502-1503.

[48] Barreca, D.; Bekermann, D.; Comini, E.; Devi, A.; Fischer, R. A.; Gasparotto, A.; Maccato, C.; Sberveglieri, G.; and Tondello, E. 1D ZnO nano-assemblies by Plasma-CVD as chemical sensors for flammable and toxic gases, *Sensors and Actuators B* 149 (2010): 1–7.

[49] Herrán, J.; Fernández-González, O.; Castro-Hurtado, I.; Romero, T.; Gª Mandayo, G.; and Castaño, E. Photoactivated solid-state gas sensor for carbon dioxide detection at room temperature, *Sensors and Actuators B* 149 (2010): 368–372.

[50] Doh, S. J.; Kim, C.; Lee, S. G.; Lee, S. J.; and Kim, H. Development of photocatalytic TiO_2 nanofibers by electrospinning and its application to degradation of dye pollutants, *Journal of Hazardous Materials* 154 (2008): 118–127.

[51] Li, H.; Zhang, W.; and Pan, W. Enhanced photocatalytic activity of electrospun TiO_2 nanofibers with optimal anatase/rutile ratio, *Journal of the American Ceramic Society* 94 (2011): 3184–3187.

[52] Mardare, D.; Iftimie, N.; Crişan, M.; Răileanu, M.; Yildiz, A.; Coman, T.; Pomoni, K.; and Vomvas, A. Electrical conduction mechanism and gas sensing properties of Pd-doped TiO_2 films, *Journal of Non-Crystalline Solids* 357 (2011): 1774–1779.

[53] Eriksson, J.; Khranovskyy, V.; Söderlind, F.; Käll, P.-O.; Yakimova, R.; and Spetz, A. L. ZnO nanoparticles or ZnO films: A comparison of the gas sensing capabilities, *Sensors and Actuators B* 137 (2009): 94–102.

[54] Ji, L. Porous nanofibers power up rechargeable batteries. [Online]. Available from: http://images.iop.org/objects/ntw/journal/8/4/9/image2.jpg [2013, August 22].

[55] Park, J. Y., and Kim, S. S. Effects of processing parameters on the synthesis of TiO_2 nanofibers by electrospinning, *Metals and Materials International* 15 (2009): 95-99.

[56] Wang, C.; Zhang, W.; Huang, Z.H.; Yan, E.Y.; and Su, Y.H. Effect of concentration, voltage, take-over distance and diameter of pinhead on precursory poly (phenylene vinylene) electrospinning, *Pigment & Resin Technology*, 35 (2006): 278–283.

[57] Heikkilä, P., and Harlin, A. Parameter study of electrospinning of polyamide-6, *European Polymer Journal* 44 (2008): 3067–3079.

[58] Kim, J., and Yong, K. Mechanism study of ZnO nanorod-bundle sensors for H_2S gas sensing, *Journal of Physical Chemistry C* 115 (2011): 7218–7224.

[59] Cosgrove, T. *Colloid Science – Principle, Methods and Applications*, Blackwell Publishing, 2010.

[60] Hai Yent seat cover (Thailand), Contact angle. [Online]. Available from: http://webiz.co.th/files/photos/0/84/05/840569/1947621.jpg [2013, August 22].

[61] Peng, L.; Zeng, Q.; Song, H.; Qin, P.; Lei, M.; Tie, B.; and Wang, T. Room-temperature gas sensing properties of cobalt-doped ZnO nanobelts with visible light irradiation, *Applied Physics A* 105 (2011): 387–392.

[62] Carotta, M.C.; Cervi, A.; Fioravanti, A.; Gherardi, S.; Giberti, A.; Vendemiati, B.; Vincenzi, D.; and Sacerdoti, M. A novel ozone detection at room temperature through UV-LED-assisted ZnO thick film sensors, *Thin Solid Films* 520 (2011): 939-946.

[63] Tang, H.; Yan, M.; Zhang, H.; Li, S.; Ma, X.; Wang, M.; and Yang, D. A selective NH_3 gas sensor based on Fe_2O_3-ZnO nanocomposites at room temperature, *Sensors and Actuators B* 114 (2006): 910-915.

[64] Yu, A.; Qian, J.; Pan, H.; Cui, Y.; Xu, M.; Tu, L.; Chai, Q.; and Zhou, X. Micro-lotus constructed by Fe-doped ZnO hierarchically porous nanosheets: Preparation, characterization and gas sensing property, *Sensors and Actuators B* 158 (2011): 9–16.

[65] Zhang, M.; Yuan, Z.; Song, J.; and Zheng, C. Improvement and mechanism for the fast response of a Pt/TiO_2 gas sensor, *Sensors and Actuators B* 148 (2010): 87–92.

[66] Landau, O., and Rothschild, A. Microstructure evolution of TiO_2 gas sensors produced by electrospinning, *Sensors and Actuators B* 171– 172 (2012): 118– 126.

[67] Dhawale, D.S.; Salunkhe, R.R.; Patil, U.M.; Gurav, K.V.; More, A.M.; and Lokhande, C.D. Room temperature liquefied petroleum gas (LPG) sensor based on p-polyaniline/n-TiO_2 heterojunction, *Sensors and Actuators B* 134 (2008): 988–992.

[68] Han, C.-H.; Hong, D.-W.; Kim, I.-J.; Gwak, J.; Han, S.-D.; and Singh, K. C. Synthesis of Pd or Pt/titanate nanotube and its application to catalytic type hydrogen gas sensor, *Sensors and Actuators B* 128 (2007): 320–325.

[69] Ostrick, B.; Mühlsteff, J.; Fleischer, M.; Meixner, H.; Doll, T.; and Kohl, C.-D. Adsorbed water as key to room temperature gas-sensitive reactions in work function type sensors: the carbonate-carbon dioxide system, *Sensors and Actuators B* 57 (1999): 115-119.

[70] Lee, J.-S.; Lee, Y.-I.; Song, H.; Jang, D.-H.; and Choa, Y.-H. Synthesis and characterization of TiO_2 nanowires with controlled porosity and microstructure using electrospinning method, *Current Applied Physics* 11 (2011): 5210-5214.

[71] Lee, D. Y.; Kim, B.-Y.; Lee, S.-J.; Lee, M.-H.; Song, Y.-S.; Lee, J.-Y. Titania nanofibers prepared by electrospinning, *Journal of the Korean Physical Society* 48 (2006): 1686-1690.

[72] Yang, Y.; Jia, Z.; Li, Q.; and Guan, Z. Experimental investigation of the governing parameters in the electrospinning of polyethylene oxide solution, *IEEE Transactions on Dielectrics and Electrical Insulation* 13 (2006): 580–585.

[73] Ding, B.; Kim, H.Y.; Lee, S.C.; Lee, D.R.; and Choi, K.J. Preparation and characterization of nanoscaled poly(vinyl alcohol) fibres via electrospinning. *Fibers and Polymers* 3 (2002): 73–79.

[74] Kidoaki, S.; Kwon, I.K.; and Matsuda, T. Structural features and mechanical properties of in situ-bonded meshes of segmented polyurethane electrospun from mixed solvents, *Journal of Biomedical Materials Research, Part B: Applied Biomaterials* 76B (2006): 219–229.

[75] Wang, C.; Hsu, C.H.; and Lin, J.H. Scaling laws in electrospinning of polystyrene solutions, *Macromolecules* 39 (2006): 7662–7672.

[76] Megelski, S.; Stephens, J.S.; Chase, D.B.; and Rabolt, J.F. Micro- and nanostructured surface morphology on electrospun polymer fibres, *Macromolecules* 35 (2002): 8456-8466.

[77] Wyckoff, R. W. G. *Crystal Structure,* 2nd edition, Interscience Publishing, 1963.

[78] Rouquerol, J.; Avnir, D.; Fairbbridge, C. W.; Everett, D. H.; Haynes, J. H.;Pernicone, N.; Ramsay, J. D. F.; Sing, K. S. W.; and Unger, K. K. Recommendations for the characterization of porous solids, *Pure and Applied Chemistry* 66 (1994): 1739-1758.

[79] Schnider, P. Adsorption isotherms of microporous-mesoporous solids revisited, *Applied Catalysis, A: General* 129 (1995): 157-165.

[80] 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.

[81] Ohtani, B. Titania photocatalysis beyond recombination: A critical review, *Catalysts* 3 (2013): 942-953.

[82] Basu, S., and Basu, P. K. Nanocrystalline metal oxides for methane sensors: Role of noble metals, *Journal of Sensors* 2009 (2009): 1-20.

[83] Kondarides, D. I.; Daskalaki, V. M.; Patsoura, A.; and Verykios, X. E. Hydrogen production by photo-induced reforming of biomass components and derivatives at ambient conditions, *Catalysis Letters* 122 (2008): 26–32.

[84] Schwarzwnbach, R. P.; Gschwend, P. M.; and Imboden, D. M. *Environmental organic chemistry*, 2nd edition, John Wiley & Sons, 2003.

[85] Adkins, H.; Elofson, R. M.; Rossow, A. G.; and Robinson, C. C. The oxidation potentials of aldehydes and ketones, *Journal of American Chemical Society* 71 (1949): 3622-3629.

[86] Iwasita, T. Electrocatalysis of methanol oxidation, *Electrochimica Acta* 47 (2002): 3663-3674.

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