

REFERENCES

- Agag, T., and Takeichi, T. (2000) Polybenzoxazine–montmorillonite hybrid nanocomposites: synthesis and characterization. *Polymer*, 41, 7083-7090.
- Agag, T., and Takeichi, T. (2001) Effect of hydroxyphenylmaleimide on the curing behavior and thermomechanical properties of rubber-modified polybenzoxazine. *High Performance Polymers*, 13(2), 327-342.
- Agag, T., and Takeichi, T. (2001) Novel benzoxazine monomers containing p-phenyl propargyl ether: polymerization of monomers and properties of polybenzoxazines. *Macromolecules*, 34, 7257-7263.
- Agag, T., and Takeichi, T. (2003) Synthesis and characterization of novel benzoxazine monomers containing allyl groups and their high performance thermosets. *Macromolecules*, 36, 6010-6017.
- Agag, T., and Takeichi, T. (2004) Synthesis and properties of silica-modified polybenzoxazine. *Materials Science Forum*, 449-452, 1157-1160.
- Agag, T., and Takeichi, T. (2006) High-molecular-weight AB-type benzoxazines as new precursors for high-performance thermosets. *Journal of Polymer Science Part A: Polymer Chemistry*, 45, 10, 1878-1888.
- Alves, M.M., Gonzalez, C.G., Guedes, C.R., Castanheira, J.M., Pereira, M.C., and Vasconcelos, L.A.T. (1993) Chromium removal in tannery wastewaters polishing by Pinus sylvestris bark. *Water Research*, 27(8), 1333-1338.
- Aziz, A.H. and Smith, P.G. (1992) The influence of pH and coarse media on manganese precipitation from water. *Water Research*, 26(6), 853-855.
- Berkeley, R.C.W. (1979) Chitin, chitosan and their degradative enzymes in microbial polysaccharides. Academic Press, New York, 205-236.
- Brunovska, Z., and Ishida, H. (1999) Thermal study on the copolymers of phthalonitrile and phenylnitrile-functional benzoxazines. *Journal of Applied Polymer Science*, 73, 2937-2949.
- Burke, W.J. (1949) 3,4-dihydro-1,3,2H-benzoxazines reaction of p-substituted phenols with N,N-dimethylolamines. *Journal of the American Chemical Society*, 71, 609-612.

- Burke, W.J., Bishop J.L., Glennie E.L.M., and Bauer W.N. (1965) A new amino alkylation reaction. Condensation of phenols with dihydro-1,3-azoxazines. Journal of the American Chemical Society, 30, 3423-3427.
- Brunovska, Z., Liu, J. P., and Ishida, H. (1999) 1,3,5-triphenylhexahydro-1,3,5-triazine - active intermediate and precursor in the novel synthesis of benzoxazine monomers and oligomers. Macromolecular Chemistry and Physics. 200(7), 1745-1752.
- Cao, C., Chung, T.S., Lui, Y., Wang, R., and Pramoda, K.P. (2003) Chemical cross-linking modification of 6FDA-2,6-DAT hollow fiber membranes for natural gas separation. Journal of Membrane Science, 216, 257-268.
- Chaisuwan, T., and Ishida, H. (2006) High-performance maleimide and nitrile-functionalized benzoxazines with good processibility for advanced composites applications. Journal of Applied Polymer Science, 101, 548-558.
- Chaisuwan, T., Komalwanich, T., Luangsukrerk, S., and Wongkasemjit, S. (2010) Removal of heavy metals from model wastewater by using polybenzoxazine aerogel. Desalination, 256, 108-114.
- Chanda, M., O'Driscoll, K.F., and Rempel, G.L. (1988) Ligand exchange sorption of arsenate and arsenite anions by chelating resins in ferric ion form. Reactive Polymers. 9, 277.
- Chung, T.S., Ren, J., Wang, R., Li, D., Liu, Y., Pramoda, K.P., and Loh, W.W. (2003) Development of asymmetric 6FDA-2,6DAT hollow fiber membranes for CO₂/CH₄ separation Part 2. Suppression of plasticization. Journal of Membrane Science, 214, 57-69.
- Dobbs, R.A., Uchida, S., Smith, L.M., and Cohen, J.M. (1975) Ammonia removal from waste water by ligand exchange. Aiche Journal. 71(152), 157-163.
- Dhawan, S., Dhawan, K., Varma, M., and Sinha, V.R. (2006) Applications of poly(ethylene oxide) in drug delivery systems part II. Pharmaceutical Technology, 82-96.
- Dietzel, J. M., Klienmeyer, J., Harris, D., and Beck Tan, N.C. (2001) The effect of processing variables on the morphology of electrospun nanofibers and textiles. Polymer, 42, 261.

- Doshi, J., and Reneker, D. (1995) Electrospinning process and applications of electrospun fibers. Journal of Electrostatics, 35, 151-160.
- Dunkers, J., and Ishida, H. (1995) Vibrational assignments of 3-alkyl-3,4-dihydro-6-methyl-2H-1,3-benzoxazines in the fingerprint region. Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy, 51(6), 1061-1074.
- Duval, J.M., Folkers, B., Mulder, M.H.V., Desgrandchamps, G., and Smolders, C.A. (1993) Adsorbent filled membranes for gas separation. Part I. Improvement of the gas separation properties of polymeric membranes by incorporation of microporous adsorbents. Journal of Membrane Science, 80, 189.
- Faisal, M., and Hasnain, S. (2004) Microbial conversion of Cr(vi) into Cr(iii) in industrial effluent. African Journal of Biotechnology, 3(11).610-617.
- Faust, S. D. and O.M. Aly. (1987) Adsorption processes for water treatment. London. ButterWorth Publisher.
- Fong, H., Chun, I., and Reneker, D. (1999) Beaded nanofibers formed during electrospinning. Polymer, 40, 4585-4592.
- Gallegos, A.K.C., and Rincón, M.E. (2006) Carbon nanofiber and PEDOT-PSS bilayer systems as electrodes for symmetric and asymmetric electrochemical capacitor cells. Journal of Power Sources, 162, 743-747.
- Groves, F.R., and White, T. (1984) Mathematical modeling of ligand exchange process. Aiche Journal. 30(3), 494-496.
- Hariri, S. and Naguib, H. (2009) Development and Characterization of Novel Biodegradable PLGA Electrospun Scaffolds for tissue engineering. B.C. Thesis, University of Toronto, Toronto, Canada.
- Helfferich, C. (1961). Ligand exchange : A novel separation technique. Nature. 189(2), 1001-1002.
- Hemvichian, K., Laobuthee, A., Chirachanchai, S., and Ishida, H. (2002) Thermal decomposition processes in polybenzoxazine model dimers investigated by TGA-FTIR and GC-MS. Polymer Degradation and Stability, 76, 1-15.
- Henry, W. D., Zhao, D. Y., SenGupta, A. K., and Lange, C. (2004) Preparation and characterization of a new class of polymeric ligand exchangers for selective removal of trace contaminants from water. Reactive & Functional Polymers. 60, 109-120.

- Holly, F.W., and Cope, A.C. (1944) Condensation products of aldehydes and ketones with o-aminobenzyl alcohol and o-hydroxy-benzylmine. Journal of the American chemocal society, 66, 1875-1879.
- Hoque, A., Alam, M. K., and Tibbetts, G. G. (2001) Synthesis of catalyst particles in a vapor grown carbon fiber reactor. Chemical Engineering Science, 56, 4233-4243.
- Hrubesh, L. W. (1998) Aerogel applications. Journal of Non-Crystalline Solids, 225, 335-342.
- Hsien, T.Y. and Rorrer, G.L. (1995) Effect of acrylation and crosslinking on the material properties and cadmium ion adsorption capacity of porous chitosan beads. Separation Science Technology, 30(12), 2455-2475.
- Huang, Z. M., Zhang, Y. Z., Kotakic, M., and Ramakrishna, S. (2003) A review on polymer nanofibers by electrospinning and their applications in nano composites. Composites Science and Technology, 63, 2223-2253.
- Ishida H. (1996) US Patent 5, 543, 516.
- Ishida, H., and Allen, D. (1996) Mechanical characterization of copolymers based on benzoxazine and epoxy. Polymer, 37, 4487-4495.
- Ishida, H., and Rodriguez, Y. (1995) Curing kinetics of a new benzoxazine-based phenolic resin by differential scanning calorimetry. Polymer, 36, 3151-3158.
- Ishida, H., and Lee, Y. H. (2001) Study of hydrogen bonding and thermal properties of polybenzoxazine and poly-(epsilon-caprolactone) blends. Journal of Polymer Science Part B: Polymer Physics, 39, 736-749.
- Ishida, H., and Ohba, S. (2005) Synthesis and characterization of maleimide and norbornene functionalized benzoxazines. Polymer, 46, 5588.
- Ismail, A.F., and Lorna, W. (2002) Penetrant-induced plasticization phenomenon in glassy polymers for gas separation membrane. Separation and Purification Technology, 27, 173-194.
- James, C. M. (2009) Assessment of electrospinning as an in-house fabrication technique for blood vessel mimic cellular scaffolding, M.S. Thesis, California Polytechnic State University, San Luis Obispo, California, USA.

- Jimenez, G.A., and Jana, S.C. (2007) Oxidized carbon nanofiber/polymer composites prepared by chaotic mixing. *Carbon*, 45, 2079-2091.
- Jin, H.J., Fridrikh, S.V., Rutledge, G.C., and Kaplan, D.L. (2002) Electrospinning Bombyx mori silk with poly(ethylene oxide). *Biomacromolecules*, 3, 1233.
- Kang, I., Heung, Y.Y., Kim, J.H., Lee, J.W., Gollapudi, R., Subramaniam S., Narasimhadvara, S., Hurd, D., Kirikera, G.R., Shanov, V., Schulz, M.J., Shi, D., Boerio, J., Mall, S., and Wren, M.R. (2006) Introduction to carbon nanotube and nanofiber smart materials. *Composites Part B*, 37, 382-394.
- Katanyoota, P., Chaisuwana, T., Wongchaisuwatb, A., and Wongkasemjita, S. (2010) Novel polybenzoxazine-based carbon aerogel electrode for supercapacitors. *Materials Science and Engineering B*, 167, 36-42.
- Kim, H.J., Brunovska, Z., and Ishida, H. (1999) Dynamic mechanical analysis on highly thermally stable polybenzoxazines with an acetylene functional group. *Journal of Applied Polymer Science*, 73, 857-862.
- Kim, H.J., Brunovska, Z., and Ishida, H. (1999) Molecular characterization of the polymerization of acetylene-functional benzoxazine resins. *Polymer*, 40, 1815-1822.
- Kim, S.H., Kim, D.U., and Lee, S.K. (2006). Elongation of vertically well-aligned carbon nanofiber bundles and their field emission characteristics, *Current Applied Physics*, 6, 766-771.
- Kima, C., Choib, Y.O., Leea, W.J., and Yanga, K.S. (2004) Supercapacitor performances of activated carbon fiber webs prepared by electrospinning of PMDA-ODA poly(amic acid) solutions. *Electrochimica Acta*, 50, 883-887.
- Kimura, H., Matsumoto, A., Hasegawa, K., and Fukuda, A. (1999) New thermo setting resin from bisphenol A-based benzoxazine and bisoxazoline. *Journal of Applied Polymer Science*, 72, 1551-1558.
- Kiskan, B., Colak, D., Muftuoglu, A.E., Cianga, I., and Yagci, Y. (2005) Synthesis and characterization of thermally curable benzoxazine-functionalized poly styrene macromonomers. *Macromolecular Rapid Communications*, 26, 819-824.

- Kiskan, B., Yagci, Y., and Ishida, H. (2008) Synthesis, characterization, and properties of new thermally curable polyetheresters containing benzoxazine moieties in the main chain. Journal of Polymer Science: Part A: Polymer Chemistry, 46, 414-420.
- Koros, W.J. (1985) Simplified analysis of gas/polymer selective solubility behavior. Journal of Polymer Science Polymer Physics Edition, 23, 1611.
- Koros, W.J., and Mahajan, R. (2002) Mixed matrix materials with glassy polymer. Part 1. Polymer Engineering and Science, 42(7), 1420-1431.
- Koros, W.J., and Mahajan, R. (2002) Mixed matrix membrane materials with glassy polymer. Part 2. Polymer Engineering and Science, 42(7), 1432-1441.
- Krishna, R., and Baten, J.V.. (2007) Using molecular simulations for screening of zeolites for separation of CO₂/CH₄ mixtures. Journal of Chemical and Engineering, 133, 121-131.
- Kurita, K., Sannan, T., and Iwakaru, Y. (1979) Studies on chitin VI. Binding of metal cations. Journal of Applied Polymer Science, 23, 511-515.
- Li, Q., Jia, Z., Yang, Y., Wang, L., and Guan, Z. (2007) Preparation and properties of poly(vinyl alcohol) nanofibers by electrospinning. International Conference on Solid Dielectrics, Winchester, UK.
- Li, Y., and Chung, T.S. (2007). Novel Ag⁺-zeolite/polymer mixed matrix membranes with a high CO₂/CH₄ selectivity. Wiley Interscience, 53(3), 610-616.
- Low, H.Y., and Ishida, H. (1999) Structural effects of phenols on the thermal and thermo-oxidative degradation of polybenzoxazines. Polymer, 4365-4376.
- Marsi, M.S. and Friedman, M. (1974) Effect of chemical modification of wool on metal ion binding. Journal of Applied Polymer Science, 18, 2367-2377.
- Manandhar, S., Vidhate, S., and Souza, N.D. (2009) Water soluble levan poly saccharide biopolymer electrospun fibers. Carbohydrate Polymers, 78, 794-798.
- Meena, A.K., Mishra, G.K., Rai, P.K., Rajagopal, C., and Nagar, P.N. (2005) Removal of heavy metal ions from aqueous solutions using carbon aerogel as an adsorbent. Journal of Hazardous Materials, 122(1-2), 161-170.

- Mo, X. M., Xu, C. Y., Kotaki, M., & Ramakrishna, S. (2004) Electrospun P(LLA-CL) nanofiber, a biomimetic extracellular matrix for smooth muscle cell and endothelial cell proliferation. *Biomaterials*, 1883-1890.
- Musselman, I.H., Balkus, K.J., and Ferraris, J.P. (2005) Mixed-matrix membranes for CO₂ and H₂ separations using metal-organic frameworks and meso porous hybrid silicas. M.S. thesis, Department of Chemistry and The UTD NanoTech Institute, University of Texas at Dallas, Texas, USA.
- Namasivayam, C. and Ranganathan, K. (1995) Removal of Cd(II) from wastewater by adsorption on “waste” Fe(III)/Cr(III) hydroxide. *Water Research*, 29(7), 1737-1744.
- Nie, H., He, A., Wu, W., Zheng, J., Xu, S., Li, J., and Han, C.C. (2009) Effect of poly(ethylene oxide) with different molecular weights on the electro spinnability of sodium alginate. *Polymer*, 50, 4926-4934.
- Ning, X., and Ishida, H. (1994) Phenolic materials via ring-opening polymerization-synthesis and characterization of bisphenol-a based benzoxazines and their polymers. *Journal of Polymer Science Part A: Polymer Chemistry*, 32, 1121-1129.
- Pakkethati, K., Boonmalert, A., Chaisuwan, T., and Wongkasemjit, S. (2011) Development of polybenzoxazine membranes for ethanol-water separation via pervaporation. *Desalination*, 267, 73-81.
- Panapoy, M., Dankeaw, A., and Ksapabutr, B. (2008) Electrical conductivity of PAN-based carbon nanofibers prepared by electrospinning method. *Thammasat International Journal of Science and Technology*, 13, 11-17.
- Petropoulos, J.H. (1992) Plasticization effects on the gas permeability and permselectivity of polymer membranes. *Journal of Membrane Science*, 75, 47.
- Reneker, D., and Chun, I. (1996) Nanometer diameter fibers of polymer, produced by electrospinning. *Nanotechnology*, 7, 216-223.
- Reneker, D.H., Yarin, A., and Fong, L.H. (2000) Bending instability of electrically charged liquid jets of polymer solutions in electrospinning. *Journal of Applied Physics*, 87, 4531-4547.

- Riess, G., Schwob, M., Guth, G., Roche, M., and Lande, B. (1985) Advances in polymer synthesis. New York: Plenum.
- Rorrer, G.L., Hsien, T.Y., and Way, J.D. (1993) Synthesis of porous-magnetic chitosan beads for removal of cadmium ions from waste water. Industrial Engineering Chemical Research, 32, 2170-2178.
- Sampranpiboon, P., Kamhom, S., and Charnkeitkong, P. (2010) Lead ion adsorption from wastewater by recycle paper processing waste sludge. Proceedings of the 3rd International Conference on Environmental and Geological Science and Engineering, 156-162.
- Santiago, I. Worland, V.P., Cazares-Rivera, E., and Cadena, F. (1992) Adsorption of hexavalent chromium onto tailored zeolites. 47th Purdue Industrial Waste Conference Proceedings (pp. 669-710). Chelsea. Lewis Publishers Inc.
- Sen, D., Kalıçlılar, H., and Yilmaz, L. (2007) Development of polycarbonate based zeolite 4A filled mixed matrix gas separation membranes. Journal of Membrane Science, 303, 194-203.
- Son, W.K., Youk, J.H., Lee, T.S., and Park, W.H. (2004) The effects of solution properties and polyelectrolyte on electrospinning of ultrafine poly(ethylene oxide) fibers. Polymer, 45, 2959-2966.
- Süer, M.G., Bac, N., and Yilmaz, L. (1994) Gas permeation characteristics of polymer-zeolite mixed matrix membranes. Journal of Membrane Science, 91, 77.
- Sun, G., and Shi, W. (1998) Sunflower stalks as adsorbents for the removal of metal ions from wastewater. Industrial and Engineering Chemistry Research, 37, 1324-1328.
- Takeichi, T., Kano, T., and Agag, T. (2005) Synthesis and thermal cure of high molecular weight polybenzoxazine precursors and the properties of the thermosets. Polymer, 46, 12172-12180.
- Taylor, G. (1969) Electrically driven jets. Proceedings of the Royal Society of London A. Mathematical and Physical Sciences, 313, 453-475.
- Tin, P.S., Chung, T.S., Liu, Y., and Wang, R. (2004) Separation of CO₂/CH₄ through carbon molecular sieve membranes derived from P84 polyimide. Carbon, 42, 3123-3131.

- Uguzdogan, E., Denkbas, E.B., Ozturk, E., Tuncel, S.A., and Kabasakal, O.S. (2009) Preparation and characterization of polyethylene glycolmethacrylate (PEGMA)-co-vinylimidazole (VI) microspheres to use in heavy metal removal. *Journal of Hazardous Materials*, 162(2-3), 1073-1080.
- Vazquez, G., Antorrena, G., Gonzalez, J., and Doval. M.D. (1994) Adsorption of heavy matal ions by chemically modified Pinus Pinaster bark. *Bioresource Technology*, 48,251-255.
- Wang, Y.X., and Ishida, H. (2002) Development of low-viscosity benzoxazine resins and their polymers. *Journal of Applied Polymer Science*, 86, 2953-2966.
- Wongsasulaka, S., Kitb, K.M., McClements, D.J., Yoovidhyaa, T., and Weissc, J. (2007) The effect of solution properties on the morphology of ultrafine electrospun egg albumen-PEO composite fibers. *Polymer*, 48(2), 448-457.
- Xie, J., and Hsieh, Y.L. (2003) Ultra-high surface fibrous membranes from electrospinning of natural proteins: casein and lipase enzyme. *Journal of Materials Science*, 38, 2125-2133.
- Xu, W.C., Takahashi, K., Matsuo, Y., Hattori, Y., Kumagai, M., Ishiyama, S., Kaneko, K. and Iijima, S. (2007) Investigation of hydrogen storage capacity of various carbon materials. *International Journal of Hydrogen Energy*, 32, 2504-2512.
- Yagci, Y., Kiskan, B., and Ghosh, N.N. (2009) Recent advancement on polybenzoxazine—a newly developed high performance thermoset. *Journal of Polymer Science: Part A: Polymer Chemistry*, 47, 5565-5576.
- Yang, S., Lozano, K., Lomeli. A., Foltz, H.D., and Jones, R. (2005) Electromagnetic interference shielding effectiveness of carbon nanofiber/LCP. *Composites Part A*, 36, 691-697.
- Yang, Y., Jia, Z. D., and Li, Q. (2006) Experimental investigation of the governing parameters in the electrospinning of polyethylene oxide solution. *IEEE Transactions on DEI*, 13(3). 580-585.
- Yao, W.L., Wang, J.L., Yang, J., and Du, G.D. (2008) Novel carbon nanofiber-cobalt oxide composites for lithium storage with large capacity and high reversibility. *Journal of Power Sources*, 176, 369-372.

- Yong, H.H., Park, H.C., Kang, Y.S., Won, J., and Kim, W.N. (2001) Zeolite-filled polyimide membrane containing 2,4,6-triaminopyrimidine. Journal of Membrane Science, 188, 151-163.
- Zhang, Y., Musselman, I.H., Ferraris, J.P., and Balkus, K.J. (2008) Gas permeability properties of mixed-matrix matrimid membranes containing a carbon aerogel: A material with both micropores and mesopores. Industrial and Engineering Chemistry Research, 47(8), 2794-2802.
- Zheng, G.B., Kouda, K., Sano, H., Uchiyama, Y., Shi, Y.F., and Quan, H.J. (2004) A model for the structure and growth of carbon nanofibers synthesized by the CVD method using nickel as a catalyst. Carbon, 42(3), 635-640.
- Zhao, D. Y., Sengupta, A. K., and Zhu Y. W. (1995) Trace contaminant sorption through polymeric ligand-exchange. Industrial & Engineering Chemistry Research. 34(8), 2676-2684.
- Zimmerman, C.M., Singh, A., and Koros, W.J. (1997) Tailoring mixed matrix composite membranes for gas separations. Journal of Membrane Science, 137, 145-154.
- Zong, X., Kim, K., Fang, D., Ran, S., Hsiao, B. S., and Chu, B. (2002) Structure and process relationship of electrospun bioabsorbable nanofiber membranes. Polymer, 43(16), 4403-441.

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2. Sukcharoen, P.; Wongkasemjit, S.; and Chaisuwan, T. (2011, April 26) Morphological study of electrospun polybenzoxazine blended with poly(ethylene oxide). Paper Presented at the 2nd Research Symposium on Petroleum and Petrochemical, and Advance Materials and the 17th PPC Symposium on Petroleum, Petrochemical, and Polymers, Bangkok, Thailand.