

Resume and Curriculum Vitae for John R. Monnier, Ph.D.

Biographical Information for Dr. John R. Monnier

Professional

Research Chemist, Eastman Kodak Company	1972-1976
University of Wisconsin-Milwaukee (academic leave of absence)	1976-1978
Research Chemist, Eastman Kodak Company	1978-1980
Senior Research Chemist, Eastman Kodak Company	1980-1986
Research Associate, Eastman Kodak Company	1986-1991
Senior Research Associate, Eastman Kodak Company	1991-1993
Senior Research Associate, Eastman Chemical Company	1993-1998
Technology Fellow, Eastman Chemical Company	1998-2004
Adjunct Professor, Dept. of Chemical Engineering, Purdue	2004-2005
Research Professor, Dept. of Chemical Engineering, USC	2004-present

Education

Ph.D., 1978, Physical chemistry, specialty in Heterogeneous Catalysis, University of Wisconsin-Milwaukee, Laboratory for Surface Studies.

Thesis Advisor: Professor George W. Keulks

Dissertation: *The Kinetics and Mechanism of Propylene Oxidation Over β -Bi₂Mo₂O₉ and Comparison to α -Bi₂Mo₃O₁₂ and γ -Bi₂MoO₆.*

M.S., Physical Chemistry, specialty in Heterogeneous Catalysis, University of Wisconsin-Milwaukee, Laboratory for Surface Studies.

Thesis Advisor: Professor George W. Keulks

Thesis: *Investigation of the Mechanism of the Heterogeneous and Heterogeneous-Homogeneous Oxidation of Propylene Using Oxygen-18.*

B.S., Chemistry, summa cum laude, St. Ambrose University, Davenport, IA.

Minor: Mathematics

Awards and Honors

Who's Who in America and the World, 2006.

Member of Professional Advisory Board, Department of Chemical Engineering, Clemson University, 2002 – 2004.

F. G. Ciapetta Lecturer for 2002, awarded by the North American Catalysis Society on behalf of W. R Grace for the research and process development on the epoxidation of butadiene and other non-allylic olefins with supported silver catalysts.

Herman Pines Award for 2000 awarded by the Catalysis Club of Chicago for the discovery and development of non-allylic olefin epoxidation processes.

Outstanding Industrial Innovator Award, 1998, awarded by The American Chemical Society for the discovery of the silver-catalyzed epoxidation of non-allylic olefins to produce 3,4-epoxy-1-butene and other non-allylic olefin epoxides.

Invited Plenary Lecturer, Third World Congress on Oxidation Catalysis, San Diego, September 1997.

NETS-ACS Speaker of the Year, 1996, for discovery of heterogeneous catalytic process for selective epoxidation of butadiene, "Epoxybutene--The New Industrial Intermediate for Chemical Production."

Member of Catalysis Advisory Board of Los Alamos National Laboratories, 1995- 1998.

Technical Interplant Conference Award for outstanding paper at the 90th Interplant Technical Conference on Catalysis, Eastman Kodak Company, October 1992.

CEK Mees Award, 1988, for most outstanding research and reporting of same at Eastman Kodak Research Laboratories for the year 1987.

NSF Pre-Doctoral Fellow, 1970-1972.

Publications

1. C. Daniel, J. R. Monnier, and G. W. Keulks, "Catalytic Oxidation of Propylene, III. Additional Evidence for Surface Initiated, Homogeneous Reactions," *J. Catal.*, **31**, 360-369 (1973).
2. J. R. Monnier and G. W. Keulks, "Comparison of α -, β -, and γ -Phases of Bismuth Molybdates for the Selective Oxidation of Propylene," *Preprint, Division of Petroleum Chemistry, National ACS Meeting, April 1979, Honolulu*, 19-26.
3. G. W. Hoefs, J. R. Monnier, and G. W. Keulks, "The Investigation of the Type of Active Oxygen for the Oxidation of Propylene Over Bismuth Molybdate Catalysts Using Infrared and Raman Spectroscopy," *J. Catal.*, **57**, 331-337 (1979).
4. J. R. Monnier and G. W. Keulks, "The Catalytic Oxidation of Propylene, IX. The Kinetics and Mechanism Over β -Bi₂Mo₂O₉," *J. Catal.*, **68**, 51-66 (1981).
5. S. A. Maslov, J. R. Monnier, and G. W. Keulks, "Kinetics and Mechanism of the Co-Oxidation of Olefins and Aldehydes in the Liquid and Vapor Phase," *Oxidation Comm.*, **3**, 61-69 (1983).
6. G. R. Apai, J. R. Monnier, and M. J. Hanrahan, "Evidence for the Stabilization of Cu(I) in Cu-Cr Oxide Methanol Catalysts," *Appl. Surf. Sci.*, **79**, 307-314 (1984).
7. J. R. Monnier, G. R. Apai, and M. J. Hanrahan, "Effect of CO₂ on the Conversion of H₂/CO to Methanol Over Copper-Chromia Catalysts," *J. Catal.*, **88**, 532-535 (1984).
8. J. R. Monnier, M. J. Hanrahan, and G. R. Apai, "A Study of the Catalytically Active Copper Species in the Synthesis of Methanol Over Cu-Cr Oxide," *J. Catal.*, **92**, 119-126 (1985).

9. J. R. Monnier and G. R. Apai, "Effect of Oxidation States on the Syngas Activity of Transition Metal Catalysts," *Preprint, Division of Fuel Chemistry, National ACS Meeting, April 1986, New York*, 239-251.
10. G. R. Apai, J. R. Monnier, and D. R. Preuss, "Low Temperature Formation of Cu⁺ in Evaporated Cu-Cr Oxide Films: Application to Methanol Synthesis," *J. Catal.*, **98**, 563-567 (1986).
11. R. C. Baetzold and J. R. Monnier, "Kinetic Modelling of Hydrocarbon and Oxygenate Formation," *J. Phys. Chem.*, **90**, 2944-2949 (1986).
12. J. R. Monnier, H. J. Gysling, and G. R. Apai, "Synthesis, Characterization, and Catalytic Properties of LaRhO₃," *J. Catal.*, **103**, 407-418 (1987).
13. A. Warshawsky, D. A. Upson, W. T. Ferrar, and J. R. Monnier, "Zero-Valent Metal-Polymer Composites," *J. Polymer Sci. Part A: Polymer Chemistry*, **27**, 3015-3041 (1989).
14. J. R. Monnier, "The Selective Epoxidation of Non-Allylic Olefins Over Supported Silver Catalysts," *Stud. Surf. Sci. Catal.*, **110**, (3rd World Congress on Oxidation Catalysis, 1997), 135-149 (1997).
15. J. R. Monnier, J. W. Medlin, and Y.-J. Kuo, "Selective Isomerization of 2,5-Dihydrofuran to 2,3-Dihydrofuran Using CO-Modified, Supported Pd Catalysts," *Appl. Catal. A*, **194-195**, 463-474 (2000).
16. J. R. Monnier, *review article entitled* "The Direct Epoxidation of Higher Olefins Using Molecular Oxygen," *Appl. Catal. A*, **221**, 73-91 (2001).
17. J. R. Monnier and G. W. Hartley, "Comparison of Cu and Ag Catalysts for Epoxidation of Higher Olefins," *J. Catal.*, **203**, 253-256 (2001).
18. J. R. Monnier, J. W. Medlin, and M. A. Barteau, "Use of Oxygen-18 to Determine the Kinetics of Butadiene Epoxidation Over Cs-Promoted, Ag Catalysts," *J. Catal.*, **203**, 362-368 (2001).
19. J. W. Medlin, J. R. Monnier, and M. A. Barteau, "Deuterium Kinetic Isotope Effects in Butadiene Epoxidation Over Unpromoted and Cs-Promoted Silver Catalysts," *J. Catal.*, **204**, 71 (2001).
20. M. V. Badani, J. R. Monnier, and M. A. Vannice, "Effects of Cesium and Chlorine on Butadiene Adsorption on α -Ag/Al₂O₃," *J. Catal.*, **206**, 29 (2002).

21. J. R. Monnier, K. T. Peters, and G. W. Hartley, "The Selective Epoxidation of Conjugated Olefins Containing Allylic Substituents and Epoxidation of Propylene in the Presence of Butadiene," *J. Catal.*, **225**, 374 (2004).
22. J. R. Monnier, J. L. Stavinoha, Jr., and G. W. Hartley, "Effects of Chlorine and Chlorine Dynamics During Silver-Catalyzed Epoxidation of Butadiene," *J. Catal.*, **226**, 321 (2004).
23. J. R. Monnier, J. L. Stavinoha, Jr., and R. L. Minga, "Stability and Distribution of Cesium in Cs-Promoted, Silver Catalysts Used for Butadiene Epoxidation," *J. Catal.*, **226**, 401 (2004).
24. J.R. Monnier, S.K. Jale, J.R. Zoeller, V.V. Guliants, Preface, *Topics in Catalysis*, **38**, 221(2006).
25. L. B. Ortiz-Soto, J. R. Monnier, and M. D. Amiridis, "Structure-Sensitivity of Propylene Hydrogenation over Cluster-Derived Bimetallic Pt-Au Catalysts," *Cat. Lett.*, **107**, 13 (2006).
26. J.W. Weidner, P. Sethupathy, M. Matthews, J. Monnier and J. Dickensheets, "Synthesis of Ketones from Secondary Alcohols using Electrochemically Generated Superoxide Ions in Room Temperature Ionic Liquids," *The Electrochemical Society, Cancun, Mexico, October 2006*.
27. S. N. Falling, J. R. Monnier, G. W. Phillips, J. S. Kanel, and S. A. Godleski, "Development of an Industrial Process for the Lewis Acid/Iodide Salt-Catalyzed Rearrangement of 3,4-Epoxy-1-butene to 2,5-Dihydrofuran," *Catalysis of Organic Reactions*, S.R. Schmidt, Ed., CRC Press, 326 (2007).
28. K. D. Beard, M.T. Schaal, J.W. Van Zee, J.R. Monnier, "Preparation of Highly Dispersed PEM Fuel Cell Catalysts Using Electroless Deposition Methods," *Appl. Catal. B: Environmental*, **72**, 262 (2007).
29. M.T. Schaal, A.Y. Metcalf, J. Montoya, J.P. Wilkinson, C.C. Stork, C.T. Williams and J. R. Monnier, "Hydrogenation of 3,4-Epoxy-1-Butene over Cu-Pd/SiO₂ catalysts prepared by electroless deposition," *Catal. Today*, **123**, 142 (2007).
30. K.D. Beard, J.R. Monnier, and J.W. Van Zee, "Synthesis and durability of improved fuel cell catalysts," *Trans. Electrochem. Soc.*, **2**, 87 (2007).
31. M.T. Schaal, A.C. Pickerell, C.T. Williams, and J.R. Monnier, "Characterization and evaluation of Ag-Pt/SiO₂ catalysts prepared by electroless deposition," *J. Catal.*, **254**, 131 (2008).
32. H. Xie, J.Y. Howe, V. Schwartz, J.R. Monnier, C.T. Williams, and H.J. Ploehn, "Hydrochlorination of 1,2-dichloroethane catalyzed by dendrimer-derived Pt-Cu/SiO₂ catalysts," *J. Catal.*, **259**, 111 (2008).

33. Kanel, J.S.; Falling, S.N.; Monnier, J.R.; Phillips, G.W.; Godleski, S.A., "Extractive catalyst recovery in an ionic-liquid process for the production of 2,5-Dihydrofuran," *Solvent Extraction: Fundamentals to Industrial Applications, Proceedings of ISEC 2008 International Solvent Extraction Conference, Tucson, AZ, USA, 2*, 937 (2008).
34. M.T. Schaal, M.P. Hyman, M. Rangan, S. Ma, C.T. Williams, J.R. Monnier, and J.W. Medlin, "Theoretical and experimental studies of Ag-Pt interactions for supported Ag-Pt bimetallic catalysts," *Surf. Sci.*, **603**, 690 (2009).
35. K.D. Beard, J.W. Van Zee, and J.R. Monnier, "Preparation of carbon-supported Pt-Pd electrocatalysts with improved physical properties using electroless deposition methods," *Appl. Catal. B:Environmental*, **88**, 185 (2009).
36. A. Siani, O.S. Alexeev, D.S. Deutsch, J.R. Monnier, P.T. Fanson, H. Hirata, S. Matsumoto, C.T. Williams, and M.D. Amiridis, "Dendrimer-mediated synthesis of subnanometer-sized Rh particles supported on ZrO₂," *J. Catal.*, **266**, 331 (2009).
37. K.D. Beard, D. Borelli, A.M. Cramer, D. Blom, J.W. Van Zee, and J.R. Monnier, "Preparation and structural analysis of carbon-supported Co core/Pt shell electrocatalysts using electroless deposition methods," *ACS Nano*, **3**, 2841 (2009).
38. J.W. Medlin, M.P. Hyman, M.T. Schaal, J.R. Monnier, C.T. Williams, and S. Ma, *Abstracts of Papers, 237th ACS National Meeting, Salt Lake City, UT, March 22-26, 2009* (2009) FUEL-100..
39. K. Punyawudho, J.R. Monnier, and J.W. Van Zee, "SO₂ adsorption on carbon-supported Pt electrocatalysts," *ECS Transactions*, **25**, 1289 (2009).
40. D. Liu, Y.M. López-DeJesús, J.R. Monnier, and C.T. Williams, "Preparation, Characterization, and kinetic evaluation of dendrimer-derived bimetallic Pt-Ru/SiO₂ catalysts," *J. Catal.*, **269**, 376 (2010).
41. Y.M. Lopez-De Jesus, C.E. Johnson, J.R. Monnier, and C.T. Williams, "Selective hydrogenation of benzonitrile by alumina-supported Ir-Pd catalysts," *Topics in Catalysis*, **53**, 1132 (2010).
42. J. Rebelli, M. Detwiler, S. Ma, C. T. Williams, and J. R. Monnier, "Synthesis and characterization of Au-Pd/SiO₂ bimetallic catalysts prepared by electroless deposition," *J. Catal.*, **270**, 224 (2010).
43. J.R. Monnier, "Preparation, characterization, and evaluation of Au-Pd bimetallic catalysts prepared by electroless deposition methods," *Abstracts of Papers, 239th ACS National Meeting, San Francisco, CA, March 21-25, 2010* (2010) IEC-71.

44. M.T. Schaal, J. Rebelli, H.M. McKerrow, C.T. Williams, and J.R. Monnier, "Effect of liquid phase reducing agents on the dispersion of supported Pt catalysts," *Appl. Catal. A: General*, **382**, 49 (2010).
45. K. Punyawudho, D.A. Blom, J.W. Van Zee and J.R. Monnier, "Comparison of different methods for determination of Pt surface site concentrations for supported Pt electrocatalysts," *Electrochim. Acta*, **55**, 5349 (2010).
46. M. Ohashi, K.D. Beard, S. Ma, D.A. Blom, J. St-Pierre, J.W. Van Zee, and J.R. Monnier, "Electrochemical and Structural Characterization of Carbon-Supported Pt-Pd Bimetallic Electrocatalysts prepared by Electroless Deposition," *Electrochimica Acta*, **55**, 7376 (2010).
47. J. Rebelli, A.A. Rodriguez, S. Ma, C.T. Williams, J.R. Monnier, "Preparation and Characterization of Silica-Supported, Group IB-Pd Bimetallic Catalysts Prepared by Electroless Deposition Methods," *Catal. Today*, **160**, 170 (2011).
48. K. Punyawudho, J. R. Monnier, and J. W. Van Zee, "SO₂ Adsorption on Carbon-Supported Pt Electrocatalysts," *Langmuir*, **27**, 3138 (2011).
49. K. Punyawudho, S. Ma, J. W. Van Zee, and J. R. Monnier, "Effect of O₂ on the Adsorption of SO₂ on Carbon-Supported Pt Electrocatalysts," *Langmuir*, **27**, 7524 (2011).
50. K. J. Uffalussy, B. K. Captain, R. D. Adams, A. B. Hungria, J. R. Monnier, and M. D. Amiridis, "Synthesis and Characterization of Cluster-Derived PtRu₅Sn Catalysts," *ACS Catalysis*, **1**, 1710 (2011).
51. P. Sethupathy, I. M. Alnashef, J. R. Monnier, M. A. Matthews, and J. W. Weidner, "Synthesis of carbonyl compounds from alcohols using electrochemically generated superoxide ions in RTILs", *Syn. Commun.* **42**, 3632 (2012).
52. S. Tan, J.R. Monnier, and C.T. Williams, "Kinetic study of asymmetric hydrogenation of α , β -unsaturated carboxylic acid over cinchona-modified Pd/al₂O₃ catalyst," *Topics in Catalysis*, **55**, 512 (2012).
53. X. Sun, J.R. Monnier, and C.T. Williams, "Enantioselective hydrogenation of α -methylcinnamic acid over Pd/al₂O₃: A kinetic study of solvent, temperature, and pressure effects," *Cat. Lett.*, **143**, 881 (2013).
54. M.B. Griffin, A.A. Rodriguez, M.M. Montemore, J.R. Monnier, C.T. Williams, and J.W. Medlin, "The selective oxidation of ethylene glycol and 1,2-propanediol on Au, Pd, and Au-Pd bimetallic catalysts," *J. Catal.* **307**, 111 (2013).
55. S.A. Tenney, K. Xie, J.R. Monnier, A. Rodriguez, R.P. Galhenage, and D.A. Chen, "Novel recirculating loop reactor for studies on model catalysts: CO oxidation on

- Pt/TiO₂(110),” *Rev. Sci. Instrument.*, **84**, 104101(2013).
56. T.R. Garrick, W. Diao, J.M. Tengco, J.R. Monnier, “The effect of bimetallic surface composition for methanol oxidation,” *ECS Trans.*, **53**, 79 (2013).
 57. Y. Zhang, W. Diao, C.T. Williams, and J.R. Monnier, “Selective hydrogenation of acetylene in excess ethylene using Ag- and Au-Pd/SiO₂ bimetallic catalysts prepared by electroless deposition,” *Appl. Cat. A: General*, **469**, 419 (2014).
 58. Y.K. Lugo-José, J.R. Monnier, and C.T. Williams, “Gas phase, catalytic hydrodeoxygenation of propanoic acid over Group VIII noble metals: Metal and support effects,” *Appl. Cat. A: General*, **469**, 410 (2014).
 59. A.A. Rodriguez, C.T. Williams, and J.R. Monnier, “Selective liquid-phase oxidation of glycerol over Au-Pd/C bimetallic catalysts prepared by electroless deposition,” *Appl. Cat. A: General*, **475**, 161 (2014).
 60. Y-J. Song, J.R. Monnier, P.T. Fanson, and C.T. Williams, “Bimetallic Ag-Ir/Al₂O₃ Catalysts prepared by electroless deposition: Characterization and kinetic evaluation,” *J. Catal.*, **315**, 59 (2014).
 61. T.R. Garrick, W. Diao, J.M. Tengco, J.R. Monnier, and J.W. Weidner, “The effect of the surface composition of Ru-Pt bimetallic catalysts for methanol oxidation,” *Electrochem. Solid State Lett.*, ---- ----(2014).
 62. W. Wittanadecha, N. Laosiripojana, A. Ketcong, N. Ningnuek, P. Praserttham, J.R. Monnier and S. Assabumrungrat, “Preparation of Au/C catalysts using microwave – assisted and ultrasonic-assisted methods for acetylene hydrochlorination,” *Appl. Catal A: General*, **475**, 292 (2014).
 63. W. Wittanadecha, N. Laosiripojana, A. Ketcong, N. Ningnuek, P. Praserttham, J.R. Monnier and S. Assabumrungrat, “Development of Au/C catalysts by the microwave-assisted method for the selective hydrochlorination of acetylene,” *Reac. Kinet. Mech. Cat.*, **112**, 189 (2014).
 64. K. Punyawudho, N. Vorayos, Y. Zhang, S. Shimpalee, and J. R. Monnier, “Identification and quantification of performance losses for PEM fuel cells as determined by selective chemisorption and ESA measurements,” *Inter. J. Hydrogen Energy*, **39**, 11110 (2014).
 65. Y.K. Lugo-José, A. Heyden, J.R. Monnier, and C.T. Williams, “Hydrodeoxygenation of Propanoic Acid over Silica-Supported Palladium: Effect of Metal Particle Size”, *Cat. Sci. Tech.* 2014.
 66. J.M.M. Tengco, Y.K. Lugo-José, J.R. Monnier. And J.R. Regalbuto, “Chemisorption-XRD particle size discrepancy of carbon-supported palladium,” *Cat. Today*, (2014).

Patents

1. U.S. Patent No. 4,748,144, "Delafossite Mixed Metal Oxide Catalysts and Methods for Their Preparation," J. R. Monnier, G. R. Apai, and M. J. Hanrahan, May 31, 1988.
2. U.S. Patent No. 4,897,498, "Selective Monoepoxidation of Olefins," J. R. Monnier and P. J. Muehlbauer, January 30, 1990.
3. U.S. Patent No. 4,925,986, "Preparation of Aldehydes From Unsaturated Terminal Epoxides," J. R. Monnier and H. M. Low, May 15, 1990.
4. U.S. Patent No. 4,925,987, "Preparation of Aldehydes From Unsaturated Terminal Epoxides," J. R. Monnier and H. M. Low, May 15, 1990.
5. U.S. Patent No. 4,942,263, "Preparation of Aldehydes," J. R. Monnier and P. J. Muehlbauer, July 17, 1990.
6. U.S. Patent No. 4,950,773, "Selective Epoxidation of Olefins," J. R. Monnier and P. J. Muehlbauer, August 21, 1990
7. U.S. Patent No. 5,081,096, "Epoxidation Catalysts," J. R. Monnier and P. J. Muehlbauer, January 14, 1992.
8. U.S. Patent No. 5,082,956, "Isomerization of Epoxyalkene to 2,5- Dihydrofurans and Catalyst Compositions Useful Thereof," J. R. Monnier, S. A. Godleski, H. M. Low, L. McCollough, L. W. McGarry, H. G. Webster, and G. W. Phillips, January 21, 1992.
9. U.S. Patent No. 5,138,077, "Selective Epoxidation of Diolefins and Aryl Olefins," J. R. Monnier and P. J. Muehlbauer, August 11, 1992.
10. U.S. Patent No. 5,145,968, "Selective Oxidation of Styrene and Styrene Derivatives to the Corresponding Epoxide with Molecular Oxygen," J. R. Monnier and P. J. Muehlbauer, September 8, 1992.
11. U.S. Patent No. 5,315,019, "Continuous Process for the Manufacture of 2,5-Dihydrofurans From Gamma, Delta-Epoxybutenes," G. W. Phillips, S. N. Falling, S. A. Godleski, and J. R. Monnier, May 24, 1994.
12. U.S. Patent No. 5,362,890, "Gas Phase Process for the Epoxidation of Olefins," J. L. Stavinoha, J. R. Monnier, D. M. Hitch, and T. R. Nolen, November 11, 1994.
13. US Patent No. 5,536,851, "Preparation of 2,3-Dihydrofurans," J. R. Monnier, July 16, 1996.

14. US Patent No. 5,614,644, "Process for the Removal of Organic Chlorides From Furan and Hydrogenated Furans," S. Liang, J. R. Monnier, S. Okrasinski, and T. Price, March 25, 1997.
15. US Patent No. 5,670,672, "Process for the Preparation of 2,3-Dihydrofurans," J. R. Monnier and C. S. Moorehouse, September 23, 1997.
16. US Patent No. 5,908,942, "Epoxidation of Butadiene Using Cesium Fluoride Promoted Silver Catalysts With Enhanced Thermal Stability Under Reaction Conditions," G. L. Oltean and J. R. Monnier, June 1, 1999.
17. US Patent No. 5,945,550, "Gas Phase Process for the Epoxidation of Non-Allylic Olefins," J. R. Monnier, S. D. Barnicki, and K. T. Peters, August 31, 1999.
18. US Patent No. 6,011,163, "Use of Fluorinated Hydrocarbons as Reaction Media for Selective Epoxidation of Olefins," S. D. Barnicki and J. R. Monnier, January 4, 2000.
19. US Patent No. 6,172,245, "Gas Phase Process for the Epoxidation of Non-Allylic Olefins," J. R. Monnier, J. L. Stavinoha, G. W. Hartley, E. E. Jameson, and S. D. Barnicki, January 9, 2001.
20. US Patent No. 6,180,559, "Novel Supported Catalysts and Catalyst Support Materials and Process for the Manufacture of 1,2-Epoxybutane," B. D. Roberts, J. R. Monnier, and D. M. Hitch, January 30, 2001.
21. US Patent No. 6,201,138, "Isomerization of Epoxyalkenes to 2,5-Dihydrofurans," J. R. Monnier, S. N. Falling, and P. Lopez-Maldonado, March 13, 2001.
22. US Patent No. 6,270,739, "Process for the Removal of Carbon Dioxide from 3,4-Epoxy-1-Butene Process Recycle Streams," S. D. Barnicki, J. R. Monnier, J. L. Stavinoha, Jr., R. S. Kline, and G. W. Hartley, August 7, 2001.
23. US Patent No. 6,310,223, "Process for the Manufacture of 1,2-Epoxybutane," B. D. Roberts, J. R. Monnier, and D. M. Hitch, October 30, 2001.
24. US Patent No. 6,342,614, "Isomerization of Epoxyalkenes to 2,5-Dihydrofurans," S. N. Falling and J. R. Monnier, January 29, 2002.
25. US Patent No. 6,388,106, "Selective Epoxidation of Conjugated Diolefins," John R. Monnier and Kimberly T. Peters, May 14, 2002.
26. US Patent No. 6,455,713, "Reactivation of Cs-Promoted, Ag Catalysts for the Selective Epoxidation of Butadiene to 3,4-Epoxy-1-Butene," J. R. Monnier, September 24, 2002.

27. US 6881858, 2005, "The Oxidation of 3-Formyl Tetrahydrofuran to 3-Tetrahydrofuroic Acid," J. R. Monnier and E. B. Mackenzie
28. J.R. Monnier, J.W. Van Zee, and K.D. Beard, "Improved Catalysts for Fuel Cell applications Using Electroless Deposition," US Patent Appl. Serial No. 12/274,063, filed November 19, 2008.
29. K. Beard, M. Schaal, J. Monnier, and J. Van Zee, "Catalysts for Fuel Cell Applications Using Electroless Deposition", US 2009/0117257, May 7, 2009.
30. US Patent 8,424,367, "Systems and Methods for Measurement of Gas Permeation Through Polymer Films," H.J. Ploehn, J.R. Monnier, and X. Chen, April 23, 2013.
31. Provisional Pat. Appl. 62/050,428, "Supported, Bimetallic Nanoparticles for Selective Catalysis," J.R. Monnier, J.R. Regalbuto, and K.C. O'Connell, September 15, 2014.

Presentations

1. "Correlations Between CH₃OH Activity and Chemical State of Cu in Cu-Cr Oxide and Cu-ZnO Catalysts," J. R. Monnier, presented at *Annual Symposium of Pittsburgh-Cleveland Catalysis Society*, March 1986.
2. "Effect of Oxidation States on the Syngas Activity of Transition Metal Oxide Catalysts," J. R. Monnier, presented at *National ACS Meeting, New York*, April 1986.
3. "The Kinetics and Mechanism of the Hydroformylation of 1,3-Butadiene Over Rh/SiO₂" J. R. Monnier, presented at *The Catalysis Society, 10th North American Meeting*, San Diego, CA, May 1987.
4. "Higher Alcohol Synthesis Over Cu-Containing Catalysts," J. R. Monnier, presented at *International Symposium on C1 Reactions, 1987*, Kingston, Ontario, July 1987.
5. Session Chairman, "Selective Oxidation," J. R. Monnier, at *The Catalysis Society, 13th North American Meeting*, Pittsburgh, PA, May 1993.
6. "Synthesis of Higher Oxygenates Over Alkali-Promoted Cu-Fe-Cr Mixed Oxide Catalysts," J. R. Monnier, presented at *SERMACS, Southeast Regional Meeting of the American Chemical Society*, October 1993.
7. "The Selective Epoxidation of Olefins Over Supported Silver Catalysts," J. R. Monnier, presented at *Seminar Series at School of Chemical Engineering, Purdue University*, West Lafayette, IN, April 1995.

8. "The Selective Epoxidation of Non-Allylic Olefins Over Supported Silver Catalysts," J. R. Monnier, presented at *The Catalysis Society, Fourteenth North American Meeting*, Salt Lake City, UT, June 1995.
9. "Epoxybutene--The New Industrial Intermediate for Chemical Production," J. R. Monnier, presented at *NETS-ACS Speaker of the Year Annual Meeting*, Kingsport, TN, January 1996.
10. "The Selective Epoxidation of Non-Allylic Olefins Over Supported Silver Catalysts," J. R. Monnier, invited lecture presented at *Florida Catalysis Conference*, Palm Coast, FL, April 18-22, 1996.
11. "The Selective Epoxidation of Non-Allylic Olefins Over Supported Silver Catalysts," J. R. Monnier, invited talk presented at *Philadelphia Catalysis Club*, Wilmington, DE, January 1997.
12. "3,4-Epoxy-1-butene, A New Chemical Intermediate for the Future," invited talk at *Fundamentals of Industrial Catalysis Symposium, American Association for the Advancement of Science*, Seattle, WA, February 1997.
13. "The Selective Epoxidation of Non-Allylic Olefins Over Supported Silver Catalysts," J. R. Monnier, invited talk presented at *14th North American Meeting of the Catalysis Society*, Snowbird, UT, June 1997.
14. "The Selective Epoxidation of Non-Allylic Olefins Over Supported Silver Catalysts," J. R. Monnier, invited plenary lecture at *3rd World Congress on Oxidation Catalysis*, San Diego, CA, September 1997.
15. "The Selective Epoxidation of Non-Allylic Olefins Over Supported Silver Catalysts," J. R. Monnier, *Chemistry Department Seminar at Wake Forest University*, February 1998.
16. "The Selective Epoxidation of Non-Allylic Olefins Over Supported Silver Catalysts," J. R. Monnier, invited talk presented at *30th Annual Meeting of the Central Region of the American Chemical Society*, Cleveland, OH, May 1998.
17. "The Selective Epoxidation of Non-Allylic Olefins Over Supported Silver Catalysts," J. R. Monnier, invited talk presented at *28th Annual Meeting of the Central Region of the American Chemical Society*, Milwaukee, WI, May 1998.
18. "The Epoxidation of Butadiene over Modified Silver Catalysts," invited talk at *1998 Leaven School on Catalysis at Bruges*, Bruges, Belgium, December 1998.
19. "Catalytic Surface Science, Heterogeneous, and Fundamental Chemistry: A Blueprint for Success in the Chemical Industry," invited talk at *Awards Day, University of Wisconsin-Milwaukee*, Milwaukee, WI, April 1999.

20. "The Selective Epoxidation of Butadiene Using Molecular Oxygen Over Ag Catalysts," *Herman Pines Award lecture given at The Chicago Catalysis Club Spring Symposium*, Naperville, IL, May 11, 2000.
21. "The Selective Isomerization of 2,5-DHF to 2,3-DHF Using CO-Modified, Supported Pd Catalysts," J. Monnier, invited talk given at *221st ACS National Meeting in San Diego*, CA, April 1-5, 2001.
22. "The Selective Epoxidation of Butadiene Using Molecular Oxygen Over Ag Catalysts," John R. Monnier and Zhufang Liu, (presented by Zhufang Liu), *New Perspectives on Catalysis for Sustainable Chemical Technologies*, Beijing, China, September, 2001.
23. "Selective Epoxidation of Butadiene Using Molecular Oxygen over Promoted Ag Catalysts," F. C. Ciapetta lecture presented at *Spring Symposium of Western States Catalysis Club*, Albuquerque, NM, February 18, 2002.
24. "Roles of Alkali and Halide Promoters for the Ag-Catalyzed Epoxidation of Butadiene", F. C. Ciapetta lecture presented at *Spring Symposium of the Southwest Catalysis Society*, Houston, TX, April 19, 2002.
25. "Selective Epoxidation of Butadiene to 3,4-epoxy-1-butene using Alkali-Promoted Silver Catalysts, F. C. Ciapetta lecture presented at *Inaugural Symposium of Southeastern Catalysis Society*, Clemson, SC, May 6, 2002.
26. "Roles of Alkali and Halide Promoters for the Ag-Catalyzed Epoxidation of Butadiene", F. C. Ciapetta lecture presented at *Spring Symposium of the Michigan Catalysis Society*, Flint, MI, May 15, 2002.
27. "Roles of Alkali and Halide Promoters for the Ag-Catalyzed Epoxidation of Butadiene", F. C. Ciapetta lecture presented at *Spring Symposium of the Tri State Catalysis Society*, Lexington, KY, May 21, 2002
28. "The Selective Isomerization of 2,5-DHF to 2,3-DHF Using CO-Modified, Supported Pd Catalysts," F. C. Ciapetta lecture presented at *Fall Symposium of the Metropolitan New York Catalysis Society*, Somerset, NJ, September 18, 2002.
29. "Roles of Alkali and Halide Promoters for the Ag-Catalyzed Epoxidation of Butadiene", F. C. Ciapetta lecture presented at *Fall Symposium of the Philadelphia Catalysis Club*, Claymont, DE, September 19, 2002.
30. "The Selective Isomerization of 2,5-DHF to 2,3-DHF Using CO-Modified, Supported Pd Catalysts," F. C. Ciapetta lecture presented at *Fall Symposium of the Southeastern Catalysis Society*, Asheville, NC, October 1, 2002.

31. "The Selective Isomerization of 2,5-DHF to 2,3-DHF Using CO-Modified, Supported Pd Catalysts," F. C. Ciapetta lecture presented at *Fall Symposium of the New England Catalysis Society*, Worcester, MA, November 16, 2002.
32. "Roles of Alkali and Halide Promoters for the Ag-Catalyzed Epoxidation of Butadiene," seminar presented at University of South Carolina, Dept. of Chemical Engineering, Columbia, SC, March 13, 2003.
33. "Selective Epoxidation of Conjugated Olefins Containing Allylic Hydrogen Functionalities," *Spring Symposium of the Southeastern Catalysis Society*, Asheville, NC, April 14, 2003.
34. "Roles of Halide Promoters for the Ag-Catalyzed Epoxidation of Butadiene and Selective Epoxidation of Conjugated Olefins Containing Allylic Hydrogen Functionalities," invited lecture presented at Texas A&M University, College Station, TX, May 16, 2003.
35. "Roles of Alkali and Halide Promoters for the Ag-Catalyzed Epoxidation of Butadiene," invited lecture presented at Universal Oil Products, Des Plaines, IL, August 15, 2006.
36. "Preparation, Characterization, and Evaluation of Bimetallic Catalysts prepared by Electroless Deposition Methods," seminar presented at University of South Carolina, Dept. of Chemistry and Biochemistry, Columbia, SC, March 20, 2007.
37. "Preparation, Characterization, and Evaluation of Bimetallic Catalysts prepared by Electroless Deposition Methods," invited lecture presented at BASF Catalysts LLC, Beachwood, OH, April 23, 2007.
38. "Preparation, Characterization, and Evaluation of Bimetallic Catalysts prepared by Electroless Deposition Methods," seminar presented at University of Rochester, Dept. of Chemical Engineering, Rochester, NY, May 9, 2007.
39. "The Role of Alkali Promoters in the Ag-Catalyzed Epoxidation of Olefins," invited talk presented at 234th ACS National Meeting, Boston, MA, August 20, 2007.
40. "Preparation, Characterization and Kinetic Evaluation of Bimetallic Catalysts Prepared by Electroless Deposition," seminar presented at University of Colorado, Department of Chemical and Biological Engineering, Boulder, CO, September 25, 2007.
41. "Industrial Applications of Catalysis: Epoxidation of Olefins," seminar presented at University of Colorado, Department of Chemical and Biological Engineering, Boulder, CO, September 26, 2007.
42. "Use of Electroless Deposition Methods to Prepare Novel Bimetallic Catalysts," talk presented at 21st Meeting of the North American Catalysis Society, San Francisco, June 10, 2009.

43. "Synthesis and Characterization of Au-Pd/SiO₂ Catalysts Prepared by Electroless Deposition," talk presented at National ACS Meeting, San Francisco, CA, March 2010.
44. "Synthesis, Characterization, and Evaluation of Supported Group IB-Pd Catalysts Prepared by Electroless Deposition," talk presented at 22nd Meeting of the North American Catalysis Society, Detroit, MI, June 8, 2011.
45. "Synthesis, Characterization, and Evaluation of Supported Bimetallic Catalysts Prepared by Electroless Deposition," seminar presented at Chiang Mai University, Department of Industrial Chemistry, Chiang Mai, Thailand, August 22, 2011.
46. "Synthesis, Characterization, and Evaluation of Supported Bimetallic Catalysts Prepared by Electroless Deposition," talk presented at Thailand Synchrotron Center, Nakorn Rachisma City, Thailand, August 24, 2011.
47. "A Case Study: The discovery, development, and commercialization of the selective epoxidation of 1,3-butadiene to form 3,4-epoxy-1-butene (EpB) and novel derivatives made from EpB," talk presented at Thai Plastics and Chemicals, Rayong, Thailand, August 25, 2011.
48. "Recent developments in the synthesis, characterization, and evaluation of bimetallic catalysts," talk presented at Thai Plastics and Chemicals, Rayong, Thailand, August 26, 2011.
49. "Synthesis, characterization, and evaluation of supported bimetallic catalysts prepared by electroless deposition," seminar presented at BP Research Laboratories, Naperville, IL, October, 18, 2011.
50. "Synthesis, characterization, and evaluation of supported bimetallic catalysts prepared by electroless deposition," talk presented at Chicago Catalysis Club, Lombard, IL, April 16, 2012.
51. "Preparation of bimetallic catalysts using electroless deposition," invited talk presented at 2012 AIChE Annual Meeting, Pittsburgh, PA, November 5, 2012.
52. "Preparation, characterization, and evaluation of Bimetallic Catalysts Using Electroless Deposition," Chemistry seminar presented at University of Wisconsin-Milwaukee, Milwaukee, WI, May 3, 2013.
53. "Preparation of alumina supported Ag-Ir bimetallic catalysts by electroless deposition for CO oxidation," talk presented at 23rd Meeting of the North American Catalysis Society, Louisville, KY, June 6, 2013.
54. "The center for rational catalysis synthesis," talk presented at Savannah River National Laboratory, Aiken, SC, May 6, 2014.

55. “When a little blue pill isn’t enough: The use of ED (Electroless Deposition) to prepare bimetallic catalysts,” talk presented at 2014 Gordon Research Conference, Colby-Sawyer College, New London, NH, June 24, 2014.

In addition to the above, Dr. Monnier has authored or co-authored approximately 70 -100 internal technical papers at Eastman Kodak Company and Eastman Chemical Company.

Curriculum Vitae, John R. Monnier, Ph.D.

John R. Monnier is currently Research Professor of Chemical Engineering at the University of South Carolina, Columbia, SC. In 2004, he retired as Technology Fellow at Eastman Chemical Company, the highest research position attainable within the Company. Dr. Monnier began his professional career in Corporate Research Laboratories of Eastman Kodak Company in Rochester, NY in 1972 after receiving a MS Degree in Heterogeneous Catalysis at the University of Wisconsin-Milwaukee from Prof. George W. Keulks in the area of catalytic olefin epoxidation. Monnier returned to UW-Milwaukee in 1976 and received a PhD in Heterogeneous Catalysis in 1978, again under the supervision of Prof. G.W. Keulks. In 1993, Dr. Monnier was transferred to Eastman Chemical Company in Kingsport, TN, from where he retired in 2004.

Dr. Monnier has spent his entire career in the areas of solid-state chemistry, materials science, and heterogeneous catalysis. Topics in solid-state chemistry have included non-silver halide photographic systems, iron-containing magnetic media for data storage, and high T_C superconductors. Specific areas of research in catalysis include paraffin hydrogenolysis, Fischer-Tropsch conversion of H_2 and CO to long chain chemicals, hydroformylation of olefins to aldehydes, aldol condensation, hydrogenation of olefins to paraffins, epoxidation of olefins to form epoxides, oxidation of alcohols and polyols to acids and ketones, PEM fuel cells, and direct methanol fuel cells. In one of these areas, Dr. Monnier began to study epoxidation of higher olefins in 1986, which culminated in the discovery of a catalyst system that selectively epoxidizes butadiene to 3,4-epoxybutene (EpB™) using molecular O_2 in the gas phase, which represented the first advancement in more than 50 years for olefin epoxidation. This work was recognized by the Scientific Council of Kodak Research Laboratories in 1988 when Monnier was awarded the C. E. K. Mees Award, given annually for the most outstanding Research conducted at Kodak Research Laboratories (over 2000 scientists and engineers at Kodak). In 1993, he was named Outstanding Researcher for the Northeast Tennessee Division of the American Chemical Society, and, more recently in 1998 was named Outstanding Industrial Innovator by the American Chemical Society. In May 2000, Monnier received the Herman Pines Award from the Chicago Catalysis Club, recognizing his pioneering work in the selective epoxidation of non-allylic olefins, which culminated in the commercialization of the selective epoxidation of butadiene to form 3,4-epoxy-1-butene, a novel and extremely versatile chemical intermediate that has been used to prepare literally hundreds of new chemical compounds. Most recently, he was awarded the F. C. Ciapetta Lectureship in Catalysis, one of the four major awards awarded biannually by the North American Catalysis Society.

The catalytic process for epoxidation of butadiene, which was commercialized in 1997, uses several novel catalytic processes, including the isomerization reactions of epoxybutene to 2,5-dihydrofuran and 2,5-dihydrofuran to 2,3-dihydrofuran. Monnier is either the sole inventor

or co-inventor of each of these reactions, for which he has received numerous patents. Altogether he has received more than 25 patents related to the EpB process. He has lectured extensively at both national and international conferences on the development of the catalyst and process for epoxidation of butadiene.

His current interests are in the areas of bimetallic catalyst synthesis using electroless deposition methods and applications for these families of catalysts. Electroless deposition represents a facile and scalable method of preparing true bimetallic catalysts with well-known surface compositions. Reactions being studied in his laboratory using bimetallic catalysts include selective hydrogenation of multi-functional olefins, selective oxidation of glycerol and related sugars, selective hydrogenation of biomass derived from pyrolysis of biomass, direct hydrochlorination of acetylene to vinyl chloride, and improved performance of direct methanol fuel cell catalysts.