

Dion D. Raftapoulos/Sigma Xi Outstanding Research Award	(2006)
Member, Phi Kappa Phi Honor Society	(2000-present)
University of Toledo Doermann Distinguished Lecturer	(2000)
University of Toledo Outstanding Faculty Research Award	(1999)
University of Toledo College of Engineering Outstanding Researcher	(1999)
Lucent Technologies Fellowship in Industrial Ecology	(1998)
AIChE Outstanding Student Chapter Advisor	(1992)
Ralph R. Teetor Educational Award of the SAE	(1989)
Member, Tau Beta Pi	(1980-present)

Student Mentorship

Undergraduate Research Projects

University of Tulsa:

1. Joe S. Horbath, "Detoxification of Pesticide-containing Wastewater through Acid Catalyzed Homogeneous Oxidation", B.S. 1990.
2. Christopher L. Phillips, "Kinetics of Formaldehyde Oxidation over Silver and Silver-Palladium Catalysts", B.S. 1990.
3. Frederick P. Ames, "Destruction of Plastic Wastes through Homogeneously Catalyzed Oxidation", B.S. 1992.
4. Catherine N. Dixon, "Direct Conversion of Methane to Methanol through Catalytic Oxidation in Supercritical Water, B.S. 1992.
5. Brenda J. Rush, "Operation of a Bubble Column Near the Critical Point of the Dispersed Phase", B.S. 1993.
6. Darin L. Rains, "Gas Holdup and Mass Transfer in a High Pressure Bubble Column", B.S. 1993.
7. Teresa Klindera, "Residence Time Distribution Studies in a Three-phase Monolith Reactor", B.S. 1994.
8. Judd Hollas, "Prediction of Catalytic Oxidation Kinetics for Mixtures", B.S., 1996.

University of Toledo:

9. Marty Goethman, "Carbonylation of Methanol to Methyl Acetate in Supercritical Carbon Dioxide", B.S., 1996.
10. Amy Nelson, "Characterization of Nickel on Activated Carbon Catalysts", B.S. May 1999.
11. Alex Rosenbom, "Catalytic Wet Oxidation of Glucose as a Model of Solid Waste Resource Recovery for use in Long Term Human Space Missions", B.S. May 1999.
12. Timothy J. LaPlante, "Effect of Pressure on Heterogeneous Catalysis in Supercritical CO₂", B.S., May 2000.
13. Ellie Phelps, "Methanol Carbonylation using Palladium on Activated Carbon", B.S., May, 2001.
14. Bevan Lewis, "Hydrocarboxylation in supercritical CO₂ for production of adipic acid", B.S. December 2001.
15. Orin Hemminger, "Comparison of Hydroformylation in Organic and Supercritical Solvents", B.S. Dec. 2003.
16. Joe Bender, "Catalytic steam reforming of cyclohexane", Honor's Thesis research, B.S. Dec. 2003.
17. Brian Seger, "Kinetics of catalytic steam reforming of ethanol", Honor's Thesis research, B.S. Dec. 2003.

18. Kristen Hejduk, “The effect of CAFÉ standards on vehicle-generated pollution”, OSGC scholarship, B.S. December 2004.
19. Marie Jardin, “Life cycle analysis of a utility pole”, Urban Affairs Center research support program, B.S. December 2004.
20. Mike Vilt, “Catalytic steam reforming of ethanol to hydrogen”, B.S. Dec. 2004.
21. Neil Schweitzer, “Green Engineering Modules for Reactor Design”, Honor’s Thesis research, B.S. Dec. 2004.
22. Amy Metz, “Kinetics of Glycerol Steam Reforming”, Honor’s Thesis research, B.S. Dec. 2007.
23. Lisa Gray, “Water Gas Shift Catalyst Evaluation”, B.S., Dec. 2007
24. Kristen Bury, “Design of a Demonstration Program for a Backup Fuel Cell”, B.S., Dec. 2009.

Youngstown State University:

25. Emily Rencewicz, “Process Modeling of the Compact Steam Reformer”, B.E., May 2009.
26. Greg McCumber, “CO₂ Capture using sorbents supported on metal foil”, B.E., May 2012.
27. Sean Gabriel, “Coating sorbents on metal foil for CO₂ capture”, B.E., May 2014.
28. Jacob Miller, “Reforming Methanol as a source of hydrogen for fuel cells”, B.E., May 2015.
29. Jeremy Hammond, “Environmental Implications of Additive Manufacturing”, B.E. May 2016.

Masters Students

University of Tulsa

1. Deepak Sodhi, “Kinetics of Formaldehyde Oxidation over Platinum and Palladium Catalysts”, M.S. 1989.
2. Sang-Yong Kim, “Development of a Novel Three-Phase Catalytic Reactor”, M.S. Aug. 1991.
3. Jin-Chu Chen, “The Influence of Supercritical Water on Catalytic Reactor Design Parameters”, M.S. Aug. 1991.
4. John E. Sawyer, “Kinetics and Mechanism of Ethyl Acetate Oxidation”, M. Eng. May 1992.
5. Todd F. Brewer, “Methanol Oxidation Mechanism over Monolith-supported Palladium Catalyst”, M.S. May 1992.
6. Narendra Borgharkar, “Catalytic Oxidation of Fixed Nitrogen Compounds”, M.S. May 1993.
7. Sudhir Aki, “Corrosion during Supercritical Water Oxidation, M.Eng., December, 1994.
8. Suresh Pisharody, “Supercritical Water Oxidation of Solid Particles” M.S. August 1995.
9. Teresa Jean Lechner-Fish, “Electrolytic Measurement of Moisture in Natural Gas”, M.S. May, 1996.
10. Shailesh Dangi, “Modelling Catalytic Oxidation Kinetics for a Mixture of Benzene and Ethanol”, M.S. August, 1996.
11. Merah Zoubida, “Catalytic Supercritical Water Oxidation: Kinetics of Ammonia Destruction”, M.S. August 1996.
12. Vijay Dhakshinamoorthy, “Selective Catalytic Partial Oxidation in Supercritical Water”, M.S. August, 1996.
13. Alec A. Klinghoffer, “Catalytic Wet Oxidation of Particulate-containing Aqueous Wastestreams in a Novel Three Phase Reactor”, M.S., May, 1997 (Phillips Petroleum – Bartlesville, OK).

University of Toledo

14. Sonia Martinez, “Development of a Reaction and Transport Model for the Movement of MTBE in the Environment”, M.S. May 1999.

15. Srinivas Dharmadhikari, "Hydroformylation of Propylene in Supercritical Carbon Dioxide", M.S. research completed May 1999 (no degree awarded).
16. Natarajan Sreekumar, "Kinetic Analysis of the Stability of Forging Lubricants", M.S., August, 1999.
17. Trent Patrick, "Catalytic Wet Oxidation of Glucose Solutions", M.S., December, 1999. (Owens Illinois, Los Angeles, CA)
18. Greg Snyder, "Heterogeneously catalyzed hydroformylation in supercritical carbon dioxide", M.S. Dec. 2000.
19. Andrew R. Tadd, "Catalyst Development for hydroformylation in supercritical carbon dioxide", M.S. August 2001. (University of Michigan, Chemical Engineering)
20. Ben Schutt, "Selective conversion of cellulosic wastes through catalytic oxidation in sub-critical water", M.S. August 2002. (Quality Environmental Professionals, Inc., Indianapolis, IN)
21. Timothy Tack, "Catalysis in confined spaces enhanced through supercritical fluid solvents", M.S. August 2003.
22. Angela Kleman, "Stereospecific hydroformylation using supported catalysts in supercritical CO₂", M.S. May 2005. (Dow Chemical, Freeport, TX)
23. Amanda McCoy, "Steam Reforming of Jet Fuel Simulants Using a Sulfur-Tolerant Catalyst", M.S. August 2006. (NexTech Materials, Columbus, OH)
24. Pradeep Kumar Sharma, "Methane steam reforming in a spiral stackable reactor", M.S. Dec. 2006 (Research Triangle Institute, RTP, NC).
25. Preshit Gawade, "Reaction Kinetics for Reforming of Fuel Simulants", M.S. Dec. 2007 (The Ohio State University).

Youngstown State University

26. Robert Sovesky, "Design and Construction of a reactor system for durability testing of steam reforming catalysis", M.S.E Dec. 2010. (Associate, K&L Gates)
27. Geetha Challa, Editorial Assistant for *Environmental Progress & Sustainable Energy*, M.S.E. May 2017 (Astellas Pharmaceuticals)
28. Derrick Houston, Editorial Assistant for *Environmental Progress & Sustainable Energy*, M.S.E. expected May 2019

Doctoral Students

University of Tulsa

1. Lei Jin, "The Influence of Supercritical Water on the Kinetics and Mechanism of 1,4-Dichlorobenzene Oxidation", Ph.D. Aug., 1991.
2. Lawrence Crynes, "Evaluation of a Novel Three Phase Monolithic Reactor, Ph. D. December 1993, with R.L. Cerro.
3. Zhong-Yi Ding, "Catalytic Supercritical Water Oxidation of Aromatic Compounds on Transition Metal Oxides", Ph. D. May, 1995.(Solutia Inc., Houston, TX)
4. John E. Sawyer, "The Oxidation of Volatile Organic Compounds on a Platinum-Alumina Catalyst", Ph.D. May, 1995. (Rogers State University, Claremore, OK)
5. Thulasidas Chellppannair, "Fluid Dynamics in a Novel Three Phase Monolithic Reactor", Ph. D. May, 1996, with R.L. Cerro. (BOC Gases, Allentown, PA)

University of Toledo

6. Sudhir N.V.K. Aki, "Catalytic Supercritical Water Oxidation: Mass Transfer and Solvation Effects in the Conversion of Nitrogen Containing Compounds" Ph.D. August 1998. (Invista – Sabine River, Orange, TX)
7. Andrei Merenov, "Development of a New Route for the Production of Acetic Acid from Synthesis Gas", Ph.D. December 1999. (Dow Chemical, Houston, TX).
8. Selma Bektesevic, "Analysis of heterogeneous catalysts for use hydroformylation of 1-hexene in supercritical carbon dioxide", Ph.D. August 2005 (Honeywell, Buffalo, NY).
9. Sandeep Goud, "Catalyst deactivation during steam reforming of higher hydrocarbons to hydrogen", Ph.D. May 2007 (SOFCO-EFS/Rolls Royce).
10. Sadashiv Swami, "Conversion of biomass-derived compounds to hydrogen for fuel cell applications", Ph.D. Dec. 2008 (Praxair, Buffalo, NY).
11. Atish Kataria, "Conversion of refined hydrocarbon fuels to hydrogen for fuel cell applications", Ph.D. Dec. 2009 (Research Triangle Institute, RTP, NC).
12. Satish Lakhapatri, "Fundamental evaluation of catalyst deactivation during steam reforming of diesel and jet fuel", Ph.D. Aug. 2010 (New Jersey Institute of Technology).

Post-Doctoral Associates

1. Dr. Ponnaiyan Ayyappan, "Development of sulfur-tolerant catalysts for hydrogen production by reforming of heavy fuels", 2006 – 2007 (Caterpillar, Inc.)
2. Dr. Rajender Kondakindi, "CO₂ capture by sorbents supported on metal foil", 2010 – 2012 (Watt Fuel Cell Corporation, New York).

Visiting Scientists

1. Dr. Benito Serrano, University of Zacatecas, Mexico, "Cellulose conversion to chemicals by catalytic oxidation in subcritical water", Summer 2000.
2. Dr. Peter Smith, Westminster University, Department of Chemistry, "Design of catalyst supports for diesel fuel steam reforming", 2009 – 2010.

Refereed Publications

1. Abraham, M.A., Klein, M.T.; "Pyrolysis of Benzylphenylamine Neat and with Tetralin, Methanol, and Water Solvents;" *I&EC Prod. Res. Dev.*; **24**(2), 300, 1985.
2. Abraham, M.A., Klein, M.T.; "Solvent Effects during the Reaction of Coal Model Compounds" in **Supercritical Fluids: Chemical Engineering Principles and Applications**, Squires, T.G. and Paulaitis, M.E., eds.; ACS Symposium Series 329, 1987.
3. Townsend, S.H., Abraham, M.A., Huppert, G.L.; Klein, M.T., Paspek, S.C.; "Solvent Effects during Reactions in Supercritical Water", *I&EC Research*, **27**(1), 1988, pp. 143-9.
4. Abraham, M.A., Wu, B.C., Paspek, S.C., Klein, M.T.; "Reactions of Dibenzylamine Neat and in Supercritical Fluid Solvents", *Fuel Sci. & Technol.*, **6**(5), 557, 1988.
5. Abraham, M.A., Klein, M.T.; "Reactions of Benzylphenylsulfide in Dense Polar Solvents", *Fuel Sci. & Technol.*, **6**(6), 633, 1988.
6. Leavitt, D.D., Abraham, M.A.; "Homogeneous Oxidation of 2,4-Dichlorophenoxyacetic Acid by Ammonium Nitrate", *Environ. Sci. Technol.*, **24**(4), 566, 1990.
7. Sodhi, D., Abraham, M.A., Summers, J.C.; "Control of Formaldehyde Emissions from Methanol Fueled Vehicles", *J. Air Waste Manage. Assoc.*, **40**(3), 352, 1990.

8. Leavitt, D.D., Horbath, J.S., Abraham, M.A.; "Homogeneously Catalyzed Oxidation for the Destruction of Aqueous Organic Wastes", *Environ. Progress*, **9**(4), 222, 1990.
9. Jin, L., Shah, Y.T., Abraham, M.A.; "The Effect of Supercritical Water on the Catalytic Oxidation of 1,4-Dichlorobenzene", *J. Supercritical Fluids*, **3**(4), 233, 1990.
10. Jin, L., Abraham, M.A.; "Low Temperature Catalytic Oxidation of 1,4-Dichlorobenzene", *Ind. Eng. Chem. Research*, **30**(1), 89, 1991.
11. Jin, L.; Ding, Z., Abraham, M.A.; "Catalytic Supercritical Water Oxidation of 1,4-Dichlorobenzene", *Chem. Eng. Sci.*, **47**(9-11), 2659, 1992.
12. Rush, B.J.; Shah, Y.T.; Abraham, M.A.; "The Effect of Gas Density on Holdup in a Supercritical Fluid Bubble Column", in **Supercritical Fluid Engineering Science**, E. Kiran and J.F. Brennecke, eds., ACS Symposium Series 514, 338-346, 1992.
13. Dixon, C.N., Abraham, M.A.; "Conversion of Methane to Methanol by Catalytic Supercritical Water Oxidation", *J. Supercritical Fluids*, **5**(4), 269, 1992.
14. Chen, J.C., Shah, Y.T., Abraham, M.A. "Liquid Phase Axial Dispersion in a High Pressure Packed Column", *Chem. Eng. Comm.*, **125**, 1-12, 1993.
15. Brewer, T.F., Abraham, M.A., Silver, R.G. "Mixture Effects and Methanol Oxidation Kinetics over a Palladium Monolith Catalyst", *Ind Eng Chem Res*, **33**(3), 526, 1994.
16. Fisher, J.W., Abraham, M.A. "Particle Size Effect on Supercritical Water Oxidation - Polystyrene Beads", *SAE Technical Paper* 941399, 1994.
17. Sawyer, J.E., Abraham, M.A. "Reaction Pathways during the Oxidation of Ethyl Acetate on a Platinum/Alumina Catalyst", *Ind Eng Chem Res*, **33**(9), 2084, 1994.
18. Aki, S.N.V.K., Abraham, M.A. "Catalytic Partial Oxidation of Methane in Supercritical Water", *J. Supercritical Fluids*, **7**(4), 259, 1994.
19. Borgharkar, N.S., Abraham, M.A. "Monomethylamine Oxidation over Palladium Catalysts", *Chem. Eng. Sci.*, **49**(24A), 4501-4513, 1994.
20. Crynes, L.E., Cerro, R.L., Abraham, M.A. "The Monolith Slug Flow Reactor: Development of a Novel Three-Phase Catalytic Reactor", *AIChE J.*, **41**(2), 337, 1995.
21. Thulasidas, T.C., Abraham, M.A., Cerro, R.L. "Bubble-Train Flow in Capillaries of Circular and Square Cross Section", *Chem. Eng. Sci.*, **50**, 183, 1995.
22. Patrick, R.H., Jr., Klindera, T., Crynes, L.L., Cerro, R.L., Abraham, M.A. "Residence Time Distribution in a Three Phase Monolith Reactor", *AIChE J.*, **41**(3), 649, 1995.
23. Thulasidas, T.C., Cerro, R.L., Abraham, M.A. "The Monolith Froth Reactor: Residence Time Modeling and Analysis" *Trans IChemE*, **73**(A), 314, 1995.
24. Ding, Z.Y., Aki, S., Abraham, M.A. "Catalytic Supercritical Water Oxidation: An Approach for Complete Destruction of Aromatic Compounds", in **Innovations in Supercritical Fluids: Science and Technology**, Hutchenson, K.; Foster, N.R., eds., ACS Symposium Series No. 608, pp. 234-247, 1995.
25. Ding, Z.Y., Aki, S.N.V.K., Abraham, M.A. "Catalytic Supercritical Water Oxidation: Phenol Conversion and Product Selectivity", *Environ. Sci. & Technol.*, **29**(11), 2748, 1995.
26. Shah, Y.T., Abraham, M.A., Cerro, R.L., "Oxidation of Phenol in a Three-Phase Monolithic Froth Reactor", Ch. 7 in **Three Phase Sparged Reactors**, Nigam, K.D.P. and Schumpe, A., eds., Gordon and Breach Science Publishers, Reading, UK, 1996.
27. Aki, S.N.V.K., Ding, Z.Y., Abraham, M.A. "Catalytic Supercritical Water Oxidation: Stability of Cr₂O₃ Catalyst", *AIChE J.*, **42**(7), 1995, 1996.
28. Pisharody, S., Fisher, J.W., Abraham, M.A. "Conversion of Solid Wastes by Supercritical Water Oxidation", *Ind Eng Chem Res*, **35**(12), 4471, 1996.

29. Dangi, S., Abraham, M.A. "Study of Mixture Effects during Complete Catalytic Oxidation of Benzene and MTBE", *Ind Eng Chem Res*, **36**(6), 1979, 1997.
30. de Tezanos Pinto, M., Abraham, M.A. and Cerro, R.L. "How do bubbles enter a capillary?", *Chem. Eng. Sci.*, **52**(11), 1685, 1997.
31. Aki, S.N.V.K., Abraham, M.A. "Catalytic Supercritical Water Oxidation of Pyridine: Kinetics and Mass Transfer Effects", in **Supercritical Fluids: Extraction and Pollution Prevention**, Abraham, M.A.; Sunol, A.K., eds., ACS Symposium Series 670, 232, 1997.
32. Thulasidas, T.C., Abraham, M.A., Cerro, R.L. "Flow Patterns in Liquid Slugs during Bubble-Train Flow inside Square Capillaries", *Chem. Eng. Sci.*, **52**(17), 2947, 1997.
33. Klinghoffer, A.A., Cerro, R.L., Abraham, M.A. "Catalytic Wet Oxidation of Acetic Acid using Platinum on Alumina Monolith Catalyst", *Catalysis Today*, **40**(1), 59-72 (1998).
34. Klinghoffer, A.A., Cerro, R.L., Abraham, M.A. "Influence of Flow Properties on the Performance of the Monolith Froth Reactor for Catalytic Wet Oxidation of Acetic Acid", *Ind & Eng Chem Res*, **37**(4), 1203, (1998).
35. Merenov, A.S., Abraham, M.A. "Catalyzing the Carbonylation of Methanol using a Heterogeneous Vapor Phase Catalyst", *Catalysis Today*, **40** (4), (1998), 397.
36. Aki, S.N.V.K., Abraham, M.A. "An Economic Evaluation of catalytic supercritical water oxidation: Comparison with alternative waste treatment technologies", *Environ Progress*, **17**(4) (1998), 246.
37. Thulasidas, T.C., Abraham, M.A., Cerro, R.L. "Dispersion during Bubble-Train Flow in Capillaries", *Chem. Eng. Sci.*, **54**(1) 61 (1999).
38. Aki, S.N.V.K, Abraham, M.A. "Catalytic Supercritical Water Oxidation of Pyridine: Comparison of Catalysts", *Ind. Eng. Chem. Res.* **38**(2), 358, (1999).
39. Aki, S.N.V.K, Abraham, M.A. "Catalytic Supercritical Water Oxidation of Pyridine: Kinetics and Mass Transfer", *Chem. Eng. Sci.* **54**(15-16), 3533 (1999).
40. Merenov, A.S., Nelson, A., Abraham, M.A. "The Effect of Support on the Activity and Stability of Ni/Activated Carbon as a Catalyst for Vapor Phase Methanol Carbonylation" *Catalysis Today*, **55**, 91, (2000).
41. Hesketh, R.P., Abraham, M.A. "Pollution Prevention Education in Chemical Reaction Engineering", in **Reaction Engineering in Pollution Prevention**, Martin A. Abraham and Robert P. Hesketh, eds, Elsevier Science, New York, 305, (2000).
42. Natarajan, S., Olson, W.W., Abraham, M.A. "Reaction Pathways and Kinetics in the Degradation of Forging Lubricants", *Ind. Eng. Chem. Res.*, **39**(8), 2837, (2000).
43. Abraham, M.A. "A Pollution Prevention Course that helps meet EC 2000 objectives", *Chem. Eng. Educ.*, **34**(3) 272 (2000).
44. Dharmidhikari, S., Abraham, M.A. "Rhodium supported on activated carbon as a heterogeneous catalyst for hydroformylation of propylene in supercritical carbon dioxide", *J. Supercritical Fluids*, **18**(1), 1 (2000).
45. Patrick, T.A., Abraham, M.A. "Evaluation of a monolith-supported Pt/Al₂O₃ catalyst for wet oxidation of carbohydrate-containing waste streams", *Environ. Sci. Technol.*, **34** (16), 3480 -3488, (2000).
46. Snyder, G., Tadd, A., Abraham, M.A. "Evaluation of Catalyst Support Effects during Rhodium-catalyzed Hydroformylation in Supercritical CO₂" *Ind. Eng. Chem. Res.*, **40**(23), 5317-5325 (2001).
47. Schutt, B.D., Serrano, B., Cerro, R.L., Abraham, M.A. "Production of chemicals from cellulose and biomass-derived compounds through catalytic sub-critical water oxidation in a monolith reactor", *Biomass & Bioenergy*, **22**(5), 365-375 (2002).

48. Tadd, A. R., Marteel, A., Mason, M. R., Davies, J. A., Abraham, M.A. "Hydroformylation of 1-Hexene in Supercritical Carbon Dioxide Using a Heterogeneous Rhodium Catalyst. 2. Evaluation of Reaction Kinetics", *Ind. Eng. Chem. Res.*, 2002, **41**, 4514-4522
49. Hemminger, O., Marteel, A., Mason, M. R., Davies, J. A., Tadd, A. R., Abraham, M.A. "Hydroformylation of 1-hexene in supercritical carbon dioxide using a heterogeneous rhodium catalyst. 3. Evaluation of solvent effects" *Green Chemistry*, 2002, **4**, 507-512.
50. Hassoun, E.A., Abraham, M.A., Kini, V., Al-Ghafri, M., Abushaban, A. "Cytotoxicity of the Ionic Liquid, 1-N-Butyl-3-Methyl Imidazolium Chloride," *Research Communications in Pathology and Pharmacology*, 2002, **7**(1-2), 23 - 32.
51. Tadd, A. R., Marteel, A., Mason, M. R., Davies, J. A., Abraham, M.A. "Hydroformylation of 1-Hexene in Supercritical Carbon Dioxide Using a Heterogeneous Rhodium Catalyst. 1. Effect of Process Parameters", *J. Supercritical Fluids*, 2003, **25**(2): 183-196.
52. Marteel, A., Davies, J. A., Mason, M. R., Abraham, M.A. Tack, T., Bektesevic, S., "Supported platinum/tin complexes as catalysts for hydroformylation of 1-hexene in supercritical carbon dioxide" *Catalysis Communications*, 2003, **4** (7), 309-314.
53. Marteel, A., Davies, J.A., Olson, W.W., Abraham, M.A. "Green Chemistry and Engineering: Drivers, Metrics, and Reduction to Practice" **Ann. Rev. Environ. Resour.** 2003, 28:401-28.
54. Tack, T., Marteel, A., Bektesevic, S., Davies, J. A., Mason, M. R., Abraham, M.A. "Hydroformylation of 1-Hexene in Supercritical Carbon Dioxide: Characterization, Activity and Regioselectivity Studies", *Environ. Sci. Technol.*, 2003, **37** (23): 5424-5431.
55. Abraham, M.A., Nguyen, N. "Results from the Sandestin Conference: Green Engineering: Defining the Principles" *Environ. Prog.*, 2003, **22**(4): 233 - 236.
56. Schutt, B.D., Abraham, M.A. "Evaluation of a monolith reactor for the catalytic wet oxidation of cellulose" *Chem. Eng. J.*, 2004, **103**(1-3): 77-88.
57. Abraham, M.A. "Sustainable Engineering: An initiative for chemical engineers", *Env. Prog.* 2004, **23**(4): 261-263.
58. Bektesevic, S., Tack, T., Mason, M.R., Abraham, M.A. "Analysis of the Hydroformylation Reaction over an Immobilized Catalyst in Supercritical Carbon Dioxide" *Ind. Eng. Chem. Res.*, 2005, **44**, 4973-4981.
59. Kleman, A.M., Abraham, M.A., "Asymmetric Hydroformylation of Styrene in Supercritical Carbon Dioxide", *Ind. Eng. Chem. Res.*, 2006, **45**, 1324-1330.
60. Bektesevic, S., Kleman, A.M., Marteel-Parrish, A. E., Abraham, M.A. "Hydroformylation in Supercritical Carbon Dioxide: Catalysis and Benign Solvents", *J. Supercrit. Fluids*, 2006, **38**, 232 - 241.
61. Swami, S., Abraham, M.A., "An Integrated Catalytic Process for Conversion of Biomass to Hydrogen", *Energy & Fuels*, 2006, **20** (6), 2616 -2622.
62. Slater, C. Stewart, Hesketh, Robert P., Fichana, Daniel, Henry, Jim, Flynn, Ann Marie, Abraham, Martin, "Expanding the Frontiers for Chemical Engineers in Green Engineering Education" *Int. J. Engng Ed.* 2007 **23**(2), 309-324.
63. Goud, S., Whittenberger, W.A., Abraham, M.A., "An evaluation of catalyst deactivation for steam reforming of diesel fuel", *International Journal of Hydrogen Energy*, 2007, **32**(14), 2868-2874.
64. McCoy, A. M., Duran, M. J., Azad, A-M., Chattopadhyay, S., Abraham, M.A., "Performance of sulfur tolerant reforming catalysts for production of hydrogen from jet fuel simulants", *Energy & Fuels*, **21** (6), 3513-3519, 2007.
65. Sharma, P. O. Abraham, M. A., Chattopadhyay, S., "Development of a Novel Metal Monolith Catalyst for Natural Gas Steam Reforming", *I&EC Research*, **46** (26), 9053 -9060, 2007.

66. Azad, A.M., Duran, M.J., McCoy, A.K., Abraham, M.A., “Development of ceria-supported sulfur tolerant nanocatalysts: Pd-based formulations”, *Appl Catal A – Gen'l*, **332** (2): 225-236, 2007.
67. Sharma, P. O., Swami, S., Goud, S., Abraham, M.A. “Catalyst development for stable hydrogen generation during steam reforming of renewable and nonrenewable resources”, *Environ. Prog.*, **27**(1): 22-29, 2008.
68. Swami, S.M., Chaudari, V., Kim, D.S., Sim, S.J., Abraham, M.A., “Production of hydrogen from glucose as a biomass simulant: Integrated biological and thermochemical approach”, *I&EC Research*, **47**(10): 3645-3651, 2008.
69. Satterfield, M.; Kolb, Charles; Peoples, Robert; Adams, Georjean; Schuster, Darlene; Ramsey, Henry; Stechel, Ellen B.; Wood-Black, Frankie; Garant, Raymond, Abraham, Martin; “Overcoming Nontechnical Barriers to the Implementation of Sustainable Solutions in Industry”, *Environ Sci & Technol.*, **43**(12), 4421 – 4426, 2009.
70. Lakhapatri, S., Abraham, M.A., “Deactivation due to sulfur poisoning and carbon deposition on Rh-Ni/Al₂O₃ catalyst during steam reforming of sulfur-doped n-hexadecane” *Appl Catal A: General*, **364**(1-2), 113-121, 2009.
71. Gawade, Preshit, Lipscomb, G. Glenn, Abraham, Martin A. “Kinetics and Modeling of the Flexible Fuel Reformer: n-Hexadecane Steam Reforming and Combustion” *Ind. & Eng. Chem. Research*, **49**(15), 6931-40, 2010.
72. Lakhapatri, S., Abraham, M.A., “Analysis of Catalyst Deactivation during Steam Reforming of Jet fuel on Ni-(PdRh)/ γ -Al₂O₃ catalyst” *Appl Catal A: General*, **405**(1-2), 149-159, 2011.
73. Kondakindi, R.R., McCumber, G., Aleksic, S., Whittenberger, W.A. Abraham, M.A. “Na₂CO₃-based sorbents coated on metal foil: CO₂ capture performance”, *International Journal of Greenhouse Gas Control* **15**, 65–69, 2013.
74. Kondakindi, R.R., Aleksic, S., Whittenberger, W.A. Abraham, M.A., “Na₂CO₃-based sorbents coated on metal foil: post testing analysis”, *Topics in Catalysis*, **56**(18-20), 1944-1951, 2013.
75. Lakhapatri, S., Abraham, M.A., “Sulfur Poisoning in Rh-Ni Catalysts during Steam Reforming of Sulfur-containing Liquid Fuels”, *Catal. Sci. Technol.*, **3** (10), 2755 – 2760, 2013.
76. Choo, K., Friedrich, B., Daugherty, T., Schmidt, A., Patterson, C., Abraham, M.A., Conner, B.P., Rogers, K., Cortes, P., MacDonald, E., “Heat Retention Modeling of Large Area Additive Manufacturing”, *J. Add Manufacturing*, 2018, accepted.
77. Oh, Y., Bharambe, V., Mummareddy, B., Martin, J., McKnight, J., Abraham, M. A., Walker, J. M., Rogers, K., Conner, B., Cortes, P., MacDonald, E., Adams, J. J., “Microwave Dielectric Properties of Zirconia Fabricated using NanoParticle Jetting”, *J. Add Manufacturing*, 2019, revision in review.

Books and Editorships

1. **Supercritical Fluids: Extraction and Pollution Prevention**, Martin A. Abraham and Aydin K. Sunol, eds., ACS Symposium Series 670, Washington, DC, 1997.
2. *Catalysis Today*, **40**(1), (1998) Special issue on Environmental Catalysis and Reaction Engineering (based on papers at the 1996 AIChE Annual meeting), with P. Smirniotis.
3. *Environmental Progress*, special issue on Environmental Applications of Supercritical Fluids (based on papers at the 1997 AIChE Annual meeting), Winter 1998.
4. **Reaction Engineering in Pollution Prevention**, Martin A. Abraham and Robert P. Hesketh, eds., Elsevier Science, New York, ISBN: 0-444-50215-7 (2000).
5. **Clean Solvents: Alternative Media for Chemical Reactions and Processing**, Martin A. Abraham and Luc Moens, eds., ACS Symposium Series 819, Oxford University Press, Washington, DC, 2002.

6. *Environmental Progress*, special issue on Sustainability in Chemical Engineering (based on papers at the 2003 AIChE Annual meeting), **23**(4), December 2004.
7. **Sustainability Science and Engineering: Defining Principles**, Elsevier Science, Amsterdam, The Netherlands, ISBN: 0-444-51712-X (2005).
8. **Innovations in Industrial and Engineering Chemistry: A Century of Achievements and Prospects for the New Millennium**, W. Flank, M.A. Abraham, and M. Matthews, eds., ACS Symposium Series 1000, Washington, DC 2008.
9. **Green Chemistry and Engineering: A Pathway to Sustainability**, Anne E. Marteel-Parrish, Martin A. Abraham, AIChE/Wiley Books, ISBN: 978-0-470-41326-5, (2014).
10. **Encyclopedia of Sustainable Technologies**, 1st edition, Martin A. Abraham, editor, Elsevier Major Reference works, ISBN: 9780128046777, July 28, 2017.
11. **Sustainable Technologies for a Changing World**, Elsevier S&T Books, in development for 2020 publication.

Additional Publications

1. Lawson, J.R., Obst, J.R., Abraham, M.A., Townsend, S.H., Klein, M.T.; "Solvent Effects During the Reaction of Coal and Biomass Model Compounds in Dense Water", ACS Div. of Fuel Chemistry preprints; **30**(1), 398, 1985.
2. Abraham, M.A., Klein, M.T.; "Solvent Effects During the Reaction of Coal Model Compounds", ACS Div. of Fuel Chemistry preprints; **30**(3), 88, 1985.
3. Abraham, M.A., Klein, M.T.; "Modelling the Thermal Reactions of Benzylphenylsulfide", ACS Div. of Fuel Chemistry preprints, **32**(3), 1987, p. 189.
4. Phillips, C.L., Abraham, M.A.; "A Comparison of Several Novel Catalysts for Emissions Control in Methanol-Fueled Vehicles", *Proceedings of IECEC 25*, **5**, 197, 1990.
5. Dixon, C.N., Abraham, M.A.; "Selective Partial Oxidation of Methane by Catalytic Supercritical Water Oxidation", ACS Div. of Fuel Chemistry preprints, **36**(4), 1846, 1991.
6. Kim, S., Shah, Y.T., Cerro, R.L., Abraham, M.A.; "Aqueous Phase Oxidation of Phenol in a Monolithic Reactor", 2nd Topical Pollution Prevention Conference preprints, AIChE, New York, 46, August, 1991.
7. Abraham, M.A. "Fluid-Solid Interactions during Reactions in Supercritical Water", *Emerging Technologies in Hazardous Waste Management V*, American Chemical Society, 304, 1993.
8. Borgharkar, N.S., Al-Mehairi, A.S., Abraham, M.A. "Catalytic Oxidation of Monomethylamine: Kinetics and Effect of Water Vapor", Proceedings of the International Petroleum Environmental Conference, PennWell Books, p. 8, 1994.
9. "Catalytic Supercritical Water Oxidation: Pathways, Kinetics, and Modeling", First International Workshop on Supercritical Water Oxidation, *Supercritical Water Oxidation: A Revolutionary Environmental Technology*, Jacksonville, FL, February 6-9, 1995, with S.N.V.K. Aki and Z.Y. Ding.
10. "Catalytic Supercritical Water Oxidation: Destruction of Nitrogen Containing Compounds", Proceedings of the Second International Symposium on Environmental Applications of Advanced Oxidation Technologies, San Francisco, CA., 1996, with S.N.V.K. Aki and Z. Merah.
11. "Heterogeneously Catalyzed Hydroformylation of Propylene in Supercritical Carbon Dioxide", 3rd Annual Green Chemistry and Engineering Conference, Washington, DC, June 29 – July 1, 1999, with G. Snyder and S. Dharmidhikari, p. 91.
12. "When is Green Really Green? A Pilot Investigation of Time Effects using LCA Data", SAE 2000-01-1494, SAE Total Life Cycle Conference, April 26-28, 2000, with W. W. Olson.

13. "Development of supported rhodium catalyst for hydroformylation of propylene in supercritical carbon dioxide." International Symposium on Supercritical Fluids, April 2000, with G. Snyder and M.R. Mason.
14. "A Pilot Investigation of Incorporating Time into LCA", 2000 Japan-USA Flexible Automation Conference, July 23-26, 2000, Ann Arbor, MI, 2000JUSFA-13202, with W. W. Olson.
15. Book Review: "Pollution Prevention: Fundamentals and Practice", *J. Haz. Mater.* **77**(1-3), 262 – 265.
16. "Development of Heterogeneous Catalysts for Hydroformylation of 1-Hexene in Supercritical Carbon Dioxide", 5th Annual Green Chemistry and Engineering Conference, Washington, DC, June 26 – 28, 2001, with A. R. Tadd, A. Marteel, J.A. Davies, and M.R. Mason.
17. "Green Engineering Education: Multiple Audiences – Multiple Presentations", Proceedings of Green Engineering: Sustainable and Environmentally Conscious Engineering, VPI&SU, Roanoke, VA, July 29 – 31, 2001.
18. "Surface Analysis of a Heterogeneous Catalyst Designed for Hydroformylation in Supercritical CO₂", A. Marteel, J. Davies, M. Mason, S. Bektesevic, and M. Abraham, Proceedings of the 4th International Symposium on High Pressure Technology and Chemical Engineering, Sept. 22 – 25, 2002, Venice, Italy, Vol. 2, p. 549 – 555.
19. R. Parab, A. Heydinger, A. Kumar, and M. A. Abraham, "A Pilot Study to Estimate Application of Atrazine on Areas near Auglaize River using AERMOD/BASINS", Paper # OS-02-26, Proceedings of Ohio Air Pollution Research Symposium, 2002.
20. Abraham, M.A. "Sustainable engineering for engineers", *Environmental Progress*, 2005, **24**(1), 10 – 11.
21. Abraham, M.A., "Energy, sustainability, and engineering", *Environmental Progress*, 2005, **24**(2), 119 – 120.
22. Abraham, M.A., "The importance of China for sustainable development", *Environmental Progress*, 2005, **24**(3), 231 - 233.
23. Abraham, M.A., "Sustainability Education", *Environmental Progress*, 2005, **24**(4), 343 - 344.
24. Abraham, M.A., "Random Thoughts on Sustainability", *Environmental Progress*, 2006, **25**(1), 9 - 10.
25. Abraham, M.A., "Sustainability: Philosophy vs. Engineering tools" *Environmental Progress*, 2006, **25**(2), 87-88
26. Abraham, M.A., "Building a reef of sustainability" *Environmental Progress*, 2006, **25**(3), 175-176
27. Abraham, M.A. "The Sustainability Challenge: You've Got to Be In It to Win It", Guest Editorial, *Chemical Engineering Progress*, December 2006, 5.
28. Abraham, M.A., "Sustainability as an individual imperative" *Environmental Progress*, 2006, **25**(4), 276-277.
29. Abraham, M.A., Clark, J., and Winterton, N., Chapter 1: *Introduction*, in **Green Chemistry Metrics: Measuring and Monitoring Sustainable Processes**, Lapkin, A., and Constable, D., eds., Wiley-Blackwell Publishing, ISBN 978-1-4051-5968-5, 2009.
30. Abraham, M.A., "YSU's STEM College – Is this what an urban research university looks like?", *The Vindicator*, March 7, 2010
31. Abraham, M.A. "Energy: Our No. 1 challenge", *The Vindicator*, January 8, 2012.
32. Abraham, M.A. "Beware attack on fossil fuel", *The Vindicator*, February 9, 2015.
33. Abraham, M.A., "Introduction to the special section on thermochemical conversion of biomass resources", *Env. Prog. Sust. Energy* 2017, **36**(3), 654.
34. Abraham, M.A., "Introduction to the special section on the food, energy, water nexus", *Env. Prog. Sust. Energy* 2018, **37**(1), 20.

35. Abraham, M.A., "Introduction to the special section on carbon dioxide", *Env. Prog. Sust. Energy* 2019, 38(1), 12..

Patents and Filings

1. Azad, A-M., Abraham, M.A., "Sulfur-Tolerant Catalysts and Sulfur Sorbents" Provisional Patent Application, filed February 21, 2007.
2. Abraham, M.A. "Formula for six novel sulfur-tolerant catalysts", trade secret licensed to Catacel Corp, Nov. 2008.
3. Abraham, M.A., Kondakindi, Rajender, Aleksic, S., Whittenberger, W.A. "CO₂ Capture Using Sorbents Supported on Structures", Provisional Patent application filed March 2012.

Grants received

University of Tulsa

1. "An Introduction to Engineering for Native American and Minority High School Students", NSF Young Scholars Program, \$67,937.
2. "Development of Automobile Emission Catalysts for use with Methanol Fuels", Allied-Signal, Inc.; 1988 - \$49,777, 1989 - \$59,130, 1990 - \$65,249, 1991 - \$62,448.
3. "Hazardous Waste Detoxification by Catalytic Oxidation in Inorganic Acids", University of Tulsa Faculty Summer Development Fellowship, Summer 1988, \$4,000.
4. "Catalyst Surface Area Measurements for Monolithic Catalysts", Airepair International, Inc., June 1, 1989 – Dec. 31, 1989, \$2,903.
5. "Evaluation of Rate Parameters during Heterogeneous Catalysis in Supercritical Fluids" National Science Foundation Research Initiation Grant, beginning 7/1/89 for 2 years, \$67,907.
6. "Hazardous Waste Treatment by Oxidation in Supercritical Fluids," Oklahoma Centers for Applied Science and Technology, beginning 1/1/90 for 3 years, \$97,043.
7. "Evaluation of Bubble-Column Parameters for Catalysis in Supercritical Fluids" NSF – Research Experience for Undergraduates, Summer 1990, \$4,850.
8. "Catalytic Destruction of Polymeric Wastes", University of Tulsa Faculty Summer Development Fellowship, Summer 1990, \$4,900.
9. "Recovery of Precious Metals from Catalytic Converters", Oklahoma Centers for Applied Science and Technology, beginning 9/1/90 for 3 years, \$300,000, with K. Wisecarver and N. Takach.
10. "Analysis of a Novel Three-Phase Catalytic Reactor for Foaming Systems," National Science Foundation, beginning 7/1/91 for 2 years, \$144,683, with R.L. Cerro. REU Supplement, \$10,000 received summer 1992.
11. "An Introduction to Engineering for Early High School Students", National Science Foundation, February 1, 1992 – April 30, 1994, \$159,424, with R. Hesketh, J. Henshaw, and M. Timmerman.
12. "Catalytic Oxidation – Student Stipend", Allied-Signal, Inc., \$3,155, Jan 1993 – May 1993.
13. "NASA-Joint Venture", Jove Grant NAG8-1005, January 1, 1994 – May 31, 1996, \$141,319, with S. Pomeranz and W. Potter.
14. "Catalytic Oxidation for Air Pollution Control", The University of Tulsa Faculty Research Grant, Fall, 1994, \$600.
15. "Catalytic Supercritical Water Oxidation", National Science Foundation, July 1, 1994 – June 30, 1997, \$185,000.
16. "Catalytic Supercritical Water Oxidation for the Partial Oxidation of Heavy Hydrocarbons", Imperial Oil Resources, Ltd., September 1, 1994 – December 31, 1994, \$27,334.

17. "Development of a New Fischer-Tropsch Catalyst", Syntroleum Corp., \$8,798, Sept. 1, 1994 – May 31, 1995.
18. "An Introduction to Engineering for Early High School Students", NSF – Young Scholars Program, \$179,931, Feb. 1, 1995 – July 31, 1997, with R. Hesketh, C. Patton, and J. Henshaw.
19. "Catalytic Wet Oxidation in a Monolith Reactor for the Destruction of Solid Wastes", NASA – Ames Research Center, \$40,000, Sept. 1, 1995 – Aug. 31, 1997.

University of Toledo

1. "Catalytic Supercritical Water Oxidation", National Science Foundation, July 1, 1994 – June 30, 1997, \$70,000 (transferred from the University of Tulsa).
2. "Determination of Oxidation Mechanism using Diffuse Reflectance FTIR", Guild Associates (prime: NSF), June 1997 – Sept. 1998, \$35,000.
3. "Development of an Environmental Chemical Engineering Laboratory", NSF Instrumentation and Laboratory Improvement Program and University of Toledo, \$100,000, with S.E. LeBlanc.
4. "Evaluation of Catalytic Wet Oxidation for the Ultimate Conversion of Solid Wastes", NASA – Ames Research Center, \$40,000, July 1, 1997 – June 30, 1998.
5. "Development of a Seminar Series on Pollution Prevention", University of Toledo Program for Academic Excellence, \$6,000, July 1, 1997 – June 30, 1999.
6. "Using Emission Master Throughout the Chemical Engineering Curriculum", Mitchell Scientific, Inc., \$30,000 (in kind).
7. "Development of Environmental Engineering Instructional Modules for Middle School Students", Ohio Board of Regents, \$85,330, Sept. 1997 – March 1999.
8. "Stability and Friction Characterization of Forging Lubricants", College of Engineering Collaborative Research Grants, \$40,000, Sept 1998 – Aug 1999, with W. Olson (MIME) and L. Valencic (Dana Corporation).
9. "High Performance Liquid Chromatograph for Biochemical and Environmental Engineering Research", NSF Equipment Grant, \$71,400, with A. Nadarajah, S. Sharfstein, and C. A. Schall.
10. "Heterogeneous Catalysis in Supercritical Carbon Dioxide", NSF – Lucent Technologies Industrial Ecology Research Fellowship, \$100,000, Sept. 1998 – August. 2000. REU Supplement, summer 1999, \$5,038.
11. "Development of a Heterogeneous Catalyst for Hydroformylation in Supercritical CO₂", Technology for a Sustainable Environment, Environmental Protection Agency, \$315,000, June 2000 – May 2003, with J.A. Davies and M.R. Mason.
12. "Catalysis in Confined Spaces" PG Research Foundation, \$48,991, May 2001 – Dec. 2002, with M.R. Mason.
13. "Sustainable Development: Modeling the Maumee River Watershed for Economic Growth", URAFP, with K. Czajkowski, K. Schneider, J. Gottgens, A. Heydinger, D.S. Kim, and A. Kumar, \$50,000, May 2001 – Dec. 2002.
14. "Evaluation of tire pyrolysis oil", Riverside Technology, Inc., July 1, 2001 – Aug. 31, 2001, \$7,500.
15. "Validation of Toxicity Database", EPA Risk Reduction Laboratory, Cincinnati, OH, August 1, 2001 – Dec. 31, 2001, \$15,000.
16. "Northwest Ohio Partnership on Alternative Energy Systems", NSF Partnership for Innovation Award, Oct. 2002 – Sept. 2005, \$600,000, F. Calzonetti, PI.
17. "BEST: Bridging Engineering and Science Teaching", NSF – Bridges for Engineering Education, 1/1/03 – 12/31/03, \$100,000, with Mark Pickett (PI), Charlene Czerniak, Doug Nims, and Rebecca Schneider.
18. "Mini-proposal on Catalyst Deactivation", Catacel, Inc., January 1, 2004 – May 15, 2004, \$3,000.

19. "Conversion of Waste Biomass to Hydrogen", EISC, Inc., March 2, 2004 – March 2, 2005, \$75,000, with D.S. Kim.
20. "Fuel Processing for Fuel Cell Applications", Ohio Department of Development Wright Centers Initiative, Feb. 1, 2004 – Jan. 31, 2007, \$1,350,000, with G. Lipscomb and M. Coleman, through Case Western Reserve University.
21. "Compact Fuel Reformer for SOFC", Catacel, Inc (through NSF SBIR program), July 2004 – Dec. 2004, \$25,542.
22. "High Performance Reforming Catalyst with in-situ Desulfurization Capability for Jet Fuels", NASA Glenn research center, Sept. 2004 – Aug. 2005, \$137,005, with A.M. Azad.
23. "Novel Spiral Stackable Reactor (SSR) for Low-cost Hydrogen Production", Dept of Energy (through EMTEC), Jan. 2005 – Aug. 2005, \$23,137, with A.M. Azad and W.A. Whittenberger (Catacel).
24. "Clean and Renewable Hydrogen", Dept of Energy, May 1, 2005 – April 30, 2006, approx. \$992,000, with A. D. Compaan, X. Deng, and others.
25. "Wright Fuel Cell Group Operating Funds", Ohio Department of Development, Wright Centers of Innovation, May 15, 2005 – May 14, 2008, \$404,840, with A.M. Azad, John McGrath (WFCG), and others.
26. Biodiesel Study, TARTA (US Department of Transportation), June 1, 2005 – May 31, 2008, \$574,685, with Mark Vonderembse.
27. "Novel Spiral Stackable Reactor (SSR) for Low-cost Hydrogen Production", Dept of Energy (through EMTEC), Phase II, Jan. 2006 – July 2007, \$50,000, W.A. Whittenberger (Catacel), P.I.
28. "Compact Fuel Reformer for SOFC", Catacel, Inc (NSF SBIR Phase II), March 1, 2006 – Feb. 2008, \$140,138.
29. "Clean Sources of Hydrogen", U.S. Army Contract W909MY-06-C-0048, August 1, 2006 – July 31, 2007, \$850,000, with A.M. Azad and X. Deng.
30. "Utility Vehicle for the Hydrogen Economy", Ohio Department of Development, Jan. 1, 2007 – Dec. 31, 2008, \$228,022, with Tom Stuart and Ed Kron.
31. "A Novel Desulfurizer-embedded Processor for Sulfur-laden Logistic Fuels", Third Frontier Fuel Cell Program, May 1, 2007 – April 30, 2009, \$613,457, with A.M. Azad and William Whittenberger.

Youngstown State University

32. Durability and Performance Evaluation of Catalysts on Metal Foil, Ohio Department of Development (Wright Capital Fund), July 1, 2008 – June 30, 2010, \$504,114, with S. Cahttopadhyay (Catacel Corp).
33. Durability and Performance Evaluation of Catalysts on Metal Foil, Ohio Department of Development (Third Frontier Alternative Energy Program), July 1, 2008 – June 30, 2010, \$124,050, with S. Cahttopadhyay (Catacel Corp).
34. Center for Efficiency of Sustainable Energy Systems, US Department of Energy, Sept. 2009 – April 2012, with M.D. Costarell and C.A. Linkous, \$1,903,000.
35. "Structured Bed for CO₂ Capture", NSF STTR Phase I, 7/1/2010 – 6/30/2011, \$150,000 (\$49,845 YSU portion) S. Cahttopadhyay (Catacel Corp), PI.
36. Ohio Hub for Innovation and Opportunity: Advanced Materials Commercialization and Software Development, Ohio Department of Development, Sept 2010 – Sept 2013, \$250,000.
37. "Advanced Automotive Fuels Research, Development, & Commercialization Cluster (OH)", US Department of Energy (NETL), \$1,000,000, Oct 2010 – Sept. 2011, C.A. Linkous, PI.
38. TechBelt Energy Innovation Center, US Department of Energy, National Energy Technology Laboratory, \$2,700,000, April 2011 – Sept. 2012.

39. “Post-Combustion Capture of CO₂, Sorbent Design and Implementation”, National Energy Technology Laboratory, \$99,544, Oct. 2010 – Sept. 2012, S.R. Lovelace-Cameron, PI.
40. Support for the Environmental Progress Office, provided by AIChE, approximately \$20,000 per year, 2008 – ongoing.
41. “CFD Analysis of Thermal Deburring”, Extrude Hone, \$84,400, 2019, with S. Moldavan.
42. “Aerosol spray coating for fuel cell development”, Hall Labs, \$18,000, with C. A. Linkous.