

## CURRICULUM VITAE

*Joseph (José) Manuel Calo*  
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### 1. Position:

Professor Emeritus of Engineering  
Professor of Engineering (Research)  
School of Engineering  
Brown University  
Providence, Rhode Island

### 2. Home Address:

### 3. Education:

B.S.Ch.E. (Chemical Engineering), Newark College of Engineering, Newark, NJ, 1966.  
A.M. (Chemical Engineering), Princeton University, Princeton, NJ, 1968.  
Ph.D. (Chemical Engineering), Princeton University, Princeton, NJ, 1970.  
Ph.D. Dissertation: "Nanosecond Studies of Fluorescence in Gases Excited by Fission Fragments," May 1970.

### 4. Professional Appointments:

Atmospheric Physicist, 1<sup>st</sup> Lt., Captain, USAF, Air Force Cambridge Research Laboratories, Hanscom AFB, MA 01731; August 1970 - August 1974.  
Research Engineer, Exxon Research and Engineering Co., Florham Park, NJ 07932; August 1974 - January 1976.  
Assistant Professor of Chemical Engineering, Princeton University, Princeton, NJ 08544; January 1976 - January 1981.  
Visiting Summer Professor, Mobil Research and Development Co., Paulsboro, NJ; Summer 1977.  
Associate Professor of Engineering, Brown University, Providence, RI 02912; February 1981 - June 1989.  
Professor of Engineering, Brown University, Providence, RI 02912; July 1989 – July 2010.  
Visiting Scientist, Department of Pure & Applied Chemistry, University of Strathclyde, Glasgow, Scotland, Spring 1992.  
Visiting Professor, Departamento de Química Inorgánica, Universidad de Alicante, Alicante, Spain, Summer 1992.  
Air Force Office of Scientific Research Summer Faculty Research Associate, 1995-96.  
Visiting Scholar, X-ray Sciences Division, Advanced Photon Source, Argonne National Laboratory, Argonne, IL, 2006.

Visiting Senior Investigator, Departamentos de Química Inorgánica y Química Física, Universidad de Alicante, Alicante, Spain, 2006.

Professor Emeritus of Engineering, Brown University, Providence, RI 02912; July 1, 2010.

Professor of Engineering (Research), Brown University, Providence, RI 02912; July 1, 2010 -

**Other:**

Licensed Professional Engineer, State of New Jersey, #22354.

Registered Professional Engineer, State of Rhode Island, #4433.

Consultant, Air Force Geophysics Laboratory, Hanscom AFB, MA; 1983-84.

Industrial Consultant to: UOP, Inc., Des Plaines, IL; Smith, Kline and French, Philadelphia, PA; IBM Records Division, Dayton, NJ; M.W. Kellogg, Inc., Houston, TX; Continuum Energy Technologies, LLC, Fall River, MA; Spectra Systems Corp., Providence, RI.

Chairman, Technical Advisory Board, Spectra Systems Corporation, Providence, RI, 2001 - present.

Chairman, Scientific Advisory Board, Solaris Nanosciences, Inc., Providence, RI, 2004 – 2009.

Advisor and Consultant, EPSRC Supergen University Consortium on Energy Storage, Scotland, UK; 2006 – 2008.

**5. Completed Research:**

**a. Books (Edited):**

Multiphase Chemical Reactors: Volume I - Fundamentals; Volume II - Design Methods, A. E. Rodrigues, J. M. Calo, and N. H. Sweed, eds., NATO Advanced Study Institute Series, Series E: Applied Sciences - Nos. 51 and 52, Sijthoff & Noordhoff, The Netherlands, 1981.

Recent Developments in Separation Science, Vol. IX, N. N. Li and J. M. Calo, eds., CRC Press, Boca Raton, FL, 1986.

Recent Developments in Separation Technology, N.N. Li and J.M. Calo, eds., Marcel-Dekker, New York, 1992.

**b. Chapters in Books:**

“The Modeling of Multiphase Chemical Reactors,” in Multiphase Chemical Reactors, Vol. II--Design Methods, Rodrigues, Calo, and Sweed, eds., NATO Advanced Study Institute Series, Sijthoff and Noordhoff, The Netherlands, 1981.

“Laser-Induced Separations (LIS),” with N.M. Lawandy, in Recent Developments in Separation Science, Vol. IX, N. N. Li and J. M. Calo, Eds., CRC Press, Inc., Boca Raton, FL, 1986.

“Applications of Energetic Distributions of Oxygen Surface Complexes to Carbon and Char Reactivity and Characterization,” with P.J. Hall, in *Fundamental Issues in the Control of Carbon Gasification Reactivity*, J. Lahaye and P. Ehrburger, eds, NATO ASI Series, Series E: Applied Sciences, Vol. 192, p. 329, Kluwer Academic Publishers, Dordrecht, 1991.

“The Nature of Isothermal Desorption of Carbon-Oxygen Surface Complexes Following

Gasification,” in *Fundamental Issues in the Control of Carbon Gasification Reactivity*, J. Lahaye and P. Ehrburger, eds, NATO ASI Series, Series E: Applied Sciences, Vol. 192, p. 369, Kluwer Academic Publishers, Dordrecht, 1991.

“Real time” determination of porosity development in carbons: a combined SAXS/TGA approach,” Calo, JM, Hall, PJ, Houtmann, S, Lozano-Castelló, D, Winans, RE, Seifert, S. (2002) “Real time” determination of porosity development in carbons: a combined SAXS/TGA approach,” in *Studies in Surface Science and Catalysis, Characterization of Porous Solids VI*, F. Rodríguez-Reinoso, B. McEnaney, J. Rouquerol, and K. Unger, eds., Elsevier, Amsterdam, 2002, pp. 59-66.

“Cyclic electrowinning/precipitation (CEP) for the removal of mixtures of heavy metals from aqueous solutions,” J.M. Calo, P. Grimshaw, and G. Hradil, in “Novel Solutions to Water Pollution,” S. Ahuja, and K. Hristovski, eds., ACS Symposium Series, American Chemical Society, Washington, D.C., invited contribution, in press, 2012.

### c. Publications (Refereed):

1. Calo, JM, Axtmann, RC, and Persing, RG. Nanosecond fluorescence apparatus with a spontaneously fissioning excitation source. *Rev. Sci. Instrum.* 1970; 41: 1639.
2. Calo, JM. Electronic energy loss by fission fragments. *Nucl. Sci. Eng.* 1970; 42:424.
3. Calo, JM, and Axtmann, RC. Vibrational relaxation and electronic quenching of the  $C^3\Pi_u$  ( $v'=1$ ) state of nitrogen. *J. Chem. Phys.* 1971; 54:1332.
4. Calo, JM, and Axtmann, RC. Cross section for the production of  $N_2(C^3\Pi_u)$  from metastable argon atoms. *J. Chem. Phys.* 1971; 54:4961.
5. Calo, JM, Axtmann RC, and Crowder, L. Collisional deactivation of  $CO_2$  and CO luminescence. *J. Chem. Phys.* 1971; 54:5428.
6. Calo, JM. Heteromolecular clusters of  $H_2O$ ,  $SO_2$ ,  $CO_2$ ,  $CO$  and  $NO$ . *Nature*, 1974; 248:665.
7. Calo, JM, and Brown, JH. The calculation of equilibrium mole fractions of polar-polar, nonpolar-polar, and ion dimmers. *J. Chem. Phys.* 1974; 61:3931.
8. Calo, JM, and Bailey, AD. Phase sensitive pulse counting in modulated beam mass spectrometry. *Rev. Sci. Instrum.* 1974; 45:1325.
9. Calo, JM. Dimer formation in supersonic water-vapor molecular beams. *J. Chem. Phys.* 1975; 62:4904.
10. Calo, JM. Cell model studies of radial flow, fixed bed reactors. *Chemical Reaction Engineering - Houston*, V. W. Weekman, Jr., and Dan Luss, Editors, ACS Symposium Series 65, Washington, DC. 1978, p. 550.
11. Chang, H-C, and Calo, JM. Exact criteria for uniqueness and multiplicity of an nth order chemical reaction *via* a catastrophe theory approach. *Chem. Eng. Sci.* 1979; 34:285.
12. Chang, H-C, and Calo, JM. A priori estimation of chemical relaxation oscillations via a singular perturbation technique. *Chem. Eng. Comm.* 1979; 3:431.
13. Chang, H-C, and Calo, JM. Exact universal uniqueness criteria for the adiabatic tubular packed bed reactor. *Chem. Eng. Sci.* 1980; 35:1611.
14. Chang, H-C, and Calo, JM. Catastrophe theory and chemical reactors--exact uniqueness criteria for the CSTR, catalyst particle, and packed bed reactor. *Chem. Eng. Sci.* 1980; 35:264.

15. Calo, JM, and Narcisi, RS. van der Waals molecules--possible roles in the atmosphere. *Geophys. Res. Lett.* 1980; 7:289.
16. Calo, JM. Degrees of freedom by the design variable method. AICHEMI Modular Instruction, Series B: Stagewise and Mass Transfer Operations, Volume 6: Separation Processes, B6.2, J. M. Calo and E. J. Henley, eds. AICHE, NY, 1981.
17. Calo, JM, and Andres, RP. Use of interactive graphics-based software for teaching chemical engineering principles. *Computers Chem. Eng.* 1981; 5:197.
18. Williams, DC, and Calo, JM. Fine structure of the CSTR parameter space. *AICHE J.* 1981; 27:514.
19. Leighton, DT, and Calo, JM. Distribution coefficients of chlorinated hydrocarbons in dilute air-water systems for groundwater contamination applications. *J. Chem. Eng. Data.* 1981; 26:381.
20. Kramer MA, Rabitz, HA, and Calo, JM. An improved computational method for sensitivity analysis - the Green's function method with AIM. *Appl. Math. Modelling.* 1981; 5:432.
21. Chang, H-C, and Calo, JM. An analysis of radial flow packed bed reactors: how are they different?" H. S. Fogler, ed., ACS Symposium Series 168, Washington, DC, 1981, p. 305.
22. Bowles, RS, Kolstad, JJ, Andres, RP, and Calo, JM. Generation of molecular clusters of controlled size. *Surf. Sci.* 1981; 106:117.
23. Multiphase Chemical Reactors: Volume I - Fundamentals; Volume II - Design Methods, A. E. Rodrigues, J. M. Calo, and N. H. Sweed, eds., NATO Advanced Study Institute Series, Series E: Applied Sciences - Nos. 51 and 52, Sijthoff & Noordhoff, The Netherlands, 1981.
24. Calo, JM. The modeling of multiphase chemical reactors, in *Multiphase Chemical Reactors, Vol. II--Design Methods*, Rodrigues, Calo, and Sweed, eds., NATO Advanced Study Institute Series, Sijthoff and Noordhoff, The Netherlands, 1981.
25. Fezza, RJ, and Calo, JM. Atmospheric gases on cold surfaces--condensation thermal desorption, and chemical reactions. *Heterogeneous Atmospheric Chemistry*, D. Schryer, Ed., Geophysical Monograph Series, Vol. 26, American Geophysical Union, 1982, p. 157.
26. Calo, JM. Molecular diffusion in gases. Module B4.1 in AICHEMI Modular Instruction Series B, Stagewise and Mass Transfer Operations, Volume 4: Heat and Mass Transfer, J. M. Calo and E. J. Henley, Editors, AICHE, New York, 1983, p. 1.
27. Sy, O, and Calo, JM. Transient kinetic studies of char reactions in a gradientless reactor system — CO<sub>2</sub> gasification. *ACS Div. Fuel Chem. Prepr.* 1983; 28:6.
28. Chang, H-C, Saucier, M, and Calo, JM. Design criterion for radial flow fixed-bed reactors. *AICHE J.* 1983; 29:1039.
29. Kramer MA, Rabitz, HA, and Calo, JM. Sensitivity analysis of oscillatory systems. *Appl. Math Modelling.* 1984; 8:328.
30. Kramer MA, Rabitz, HA, and Calo, JM. Parametric scaling of mathematical models. *Appl. Math Modelling.* 1984; 8:341.
31. Kramer MA, Rabitz, HA, Kee, RJ, and Calo, JM. Sensitivity analysis in chemical kinetics: recent developments and computational comparisons. *Int. J. Chem. Kin.* 1984; 16:559.
32. Gallagher, CC, Pieri, RV, Faucher, G, Forsberg, C, and Calo, JM. Oxides of nitrogen

- content of whole air samples obtained at altitudes from 12 to 30 km. *J. Geophys. Res.* 1985; 90:7899.
33. Hunton, DE, and Calo, JM. Low energy ions in the shuttle environment: evidence for strong ambient-contaminant interactions. *Planet. Space Sci.* 1985; 33:945.
  34. Calo, JM, Ganapathi, R, and Ellison, SE. Transient kinetic studies of char-gas reactions: steam gasification. *ACS Div. Fuel Chem. Prepr.* 1985; 30:294.
  35. Suuberg, EM, Wojtowicz, M, and Calo, JM. Oxygen chemisorption as a tool for characterizing “young” chars. *ACS Div. Fuel Chem. Prepr.* 1986;31:186.
  36. *Recent Developments in Separation Science, Vol. IX*, Li, NN, and Calo, JM, eds., CRC Press, Boca Raton, FL, 1986.
  37. Lawandy, NM, and Calo, JM. Laser-induced separations (LIS). *Recent Developments in Separation Science, Vol. IX*, N. N. Li and J. M. Calo, Eds., CRC Press, Inc., Boca Raton, FL, 1986.
  38. Calo, JM, and Perkins, MT. A heterogeneous surface model for steady-state kinetics of the Boudouard reaction. *Carbon.* 1987; 25:395.
  39. Calo, JM, Lawandy, NM, Frezzo, D, and Perkins, MT. Modeling of the optical piston - density wave shape and resonance fluorescence effects. *Phys. Rev. A.* 1988. 38:2386.
  40. Suuberg, EM, Wojtowicz, M, and Calo, JM. Reaction order for low temperature oxidation of carbons. *Twenty-Second Symp. (Int.) Comb.* 1988, p. 79.
  41. Suuberg, EM, Wojtowicz, M, and Calo, JM. Some aspects of the thermal annealing process in a phenol-formaldehyde resin char. *Carbon.* 1989; 27:431.
  42. Hall, PJ, and Calo, JM. Secondary interactions upon thermal desorption of surface oxides from coal chars. *Energy and Fuels.* 1989; 3:370.
  43. Calo, JM, and Hall, PJ. A mathematical model of temperature programmed desorption of oxygen complexes from porous chars and carbons. *ACS Div. Fuel Chem. Prepr.* 1989;34(1):71.
  44. Hall, PJ, Calo, JM, Teng, H, Suuberg, EM, May, JA, and Lilly, WD. The nature of carbon-oxygen surface complexes produced by different oxidants: towards a unified theory of gasification. *ACS Div. Fuel Chem. Prepr.* 1989;34(1):112.
  45. Suuberg, EM, Teng, H, and Calo, JM. Studies on the kinetics and mechanism of the reaction of NO with carbon. *Proc. 23rd Symp. (Int.) Combustion.* 1990; pp. 1199-1205.
  46. Teng, H, Suuberg, EM, and Calo, JM. Reactions of nitric oxide with carbons: the kinetics of NO chemisorption on carbon. *ACS Div. Fuel Chem. Prepr.* 1990;35(3):592-597.
  47. Calo, JM, and Hall, PJ. The prediction/correlation of char reactivity from distributions of desorption activation energies. *ACS Div. Fuel Chem. Prepr.* 1990;35(3):598-605.
  48. Calo, JM, and Hall, PJ. Energetic distributions of oxygen complexes on porous carbons and chars. *ACS Div. Fuel Chem. Prepr.* 1990;35(3):689-696.
  49. Hall, PJ, and Calo, JM. The interpretation of secondary interactions during temperature programmed desorption of oxygen complexes in terms of char porosity morphology. *ACS Div. Fuel Chem. Prepr.* 1990;35(3):705-712.
  50. Driscoll, T, Lawandy, NM, and Calo, JM. Explaining the optical fuse. *Optics Lett.* 1991;16:1046.
  51. Perkins, MT, and Calo, JM. The role of activated diffusion in the gasification of porous carbons and chars. *ACS Div. Fuel Chem. Prepr.* 1991; 36(3):914-921.
  52. “Applications of Energetic Distributions of Oxygen Surface Complexes to Carbon and

- Char Reactivity and Characterization,” with P.J. Hall, in *Fundamental Issues in the Control of Carbon Gasification Reactivity*, J. Lahaye and P. Ehrburger, eds, NATO ASI Series, Series E: Applied Sciences, Vol. 192, p. 329, Kluwer Academic Publishers, Dordrecht, 1991.
53. “The Nature of Isothermal Desorption Of Carbon-Oxygen Surface Complexes Following Gasification,” in *Fundamental Issues in the Control of Carbon Gasification Reactivity*, J. Lahaye and P. Ehrburger, eds, NATO ASI Series, Series E: Applied Sciences, Vol. 192, p. 369, Kluwer Academic Publishers, Dordrecht, 1991.
  54. *Recent Developments in Separation Technology*, N.N. Li and J.M. Calo, eds., Marcel-Dekker, New York, 1992.
  55. Teng, H, Suuberg, EM, and Calo, JM. Studies on the reduction of nitric oxide by carbon: the NO-carbon gasification reaction. *Energy & Fuels*. 1992; 6: 398.
  56. Calo, JM, Hradil G, and Wunderlich, TK, Jr. Characterization of aspen wood chip beds *via* stimulus-response tracer techniques. *Biotech. & Bioeng.* 1993; 41: 354.
  57. Illán-Gómez, MJ, Linares-Solano, A, Salinas-Martínez de Lecea, C, and Calo, JM. NO reduction by activated carbons - I. the role of carbon porosity and surface area. *Energy & Fuels*, 1993; 7:146.
  58. Calo, JM, Zhang, L-H, and Lu, W. The effect of char “age” on gasification reactivity. *ACS Div. Fuel Chem. Prepr.* 1996; 41(1):98.
  59. Calo, JM, and Zhang, L-H. Determination of porosity and porosity development during gasification from thermal desorption methods. *ACS Div. Fuel Chem. Prepr.* 1996; 41(1):123.
  60. Calo, JM, and Zhang, L-H. The effect of CO<sub>2</sub> partial pressure on gasification reactivity. *ACS Div. Fuel Chem. Prepr.* 1996; 41(1):138.
  61. Calo, JM, Lilly, WD, Hradil, G, and and Mohsen, P. Separation of waste plastic particles *via* liquid-fluidized bed classification (LFBC), in *Advances in Filtration and Separation Technology*, B. Scheiner, ed., American Filtration & Separations Society, 1999, 399-410.
  62. Calo, JM, Cazorla-Amorós, D, Linares-Solano, A, Román-Martínez, MC, and Salinas-Martínez de Lecea, C. The effects of hydrogen on thermal desorption of oxygen surface complexes. *Carbon*. 1997; 35: 543.
  63. Mondragon, F, Quintero, G, Jaramillo, A, Fernandez, J, Ruiz, W, Hall, PJ, and Calo, JM. The production of high surface carbons from coal using pre-swelling in solvents to disperse coking catalysts. *J. Material Sci.* 1997; 32: 1455-1459.
  64. Hall, PJ, Berlouis, LEAB, Mackinnon, AJ, Wilson, J, Browning, D, Morris, S, Jones, P, and Calo, JM. Analysis of FeTi hydride alloys by thermal analysis, small angle neutron scattering and positron annihilation. *J. Alloys and Compounds*, 1997; 253: 195-200.
  65. Hall, PJ, Gascon Galan, D, Ruiz Machado, W, Mondragon, F, Barrientos Barria, E, Sherrington, DC, and Calo, JM. Use of contrast-enhanced small-angle neutron scattering to monitor the effects of solvent swelling on the pore structure of styrene-divinylbenzene resins. *J. Chem. Soc. Far. Trans.* 1997; 93(3): 463-466.
  66. Antxustegi, MM, Hall, PJ, and Calo, JM. The use of contrast matching small angle neutron scattering techniques to monitor closed porosity in carbons. *J. Coll. Intf. Sci.* 1998; 202: 490-498.
  67. Hall, PJ, Antxustegi, MM, and Calo, JM. Development of porosity in Pittsburgh no. 8 coal char as investigated by contrast-matching small angle neutron scattering and gas

- adsorption techniques. *Energy & Fuels*. 1998; 12: 542-546.
68. Hurt, R, Calo, JM, and Hu, Y. Nanostructures in coal-derived carbons. *ACS Div. Fuel Chem. Prepr.* 1999; 44(1): 157-161.
  69. Hu, Y, Hurt, R, Calo, JM, and Kerstein, A. Kinetics of orientation order/disorder transitions and their application to carbon material synthesis. *Modelling Simul. Mater. Sci. Eng.* 1999; 7: 275-288.
  70. Calo, JM, Suuberg, EM, Aarna, I, Linares-Solano, A, Salinas-Martínez de Lecea, C, and Illán-Gómez, MJ. The role of surface area in the NO-carbon reaction. *Energy & Fuels*. 1999; 13: 761-762.
  71. Calo, JM, Hradil, G, and Tucker, M. Separation of Plastic Particles in a Liquid-Fluidized Bed Classifier (LFBC). *AIChE Topical Conf. Proc., Process Development From Research to Manufacturing*, K. Bhatia and M. Malone, eds., 1999. pp. 270-279.
  72. Hall, PJ, Brown, S, Fernandez, J, and Calo, JM. The effects of the electronic structure of micropores on the small angle scattering of X-rays and neutrons. *Carbon*. 2000; 38: 1257-1259.
  73. Hall, PJ, Brown, SD, and Calo, JM. The pore structure of the Argonne Coals as Interpreted from contrast matching small angle neutron scattering. *Fuel*. 2000; 79: 1327-1332.
  74. Calo, JM, and Lu, W. The effects of hydrogen during steam gasification. *ACS Div. Fuel Chem. Prepr.* 2001; 46(2):524.
  75. Calo, JM, Hall, PJ, Houtmann, S, Winans, RE, and Seifert, S. In situ determination of porosity during gasification via SAXS/TGA. *ACS Div. Fuel Chem. Prepr.* 2001; 46(2):528.
  76. Calo, JM, Hall PJ, and Antxustegi, M. Porosity characterization of Wyodak coal char *via* small angle neutron scattering (SANS). *ACS Div. Fuel Chem. Prepr.* 2001; 46(2):588.
  77. Zhang, L-H, and Calo, JM. Thermal desorption methods for porosity characterization of carbons and chars. *Colloids and Surfaces A: Physicochemical and Engineering Aspects*; 2001; 187-188: 207-218.
  78. Calo, JM, Hall, PJ, and Antxustegi, M. Carbon porosity characterization *via* small angle neutron scattering,” *Colloids and Surfaces A: Physicochemical and Engineering Aspects*. 2001; 187-188: 219-232.
  79. Hurt, RH, and Calo, JM. Semi-global intrinsic kinetics for char combustion modeling. *Combustion and Flame*. 2001; 125: 1138-1149.
  80. Calo, JM, and Hu, X. Coal cleaning *via* liquid-fluidized bed classification (LFBC) with selective particle modification. *Div. Fuel Chem. Prepr.* 2002; 47(2):645.
  81. Lopez, DP, and Calo, JM. NO<sub>x</sub> reduction over promoted carbon systems. *ACS Div. Fuel Chem. Prepr.* 2002; 47(2):691.
  82. Calo, JM, Hall, PJ, Houtmann, S, Winans, RE, and Seifert, S. “Real time” determination of porosity development in carbons: a combined SAXS/TGA approach,” in *Studies in Surface Science and Catalysis, Characterization of Porous Solids VI*, F. Rodríguez-Reinoso, B. McEnaney, J. Rouquerol, and K. Unger, eds., 2002. Elsevier, Amsterdam.
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84. Calo, JM, Hu, X, Logan, T, Choi, D, Apicello, J. Coal cleaning *via* liquid-fluidized bed classification (LFBC) with selective particle modification. *J. Separation Sci.* 2003; 26:1429-1435.
85. Calo, JM, and Hall, PJ. The application of small angle scattering (SAS) techniques to porosity characterization in carbons. *Carbon* 2004; 42:1299-1304.
86. Shirvanian, PA, and Calo, JM. Hydrodynamic scaling of a rectangular spouted vessel with a draft duct. *Chem. Eng. J.* 2004; 103/1-3:29-34.
87. Shirvanian, PA, and Calo, JM. Copper recovery in a particulate spouted bed electrode. *J. Appl. Electrochem.* 2005; 35(1): 101-111.
88. Hu, X, and Calo, JM. Enhancement of liquid fluidized bed classification (LFBC) of plastic particle mixtures *via* selective thermal particle modification. *Powder Tech.* 2005; 151(1-3): 44-53.
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90. Shirvanian, PA, Calo, JM, and Hradil, G. Numerical simulation of fluid-particle hydrodynamics in a rectangular spouted vessel. *Int. J. Multiphase Flow*, 2006; 32:739-753.
91. Calo, JM. Comments on “A new gaseous and combustible form of water,” by R.M. Santilli (*Int. J. Hydrogen Energy*. 2006: 31(9), 1113-1128), *Int. J. Hydrogen Energy*, 2007: 32: 1309-1312.
92. López, D, Calo JM. The N<sub>2</sub>O-carbon reaction: The influence of CO and potassium on reactivity and populations of oxygen surface complexes. *Fuel*, 2007; 86: 1900-1907.
93. López, D, Calo JM. The NO-Carbon Reaction: The Influence of potassium and CO on reactivity and populations of oxygen surface complexes. *Energy & Fuels*, 2007; 21: 1872-1877.
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95. Calo, JM, Bain, EJ, Winans, RE, Seifert, S, Clemens AH. Time-resolved pressure studies of CO<sub>2</sub> in coal by SAXS, ACS Div. Fuel Chem. Prepr. 2008; 53(1):359.
96. Morallon-Nuñez, E, Arias-Pardilla, J, Calo, JM, Cazorla-Amorós, D. Arsenic species interactions with a porous carbon electrode as determined with an electrochemical quartz crystal microbalance. *Electrochim. Acta*, 2009; 54: 3996–4004.
97. Calo, JM, Bain, EJ, Winans, RE, Seifert, S, Clemens AH. Interaction of CO<sub>2</sub> with coals *via* SAXS, ACS Div. Fuel Chem. Prepr. 2009; 54(1): 68.
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99. Jung, HY, Park, HJ, Calo JM, Diebold GJ. Comparison of ultrasonic distillation to sparging of liquid mixtures. *Analytical Chemistry*, 2010; 82(24): 10090-10094.
100. Grimshaw, P, Calo, JM, Hradil, G, Shirvanian, PA. II. Removal/recovery of nickel from acidic solutions with a spouted particulate electrode, *Ind. Eng. Chem. Res.*, 2011; 50(16), 9525-9531.
101. Grimshaw, P, Calo, JM, Hradil, G. III. Co-removal/recovery of copper and nickel from acidic solution mixtures with a spouted particulate cathode, *Ind. Eng. Chem. Res.*, 2011; 50(16): 9532-9538.



102. Grimshaw, P, Calo, JM, Hradil, G. Cyclic Electrowinning/precipitation (CEP) system for the removal of heavy metal mixtures from aqueous solutions, *Chem. Eng. J.*, 2011; 175; 103-109.
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104. Castro-Marcano F, Winans RE, Chupas P, Chapman K, Calo JM, Watson JK, Mathews JP, Fine structure evaluation of the pair distribution function with molecular models of the Argonne Premium coals. *Energy & Fuels* 2012, 26, 4336-45.

**d. Unrefereed (Conference Proceedings, etc.)**

1. Chang, H-C (Speaker), and Calo, JM. Two dimensional, nonisothermal cell model of a radial flow, fixed bed reactor. *Proc. 1978 SCSC*, Newport Beach, California, July 24-26, 1978, p. 272.
2. Chang, H-C, and Calo, JM (Speaker). Two dimensional, nonisothermal cell model of a radial flow, fixed bed reactor. *CHISA '78*, Prague, Czechoslovakia, August 1978.
3. Chang, H-C, and Calo, JM (Speaker). The comparison of packed bed reactor models via exact bounds for uniqueness and multiplicity. *Proc. 1979 SCSC*, Toronto, Canada, July 16-18, 1979, p. 179.
4. Johnson, EF, and Calo, JM (Speaker). The General Examination in Chemical Engineering at Princeton University, 1980 ASEE Annual Conference Proc., Amherst, MA, June 22-27, 1980.
5. Calo, JM (Moderator and Speaker) The CHEMI Project – Update and Preliminary Results. Panel Discussion at the 1980 ASEE Annual Conference Proc., Amherst, MA, June 22-27, 1980.
6. Williams, DC, and Calo, JM (Speaker). The dynamics behavior of coupled, lumped parameter, heterogeneous chemical oscillators, presented at the 73<sup>rd</sup> Annual AIChE Meeting, Chicago, IL, November, 1980.
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88. Cazorla-Amorós, D, Domínguez-Domínguez, S, Lillo-Ródenas MA, Berenguer-Murcia, Calo, JM. "Ni/Pd nanoparticles supported on carbon as catalysts for MgH<sub>2</sub> decomposition," Oral Presentation, Proc., Carbon2008, Nagano, Japan, July, 2008.
89. Axén, J, Bain, EJ, Spitz, R, Kirchner, J, Calo, JM. "Arsenic Removal by Electrosorption," Poster Presentation, Brown University Student Summer Research Symposium, 1 August, 2008.
90. Morallón, E, Arias-Pardilla, J, Calo, JM, Cazorla-Amorós, D. "Arsenic species interactions on porous carbon electrode determined by electrochemical quartz crystal microbalance," Oral Presentation, Proc 59<sup>th</sup> Annual Meeting of the International Society of Electrochemistry, Seville, Spain, Symposium 10, Paper #2, September, 2008.
91. Spitz, R, Bain, EJ, Calo, JM, Kirchner, J, DiCocco, E. "Electrodeposited Selenium on Carbon - An Improved Adsorbent for Mercury Capture from Aqueous Solutions," Poster Presentation, Fall National Meeting of the American Institute of Chemical Engineers, Philadelphia, PA, 17 November 2008. (This poster was awarded 3<sup>rd</sup> place in the Environmental Section.)
92. Calo, JM, Bain, EJ, Winans, RE, Seifert S, Clemens, AH. "Time-resolved pressure studies of CO<sub>2</sub> in coals by SAXS," Poster Presentation, Argonne National Laboratory, Advanced Photon Source, SAC Chemistry Review, November, 2008.
93. Bain, EJ, Calo, JM, Spitz-Steinberg, R, Kirchner, J, Axén, J. "Electrosorption/ Electrodesorption of Arsenic on a Granular Activated Carbon in the Presence of Other Heavy Metals," Keynote Paper 8; Invited Keynote Talk at the Carbon for Energy Storage and Environment Protection 2009 Conference (CESEP'09), Torremolinos, Spain, October, 28, 2009.
94. Morallon-Nuñez, E, Arias-Pardilla, J, Calo, JM, Cazorla-Amorós, D. "Arsenic Deposition/Desorption in a Porous Carbon Electrode *Via* Combined CV/EQCM," Paper No. 515 presented at CARBON'09, The Annual World Conference on Carbon, Biarritz, France, 14-19 June 2009.
95. Madhavan, L, Yao, P, Calo, JM. "Heavy Metals Remediation *via* Cyclic Electrowinning/Precipitation (CEP)," poster presentation at the 2009 Summer Research Symposium, Brown University, 6 August 2009.
96. Madhavan, L, Calo, JM, Yao, P, Kūlaots, I. "Heavy Metals Remediation *via* Cyclic Electrowinning/Precipitation (CEP)," poster presented in the Environmental Section at the 2009 AIChE Annual Meeting, Nashville, TN, 8 November 2009.

97. Calo, JM, Bain, EJ, Winans, RE, Seifert, S, Clemens AH. "Interaction of CO<sub>2</sub> with coals via SAXS," Paper No. 68, presented in the Division of Fuel Chemistry Symposium on Methods and Techniques in Analytical Characterization for Fuel Nanoscience at the 237<sup>th</sup> American Chemical Society National Meeting & Exposition, Salt Lake City, UT, March 23, 2009.
98. Clemens, AH, Seifert, S, Calo, JM, Bain, EJ, Locke, DR, Winans, RE. "Direct Observation of CO<sub>2</sub> Injection into Coal using Small Angle X-Ray Scattering (SAXS)," Presented at the Twenty Sixth Annual International Pittsburgh Coal Conference, University of Pittsburgh, Pittsburgh, PA, September 20-23, 2009.
99. Fidel Castro-Marcano, Randall E. Winans, Peter Chupas, Karena Chapman, Joseph M. Calo, and Jonathan P. Mathews, "Fine Structure Evaluation of the Pair Correlation Function with Molecular Slice Models of the Argonne Premium Coals," Session 30, Wednesday, September 14, 2011, 28<sup>th</sup> Annual International Pittsburgh Coal Conference, September 12-15, 2011, Pittsburgh, PA.

#### e. Patents

- "Liquid-Fluidized Bed Classifier (LFBC) for Sorting Waste Plastics and Other Solid Waste Materials for Recycling," J.M. Calo and E.M. Suuberg, U.S. Patent No. 5,988,395, Nov. 23, 1999.
- "Methods For Direct Carbon Fuel Cell Operation With a Circulating Electrolyte Slurry," J.M. Calo, V. Bloomfield, D. Harjes A. Dineen, and L. Guo, U.S. Provisional Patent, 61/514,393; August 2, 2011.
- "Hybrid Spouted Vessel/Fixed Bed Filter System for Arsenic Removal," J.M. Calo, U.S. Provisional Patent, February 17, 2012.

#### Invention Disclosures to Brown University

Brown Tech ID 2115, Cyclic Electrowinning/Precipitation (CEP) System, December 20, 2011.

#### g. Invited Lectures:

1. "Complex Chemical Kinetics in Continuous Flow Reactors," presented at the AIChE Central Jersey Section Symposium on Continuous Chemical Processing, October 18, 1978.
2. "The Ozone Controversy--Fact or Myth?" *AIChE Central Jersey Section Meeting*, September, 1979.
3. "Continuous Chemical Reactors--How Are They Different?" *Smith, Kline, and French*, Philadelphia, PA, October, 1979.
4. "Radial Flow, Fixed Bed Reactors," *Department of Chemical Engineering, University of Notre Dame*, Notre Dame, IN, October, 1979.
5. "Radial Flow, Fixed Bed Reactors," Department of Chemical and Nuclear Engineering, University of California at Santa Barbara, November, 1979.
6. "Multiphase Reactor Models," *NATO Advanced Study Institute on Multiphase Chemical Reactors*, Vimeiro, Portugal. August, 1980.
7. "Hysteresis, Self-Oscillation, and Propagating Front Phenomena in Heterogeneous Catalytic Systems," *Department of Chemical Engineering, Louisiana State University*,



- Baton Rouge, LA, November, 1981.
8. "Radial Flow, Fixed Bed Reactors," *Department of Chemical Engineering, University of Rhode Island*, Kingston, RI. April 15, 1982.
  9. "What do Chemical Engineers do?" *Department of Chemistry, Wheaton College*, MA, May 10, 1982.
  10. "Transient Kinetic Studies of Char-Gas Reactions," Department of Chemical Engineering, University of Southern California, May 25, 1984.
  11. "Determination of Water Vapor in the Space Shuttle Environment Via Mass Spectrometer Ion Measurements," *Dept. of Chemical Engineering, Yale University*, April 19, 1985.
  12. "The Boudouard Reaction Revisited," Chemical and Petroleum Engineering Department, University of Pittsburgh, Pittsburgh, PA, September 20, 1985.
  13. "Laser-Induced Separations," *Allied Signal Engineered Materials Laboratory*, Des Plaines, Illinois, November 20, 1985.
  14. "Active Sites in Chars," DOE Working Group on Assessment of Research Needs for Coal Gasification (COGARN), MIT, Cambridge, MA, May, 1986.
  15. "Laser-Assisted Separations," *Smith-Kline & French*, Swedeland, PA, May, 1986.
  16. "Temperature Programmed Desorption of Carbon-Oxygen Surface Complexes and Carbon/Char Reactivity," *Department of Chemical Engineering, Massachusetts Institute of Technology*, Cambridge, MA, October, 1988.
  17. "Temperature Programmed Desorption of Carbon-Oxygen Surface Complexes and Carbon/Char Reactivity," *Advanced Fuel Research*, East Hartford, CT, October, 1989.
  18. "Carbon and Char Reactivity From the Perspective of Energetic Heterogeneity," Fuel Science Program, Department of Materials Science and Engineering, The Pennsylvania State University, March 9, 1990.
  19. "Applications of Energetic Distributions of Oxygen Surface Complexes to Carbon and Char Reactivity and Characterization," *NATO Advanced Research Workshop on Fundamental Issues in the Control of Carbon Gasification Reactivity*, Cadarache, Saint Paul lez Durance, France, 30 July - 3 August 1990.
  20. "Research in Surface Chemistry of Carbon Oxidation," *AFOSR/NIST, Fundamentals of Carbon/Carbon Workshop*, Gaithersburg, MD, December 6-7, 1990.
  21. "Applications of Energetic Distributions of Oxygen Surface Complexes on Carbons and Chars," *Allied-Signal Engineered Materials Research Laboratory*, Des Plaines, IL, July, 1991.
  22. "The Reduction of NO by Carbon—The NO-Carbon Gasification Reaction," *Centre de Recherches sur la Physico-Chimie des Surfaces Solides, CNRS*, Mulhouse, France, April 9, 1992.
  23. "The Reduction of NO by Carbon—The NO-Carbon Gasification Reaction," *Department of Pure & Applied Chemistry, University of Strathclyde*, Glasgow, Scotland, April 22, 1992.
  24. "The Reduction of NO by Carbon—The NO-Carbon Gasification Reaction," *Instituto Nacional de Carbon*, Oviedo, Spain, July 6, 1992.
  25. "Applications of Energetic Distributions of Oxygen Surface Complexes to Porous Carbons and Chars," *Departamento de Química Inorgánica, Universidad de Granada*, Granada, Spain, July 8, 1992.
  26. "The Reduction of NO by Carbon—The NO-Carbon Gasification Reaction,"

- Departamento de Química Inorgánica, Universidad de Alicante, Spain, July 14, 1992.*
27. "Applications of Energetic Distributions of Oxygen Surface Complexes to Porous Carbons and Chars," *Departamento. de Química Inorgánica, Universidad de Alicante, Spain, July 23, 1992.*
  28. "Liquid Fluidization of Aspen Wood Chip Beds," *Departamento de Química Inorgánica, Universidad de Alicante, Spain, July 28, 1992.*
  29. "La Reducción de Carbon por NO" ("The Reduction of Nitric Oxide By Carbon"), *Laboratorio de Carboquímica y Catalisis, Departamento de Química, Universidad de Antioquia, Medellin, Colombia, June 11, 1996.*
  30. "Porosidad y el Desarrollo de Porosidad en Carbons" ("Porosity and Porosity Evolution in Carbons"), *Laboratorio de Carboquímica y Catalisis, Departamento de Química, Universidad de Antioquia, Medellin, Colombia, June 12, 1996.*
  31. "Lechos Fluidizados en Brown University" ("Fluidized Beds at Brown University"), *Centro del Carbón, Facultad de Minas, Universidad Nacional de Colombia, Medellin, Colombia, June 13, 1996.*
  32. "Structure-Based Modeling of Coal and Char, and its Impact," R. Hurt, J.M. Calo, C. Hadad, and R. Essenhig, presented at A Workshop on Modeling Coal, Char, Soot, and Other Carbon Based Materials, U.D.D.O.E., Germantown, MD, May 28, 1998.
  33. "Development of High Activity, Coal-Derived, Promoted Catalytic Systems for NO<sub>x</sub> Reduction at Low Temperatures," (DE-FG22-97PC97267). Presented at Annual Contractors Review Meeting, DOE University Coal Research Program, Pittsburgh, PA. June 2-3, 1998, p. 119.
  34. "Spouted Bed Electrolytic Reactor (SBER) for Point Source Metals Recovery From Aqueous Waste Streams," Bell Laboratories, Murray Hill, NJ, June 20, 1998.
  35. "Liquid-Fluidized Bed Research at Brown University," Department of Chemical Engineering, Chemistry, and Environmental Science, New Jersey Institute of Technology, Newark, NJ, June 1, 2000.
  36. "The Use of Small Angle Scattering Techniques to Monitor Porosity Evolution in Carbons," Oak Ridge National Laboratory, Oak Ridge, TN, July 9, 2002.
  37. "The Application of Small Angle Scattering Techniques to Porosity Characterization in Carbons," invited keynote lecture, Carbon 2003, Oviedo, Spain, July, 2003.
  38. "Catalysis on Carbon Surfaces: Some Energy and Environmental Applications," Plenary Lecture, VIII Reunión del Grupo Español del Carbon, Universidad Internacional de Andalucía, Baeza (Jaen), Spain, 9 November 2005.
  39. "Control of CO<sub>2</sub> Emissions," in *Energía y Medio Ambiente: Uso Limpio de los Combustibles Fósiles* ("Energy and the Environment: Clean Use of Fossil Fuels"), VIII Reunión del Grupo Español del Carbon, Postconference Tutorial, Universidad Internacional de Andalucía, Baeza (Jaén), Spain, 10 November 2005.
  40. "Carbon Materials for Catalysis," Departamento Química Inorgánica, Universidad de Alicante, Alicante, Spain, 14 November 2005.
  41. "Recuperación y eliminación de metales pesados con electrodos de partículas en chorro," ("Heavy metals recovery and remediation with spouted particulate electrodes"), Departamento de Ingeniería Química, Universidad Autónoma de Madrid, Madrid, Spain, 24 May 2006.
  42. "Recuperación y eliminación de metales pesados con electrodos de partículas en chorro," ("Heavy metals recovery and remediation with spouted particulate

- electrodes”), Departamento de Ingeniería Química, Universidad de Málaga, Málaga, Spain, 26 May 2006.
43. “Aplicación de técnicas de dispersión a ángulos pequeños a la caracterización de la porosidad, desarrollo de porosidad y comportamiento de materiales carbonosos,” (“The application of small angle scattering techniques to the characterization of porosity, porosity development, and properties of carbon materials”), Departamento de Química Inorgánica, Universidad de Granada, Granada, Spain, 30 May 2006.
  44. “Recuperación y eliminación de metales pesados con electrodos de partículas en chorro,” (“Heavy metals recovery and remediation with spouted particulate electrodes”), Departamento de Química Inorgánica, Universidad de Alicante, Alicante, Spain, 14 June 2006.
  45. “Aplicación de técnicas de dispersión a ángulos pequeños a la caracterización de la porosidad, desarrollo de porosidad y comportamiento de materiales carbonosos,” (“The application of small angle scattering techniques to the characterization of porosity, porosity development, and properties of carbon materials”), Departamento de Química Inorgánica, Universidad de Alicante, Alicante, Spain, 21 June 2006.
  46. “Heavy metals recovery and remediation *via* spouted particulate electrodes,” Department of Chemical and Process Engineering, University of Strathclyde, Glasgow, Scotland, UK, 24 July 2006.
  47. “Novel Electrochemical Techniques for Heavy Metals Removal/ Recovery/Remediation, Invited Talk, Department of Chemical Engineering, Colorado School of Mines, Golden, CO, 14 November 2008.
  48. “Electrosorption/ Electrodesorption of Arsenic on a Granular Activated Carbon in the Presence of Other Heavy Metals,” Keynote Paper 8, Invited Keynote Talk at the Carbon for Energy Storage and Environment Protection 2009 Conference (CESEP’09), Torremolinos, Spain, October, 28, 2009.

#### **h. Papers Read:**

1. “Cell Model Studies of Radial Flow, Fixed Bed Reactors,” *Fifth International Symposium on Chemical Reactor Engineering (ISCRE 5)*, Houston, TX, March, 1978.
2. “Cryogenic Deposition and Desorption of Stratospherically Relevant Species,” *Tenth Northeast Regional Meeting of the American Chemical Society (NERM-10)*, June, 1978.
3. “Two-Dimensional Cell Model of a Radial Flow, Fixed Bed Reactor,” *1978 Summer Computer Simulation Conference*, Newport Beach, CA, July, 1978.
4. “Two-Dimensional Cell Model of a Radial Flow, Fixed Bed Reactor,” *CHISA ‘78*, Prague, Czechoslovakia, August, 1978.
5. “Cryogenic Deposition and Desorption of Stratospherically Relevant Species,” Paper No. 99b, *71<sup>st</sup> AIChE Annual Meeting*, Miami Beach, FL, November, 1978.
6. “Cryosampling of Stratospheric Gases.” *VII International Symposium on Molecular Beams*, Riva del Garda, Italy, May 28-June 1, 1979.
7. “Capabilities in Cryogenic Sampling Analysis,” Air Force Office of Scientific Research Workshop-Status of Chemical Instrumentation and Analytical Programs in the Air Force, Dayton, OH, June 14 and 15, 1979.
8. “Generation and Photoionization of Molecular Clusters of Atmospheric Interest.” Air Force Office of Scientific Research Workshop-Status of Chemical Instrumentation and

- Analytical Programs in the Air Force, Dayton, OH, June 14 and 15, 1979.
9. "The Role of van der Waals Molecules in Atmospheric Chemistry," Gordon Research Conference, Environmental Sciences-Air, New Hampton, NH, June 18-22, 1979.
  10. "The Comparison of Packed Bed Reactor Models *Via* Exact Bounds for Uniqueness and Multiplicity," 1979 Summer Computer Simulation Conference, Toronto, Canada, July 16-18, 1979.
  11. "Use of Interactive Graphics-Based Software for Teaching Chemical Engineering Principles," Paper No. 20e, 87<sup>th</sup> National AIChE Meeting, Boston, MA, Aug 19-22, 1979.
  12. "Generation and Photoionization of Molecular Clusters of Atmospheric Interest," ACS Annual Meeting, Washington, DC, September 9-14, 1979.
  13. "Possible Roles of van der Waals Molecules in the Atmosphere," *AFOSR/FJSRL Molecular Dynamics Research Conference*, Colorado Springs, CO, October 3-5, 1979.
  14. "Catastrophe Theory and Chemical Reactors—Exact Uniqueness Criteria for the CSTR, Catalyst Particle, and Packed Bed Reactor," 72<sup>nd</sup> Annual AIChE Meeting, San Francisco, CA, November 25-29, 1979.
  15. "Catastrophe Theory and Chemical Reactors," *Sixth International Symposium on Chemical Reaction Engineering (ISCRE 6)*, Nice, France, March 25-27, 1980.
  16. "van der Waals Molecules—Possible Roles in the Atmosphere," *Department of Chemistry, University of Bern, Bern, Switzerland*, May, 1980.
  17. "Radial Flow, Fixed Bed Reactors—How Are They Different?" *Department of Technical Chemistry, Swiss Federal Institute (ETH), Zurich, Switzerland*, May, 1980.
  18. "Generation and Photoionization of Molecular Clusters of Atmospheric Interest," *VIth International Conference on Atmospheric Electricity*, Manchester, England, July, 1980.
  19. "van der Waals Molecules—Possible Roles in the Atmosphere," *VIth International Conference on Atmospheric Electricity*, Manchester, England, July, 1980.
  20. "Propagating Spatial Patterns in Nonlinear Heterogeneous Reaction Systems," Paper No. 9d, AIChE 73<sup>rd</sup> Annual Meeting, Chicago, IL, November 16-20, 1980.
  21. "The Dynamic Behavior of Coupled, Lumped Parameter, Heterogeneous, Chemical Oscillators," Paper No. 11f, AIChE 73<sup>rd</sup> Annual Meeting, Chicago, IL, November 16-20, 1980.
  22. "Atmospheric Gases on Cold Surfaces—Condensation, Thermal Desorption, and Chemical Reactions," *Workshop/Conference on Heterogeneous Catalysis - Its Importance to Atmospheric Chemistry*, Albany, NY, June 28 - July 3, 1981.
  23. "Sensitivity Analysis of Open Chemical Reaction Systems," Paper No. 456 in *Symposium on Dynamics and Control of Chemical Reactors and Process Systems*, , 1981 Annual AIChE Meeting, New Orleans, LA, November 8-12, 1981. (M.A. Kramer, J.M. Calo, and H.A. Rabitz)
  24. "Transient Kinetic Studies of Char Reactions in a Gradientless Reactor System – CO<sub>2</sub> Gasification," Paper No. 56h, *1982 Annual AIChE Meeting*, Los Angeles, CA, November, 1982.
  25. "Transient Kinetic Studies of Char-Gas Reactions." Department of Technical Chemistry, Twente University of Technology, Enschede, The Netherlands, March, 1983.
  26. "Radial Flow, Packed Bed Reactors," Department of Technical Chemistry, University of Groningen, Groningen, The Netherlands, March, 1983.

27. "Transient Kinetic Studies of Char Reactions in a Gradientless Reactor System—CO Gasification," *185<sup>th</sup> ACS National Meeting*, Seattle, WA, March, 1983.
28. "Transient Kinetic Studies of Char-Gas Reactions," *1983 International Conference on Coal Science*, Pittsburgh, PA, August 1983.
29. "Measurement of Growth Rate Constants for Water Clusters," *186<sup>th</sup> ACS National Meeting*, Division of Colloid and Surface Chemistry, Washington, DC, August 1983.
30. "Transient Kinetic Studies of Char-Gas Reactions: Gasification in Steam-Argon Mixtures and Summary of Techniques," Division of Fuel Chemistry, Symposium on Coal Gasification, Paper No. 30, *189<sup>th</sup> ACS National Meeting*, Miami Beach, FL, Tuesday (10:30 a.m.), April 30, 1985.
31. "The Behavior of Active Sites in a Model Compound Char," Paper No. 30f, *1985 Annual AIChE Meeting*, Chicago, IL, November 1985.
32. "A Jet-Stirred Reactor for Transient Studies of Char Gasification," Paper No. 83d, *1986 Annual AIChE Meeting*, Miami Beach, FL, November 1986.
33. "A Mechanistic Study of the Energetic Heterogeneity of Coal Char Surfaces," *Seventh Annual Gasification and Gas Stream Cleanup Systems Contractors Review Meeting*, METC, Morgantown, WV, June 1987.
34. "Toxin Production Kinetics in a Bioreactor," *1987 ASEE Summer School for Chemical Engineering Faculty*, Southeastern Massachusetts University, North Dartmouth, MA, August 1987.
35. "Packed Bed Hydrodynamics of an Acid Hydrolysis Percolation Reactor," *Biochemical Conversion/Alcohol Fuels Program Annual Review Meeting*, Solar Energy Research Institute, Golden, CO, October 14, 1987.
36. "Modeling of the Optical Piston—Coupled Mass and Photon Transport," Paper No. 107f, *1987 Annual AIChE Meeting*, NY, November 10, 1987.
37. "NO-Char Reactions—Kinetics and Transport Aspects," *8<sup>th</sup> Annual Gasification/Gas Stream Cleanup Systems Contractors Review Meeting*, METC, Morgantown, WV, May 1988.
38. "A Mechanistic Study of the Energetic Heterogeneity of Coal Char Surfaces," *Eighth Annual Gasification and Gas Stream Cleanup Systems Contractors Review Meeting*, METC, Morgantown, WV, May 1988.
39. "Micropore Diffusion in Coal Chars Under Reactive Conditions," *University Coal Research Program Review Meeting*, Pittsburgh, PA, July 1988.
40. "Oxygen Chemisorption as a Carbon Surface Diagnostic Technique," *Carbon '88*, Newcastle, England, September 1988.
41. "The Energetic Heterogeneity of Coal Char Surfaces: Effects of Heating Rate on TPD Spectra," *Carbon '88*, Newcastle, England, September 1988.
42. "Temperature Programmed Desorption of Carbon-Oxygen Surface Complexes and Carbon/Char Reactivity," *Department of Chemical Engineering, Massachusetts Institute of Technology*, Cambridge, MA, October 1988.
43. "Hydrodynamics of Hydrolysis Reactors," *Biochemical Conversion/Alcohol Fuels Program Annual Review Meeting*, Solar Energy Research Institute, Golden, CO, January 1989.
44. "A Mechanistic Study of the Energetic Heterogeneity of Coal Char Surfaces," *Ninth Annual Gasification and Gas Stream Cleanup Systems Contractors Review Meeting*, METC, Morgantown, WV, June 1989.

45. "The Relationship Between Desorption Spectra Carbon Oxides and Active Surface Areas," *Nineteenth Biennial Conference on Carbon*, Penn State University, June 1989.
46. "Effective Dispersion in Liquid-Fluidized Wood Chip Beds as a Function of Angle of Inclination," Paper No. 181a, *1990 Annual AIChE Meeting*, Chicago, IL, Sept., 1990.
47. "Activated Diffusion Measurements in Carbons and Chars at Elevated Temperatures," Paper No. 271g, *1990 Annual AIChE Meeting*, Chicago, IL, November, 1990.
48. "Liquid-Fluidization of Aspen Wood Chip Beds," *Ethanol From Biomass Review Meeting*, Solar Energy Research Institute, Lincoln, Nebraska; October, 1990.
49. "The Prediction/Correlation of Char Reactivity From Distributions of Desorption Activation Energies," *Twentieth Biennial Conference on Carbon*, University of California, Santa Barbara, June, 1991.
50. "The Role of Activated Diffusion in the Gasification of Porous Carbons and Chars," *Annual Meeting of the American Chemical Society*, New York, NY, September, 1991.
51. "The Elucidation of Carbon Active Site Behavior *Via* Desorption Techniques," Annual Meeting of the American Chemical Society, New York, NY, September, 1991.
52. "The Reduction of NO by Carbon — The NO-Carbon Gasification Reaction," *Environmental Aspects of Coal Utilization & Carbon Science Meeting*, University of Newcastle upon Tyne, Newcastle upon Tyne, UK, 31 March - 1 April 1992.
53. "The Reduction of Nitric Oxide by Char in Combustion Systems - The NO-Carbon Gasification Reaction," *1992 Annual AIChE Meeting*, Miami Beach, Florida, Nov., 1992.
54. "The Chemisorption of Nitric Oxide on Char," *1992 Annual AIChE Meeting*, Miami Beach, Florida, November, 1992.
55. "The Correlation/Prediction of Reactivity *Via* Distributions of Surface Complexes. I. Partial Pressure Effects in Steam," *Twenty First Biennial Conference on Carbon*, SUNY Buffalo, Buffalo, NY, June, 1993.
56. "The Use of Contrast Matching Techniques to Investigate Interparticle Scattering Effects in Small Angle Scattering Investigations of Porous Carbons," *Carbon '94*, Granada, Spain, July, 1994.
57. "The Correlation/Prediction of Reactivity *Via* Distributions of Surface Complexes. II. Mineral Matter Effects in Steam Gasification," *Carbon '94*, Granada, Spain, July, 1994.
58. "'Anomalous' CO Peaks During Isothermal Desorption Following CO<sub>2</sub> Gasification," *Carbon '94*, Granada, Spain, July, 1994.
59. "The Effects of Hydrogen on Thermal Desorption Data," *Carbon '94*, Granada, Spain, July, 1994.
60. "Continuous Micro-sorting of Plastic Particles *via* Liquid-Fluidized Bed Classification (LFBC)," presented at the Center for Plastics Recycling Research, Technical Seminar IX, Rutgers University, Piscataway, NJ, October 27, 1994.
61. "Separation of Waste Plastics for Recycling *via* Liquid-Fluidized Bed Classification," J.M. Calo, W.D. Lilly, and M.W. Harrison, presented in Session 135, Symposium on Solid/Fluid Separation in Waste Reduction I, 1994 Annual AIChE Meeting, San Francisco, CA, Paper No. 135f, November 18, 1994.
62. "Engineering and Industrial Ecology: Addressing the Issues," J.M. Calo and M. Mattiah, presented at Brown University: Advancing Society through Multidisciplinary Science, Brown University, March 31 – April 1, 1995.
63. "Porosity Evolution *Via* Contrast-Matching, Small Angle Neutron Scattering," 22<sup>nd</sup>

- Biennial Conf. on Carbon*, University of California, San Diego, July 1995.
64. "Porosity Development via TPD," *22<sup>nd</sup> Biennial Conf. on Carbon*, University of California, San Diego, July 1995.
  65. "The Effect of Char 'Age' as Revealed by Thermal Desorption Spectra," *22<sup>nd</sup> Biennial Conf. on Carbon*, University of California, San Diego, July 1995.
  66. "The 'Inert Gas Effect' on Carbon Reactivity," *22<sup>nd</sup> Biennial Conf. on Carbon*, University of California, San Diego, July 1995.
  67. "On the Kinetics of NO Reduction Over Carbon," *22<sup>nd</sup> Biennial Conf. on Carbon*, University of California, San Diego, July 1995.
  68. "Separation of Waste Plastic Particles Via Liquid-Fluidized Bed Classification (LFBC)," *Eleventh International Conference on Solid Waste Technology and Management*, Philadelphia, PA, 1995.
  69. "The Effect of Char 'Age' on Gasification Reactivity," *211<sup>th</sup> American Chemical Society National Meeting*, New Orleans, LA, March, 1996.
  70. "Determination of Porosity and Porosity Development During Gasification From Thermal Desorption Methods," *211<sup>th</sup> American Chemical Society National Meeting*, New Orleans, LA, March, 1996.
  71. "The Effect of CO<sub>2</sub> Partial Pressure on Gasification Reactivity," *211<sup>th</sup> American Chemical Society National Meeting*, New Orleans, LA, March, 1996.
  72. "Separation of Waste Plastic Particles Via Liquid-Fluidized Bed Classification (LFBC)," *9<sup>th</sup> Annual Technical Conference, American Filtration & Separations Society*, Valley Forge, PA, April 21-24, 1996. (J.M. Calo, W.D. Lilly, G. Hradil and P. Mohsen)
  73. "Spouted-Bed Electrolytic Reactor (SBER) for Metals Recovery," *Second Joint China/USA Chem. Eng. Conf.*, Beijing, China, May 19-22, 1997.
  74. "Separation of Waste Plastic Particles Via Liquid-Fluidized Bed Classification (LFBC)," *Second Joint China/USA Chem. Eng. Conf.*, Beijing, China, May 19-22, 1997.
  75. "Spouted Bed Electrodes for 'Point Source' Metals Recovery From Aqueous Waste Streams," *Industrial Ecology Symposium*, Lucent Technologies/Bell Laboratories, Murray Hill, NJ, June 4, 1997.
  76. "Free-Jet, Molecular Beam Mass Spectrometer System for Monitoring the Gas Phase Composition in a Well-Stirred Combustor," *Fifth International Congress on Toxic Combustion Byproducts*, University of Dayton, Dayton, OH, June 25-27, 1997.
  77. "The Effects of the 'Quench Process' on Measurements of Oxygen Surface Complex Populations," *Carbon '97, 23<sup>rd</sup> Biennial Conf. Carbon*, Penn State University, July 18-23, 1997.
  78. "The Effects of Hydrogen on Oxygen Surface Complexes During Steam Gasification," *Carbon '97, 23<sup>rd</sup> Biennial Conf. Carbon*, Penn State University, July 18-23, 1997.
  79. "Spouted Bed Electrolytic Reactor (SBER) for Point Source Metals Recovery From Aqueous Waste Streams," Paper No. 114c, presented at the 1998 AIChE Spring National Meeting, New Orleans, LA, March 10, 1998.
  80. "Nanostructures in coal-derived carbons," ACS Spring National Meeting, Anaheim, CA March, 1999.
  81. "Carbon Porosity Development Via Small Angle Scattering," *Carbon '99 - 24<sup>th</sup> Biennial Conf. Carbon*, Charleston, SC, July 11-16, 1999.

82. "Separation of Plastic Particles in a Liquid-Fluidized Bed Classifier (LFBC)," Annual AIChE National Meeting, Separation Processes for a Sustainable Environment, Paper No. 47h, Dallas, TX, Oct. 31 - Nov. 5, 1999.
83. "Deposition and Backstripping at the Particle-Liquid Interface in Spouted Bed Electrolytic Reactors for Point Source Metals Recovery," AIChE 1999 Annual Meeting, Environmental Reaction Engineering II, Paper No. 295i, Dallas, TX, Oct. 31 - Nov. 5, 1999.
84. "Carbon Porosity Characterization *Via* Small Angle Neutron Scattering," Second International TRI/Princeton Workshop on Characterization of Porous Materials: From Angstroms to Millimeters, June 19-21, 2000, Princeton, NJ.
85. "Thermal Desorption Methods for Porosity Characterization of Carbons and Chars," Second International TRI/Princeton Workshop on Characterization of Porous Materials: From Angstroms to Millimeters, June 19-21, 2000, Princeton, NJ.
86. "The Residence Time Distribution (RTD) of a Jet-Stirred Reactor," Third Joint China/USA Chemical Engineering Conference, Beijing, China, September 25-28, 2000.
87. "Deposition and 'Backstripping' in Spouted Bed Electrolytic Reactors (SBER) for Point Source Metals Recovery," Third Joint China/USA Chemical Engineering Conference, Beijing, China, September 25-28, 2000.
88. "Transient Studies of the Effects of Fire Suppressants in a Well-Stirred Combustor," AIChE 2000 Annual Meeting, Environmentally Benign Combustion Processes II, Paper No. 39b, Los Angeles, CA, Nov. 12-17, 2000.
89. "Real Time Determination of Porosity Development in Carbons Using SAXS," AIChE 2000 Annual Meeting, Characterization of Nanoporous Materials, Paper No. 157d, Los Angeles, CA, Nov. 12-17, 2000.
90. "Hydrodynamics of Spouted Bed Electrolytic Reactors for Metals Recovery," AIChE 2000 Annual Meeting, Computational Fluid Dynamics in Reaction Engineering, Paper No. 347c, Los Angeles, CA, Nov. 12-17, 2000.
91. "The NO-Carbon Reaction: The Influence of CO and Potassium on Reactivity and Populations of Surface Complexes," Paper No. 6.1, *Proc. Carbon '01*, Lexington, KY, July 15-19, 2001.
92. "'Real Time' Determination of Porosity Development in Carbons: A Combined SAXS/TGA Approach," Paper No. 15.4, *Proc. Carbon '01*, Lexington, KY, July 15-19, 2001.
93. "The Effects of Hydrogen During Steam Gasification," 222<sup>nd</sup> ACS National Meeting, August 26-30, 2001, Chicago, Illinois.
94. "*In Situ* Determination of Porosity During Gasification *Via* SAXS/TGA," 222<sup>nd</sup> ACS National Meeting, August 26-30, 2001, Chicago, Illinois.
95. "Porosity Characterization of Wyodak Coal Char *Via* Small Angle Neutron Scattering (SANS)," 222<sup>nd</sup> ACS National Meeting, August 26-30, 2001, Chicago, Illinois.
96. "A Numerical Investigation of the Hydrodynamics of the Spouted Bed Electrolytic Recovery System," presented in Session FE-10B, Forum on Industrial Applications of Multiphase Flows, 2001 ASME International Mechanical Engineering Congress & Exposition, November 11-16, 2001, New York.
97. "Point Source Metals Recovery in a Spouted Bed Electrolytic Reactor," presented at 6<sup>th</sup> Annual Green Chemistry and Engineering Conference, Georgetown University Conference Center, Washington, D.C., July 24-27, 2002.



98. "Spouted bed electrolytic reactors for metals recovery," Paper No. 50, ACS Division of Environmental Chemistry, ACS National Meeting, Boston, MA, August 19, 2002.
99. "Coal cleaning *via* liquid fluidized bed classification with selective particle modification," Paper No. 91, ACS Division of Fuel Chemistry, ACS National Meeting, Boston, MA, August 20, 2002.
100. "NO<sub>x</sub> reduction over promoted carbon systems," Paper No. 1112, ACS Division of Fuel Chemistry, ACS National Meeting, Boston, MA, August 20, 2002.
101. "Spouted bed electrolytic reactors for metals recovery," Paper No. 98, ACS Division of Industrial & Engineering Chemistry, ACS National Meeting, Boston, MA, August 20, 2002.
102. "An Experimental Investigation of the Hydrodynamics of a Rectangular Slot, Spouted Bed," Paper No.138c, presented at the AIChE 2002 Annual Meeting, Indianapolis, IN, November 4, 2002.
103. "A Circulating Spouted Bed Electrode for Recovery of Metals From Aqueous Solutions," Paper No.140g, presented at the AIChE 2002 Annual Meeting, Indianapolis, IN, November 4, 2002.
104. "Liquid Fluidization Hydrodynamics of Binary Plastic Mixtures," Paper No.147f, presented at the AIChE 2002 Annual Meeting, Indianapolis, IN, November 6, 2002.
105. "Real time determination of porosity development in carbons: a combined SAXS/TGA approach," presented at Characterization of Porous Solids VI, Alicante, Spain, May 2002.
106. "The Application of Small Angle Scattering (SAS) Techniques to Porosity Characterization in Carbons," invited keynote lecture, Carbon 2003, Oviedo, Spain, July, 2003.
107. "Chemical activation of a Spanish anthracite as explored by thermal desorption techniques," Carbon 2003, Oviedo, Spain, July, 2003.
108. "Catalytic' NO<sub>x</sub> reduction over promoted carbons," Carbon 2003, Oviedo, Spain, July, 2003.
109. "Hydrodynamic Reaction Model of a Spouted Bed Electrolytic Reactor," Paper No. 190a, presented at the AIChE 2003 Annual Meeting, San Francisco, CA, November 17, 2003.
110. "A Kinetic-theory Analysis of the Scale-up for the Hydrodynamics of a Rectangular Slot, Spouted Fluidized Vessel," Paper No. 292g, presented at the AIChE 2003 Annual Meeting, San Francisco, CA, November 17, 2003.
111. "CFD Simulation of Segregation in Liquid Fluidization of Binary Solids," Paper No. 367d, presented at the AIChE 2003 Annual Meeting, San Francisco, CA, November 20, 2003.
112. "Enhancement of Liquid Fluidized Bed Classification (LFBC) of Waste Plastics Particle Mixture Via Particle Modification," Paper No. 53e, presented at the AIChE 2003 Annual Meeting, San Francisco, CA, November 20, 2003.
113. "The Effects of Particle Size on Small Angle Neutron Scattering From a Granular Phenolic Resin Char," Paper No. G031, presented at *Carbon2004*, Brown University, Providence, RI, July, 2004.
114. "Porosity Characterization of Activated carbons From Wood Precursors *Via* Small Angle Neutron Scattering," Paper No. G032, presented at *Carbon2004*, Brown University, Providence, RI, July, 2004.

115. "TPR/TPD Studies of N<sub>2</sub>O Decomposition on Carbons – Effects of Potassium and CO," Paper No. L048, presented at *Carbon2004*, Brown University, Providence, RI, July, 2004.
116. "Electrosorption/electro-desorption of arsenic on an activated carbon in a continuous flow cell." Paper No. SA477, presented at *Carbon2006*, Aberdeen, Scotland, July 2006.
117. "Interaction of CO<sub>2</sub> with coals *via* SAXS," Paper No. 68, presented at the 237<sup>th</sup> American Chemical Society National Meeting, Division of Fuel Chemistry, Symposium on Methods and Techniques in Analytical Characterization for Fuel Nanoscience," March 23, 2009.
118. "Direct Carbon Fuel Cell." Presented at the Charles Stark Draper Laboratory, Cambridge, MA, September 13, 2010.
119. "Heavy Metal Removal/Remediation/Recovery *Via* Electrochemical Methods," Research Highlight from Brown University Superfund Research Program. Presented at NUTMEG 2010 - 28<sup>th</sup> Annual Meeting, Marine Biological Laboratory, Woods Hole, MA, October 9, 2010.
120. "Arsenic Removal with Zero-Valent Iron in a Spouted Vessel," L.Madhavan, J. Kirchner and J.M. Calo. Presented at the 2010 AIChE Annual Meeting, November 8, 2010.
121. "Porosity and gas absorption of coals studied by X-ray scattering and modeling with correlations to other methods," Randall E Winans, Soenke Seifert, Darren R Locke, Peter J Chupas, Karena W Chapman, Jonathan P Mathews, Fidel Catro-Marcano, Joseph M Calo. Presented at the 242<sup>nd</sup> American Chemical Society National Meeting, Denver, CO, in the Division of Geochemistry, Symposium on Multiscale Spatiotemporal Complexity in Geologic Carbon Sequestration: Linking Experimentation and Modeling, Paper No. 63, August 30, 2011.
122. "Cyclic electrowinning/precipitation (CEP) system for the removal of mixtures of heavy metals from aqueous solutions," P. Grimshaw, J.M. Calo, G. Hradil. Presented at the 242<sup>nd</sup> American Chemical Society National Meeting, Denver, CO, in the Division of Environmental Chemistry, Symposium on Novel Solutions to Water Pollution – Novel Materials, Paper No. 459, September 1, 2011.

**i. Other - Reports (Final and Topical):**

1. With R. J. Fezza and E. J. Dineen, "Gas-Surface Interactions in Cryogenic Whole Air Sampling," AFGL-TR-81-0162, Air Force Geophysics Laboratory, Hanscom AFB, MA, May 1981.
2. With M. A. Kramer, H. Rabitz, and R. J. Kee, "AIM: The Analytically Integrated Magnus Method for Linear and Second Order Sensitivity Coefficients," Department of Chemistry, Princeton University, Princeton, NJ, 1981.
3. With R. J. Fezza and G. F. Ryan, "Chemical Reactions and Molecular Aggregation in Cryogenic Whole Air Sample Matrices," AFGL-TR-82-0061, Air Force Geophysics Laboratory, Hanscom AFB, MA, January 1982.
4. With W. D. Lilly, "Chemical Reactions and Molecular Aggregation in Cryogenic Whole Air Sample Matrices," AFGL-TR-83-0235, Air Force Geophysics Laboratory, Hanscom AFB, MA, July 1983.
5. "Composition Alteration of Stratospheric Air Due to Sampling Through a Flow Tube,"

- AFGL-TR-84-0045, Air Force Geophysics Laboratory, Hanscom AFB, MA, January 1984.
6. With O. Sy, R. Ganapathi, and S.E. Ellison, "Heterogeneous Kinetics of Coal Gasification," DOE/PC40786 -F, Final Technical Report submitted to the Pittsburgh Energy Technology Center, Pittsburgh, PA, DOE Grant No. DE-FG22-83PC40786, October 1984.
  7. With E. M. Suuberg, M. Wojtowicz, W.D. Lilly, "Active Sites in Char Gasification," DOE/PC60800-F, Final Technical Report submitted to the Pittsburgh Energy Technology Center, Pittsburgh, PA, DOE Grant No. DE-FG22-83PC60800, June, 1987.
  8. With P.J. Hall and W.D. Lilly, "A Mechanistic Study of the Energetic Heterogeneity of Coal Chars," DOE/MC23284-F, Final Technical Report submitted to the Morgantown Energy Technology Center, Morgantown, WV, on DOE Contract No. DE-AC21-87MC23284, November, 1989.
  9. With M. T. Perkins, "Micropore Diffusion in Coal Chars Under Reactive Conditions," DOE/PC90529-F, Final Technical Report, submitted to Pittsburgh Energy Technology Center, Pittsburgh, PA, on DOE Grant No. DE-FG22-86PC90529, June, 1990.
  10. With G. Hradil, "Experimental Studies of the Behavior of Liquid-Fluidized Beds of Aspen Wood Chips," Final Technical Report submitted to the Solar Energy Research Institute, Golden, CO, Subcontract No. XK-7-07031-8, under Prime Contract No. DE-AC02-83CH10093, April, 1991.
  11. With E.M. Suuberg, H. Teng, and W.D. Lilly, "NO-Char Reactions: Kinetics and Transport Aspects," DOE/PC79929-F, Final Technical Report submitted to the Pittsburgh Energy Technology Center, Pittsburgh, PA, on DOE Grant No. DE-FG22-87PC79929, July 1991.
  12. With W.D. Lilly, "The Development of Laboratory Ion Sources for Mass Spectrometer Calibration," PL-TR-93-2192, Final Technical Report submitted to the Phillips Laboratory, Directorate of Geophysics, Air Force Materiel Command, Hanscom AFB, MA, on Contract No. F19628-91-K-0015, August, 1993.
  13. "REMS/WSR Experimental Program: Data Analysis & Modeling," Final Report for AFOSR Summer Faculty Research Program, submitted to Air Force Office of Scientific Research, Bolling Air Force Base, DC, September, 1995.
  14. With L. Zhang, W. Lu, and W.D. Lilly, "Reactivity of Young Chars *Via* Energetic Distribution Measurements," DE-FG22-90PC90307-FINAL, Final Technical Report submitted to the Pittsburgh Energy Technology Center, Pittsburgh, PA, on DOE Grant No. DE-FG22-90PC90307, January, 1996.
  15. With E.M. Suuberg, "Clean Process Technology" - A Novel Course in Industrial Ecology," Final Report to DoD Environmental Grants Program (1333), on Contract No. MDA 905-94-Z-0048, September, 1996.
  16. "Transient Studies of The Effects of Fire Suppressants In A Well-Stirred Combustor," Final Report for AFOSR Summer Faculty Research Program, submitted to Air Force Office of Scientific Research, Bolling Air Force Base, DC, September, 1996.
  17. "Characterization of Porosity *Via* Secondary Reactions," DE-FG22-91PC91305-FINAL, Final Technical Report submitted to the Federal Energy Technology Center, Pittsburgh, PA, on DOE Grant No. DE-FG22-91PC91305, September, 1997.
  18. "Coal Cleaning *Via* Liquid-Fluidized Classification (LFBC) With Selective Solvent Swelling," DE-FG26-98FT40121-Final, Final Technical Report submitted to the

- National Energy Technology Laboratory, Pittsburgh, PA, on DOE Grant No. DE-FG26-98FT40121, December, 2000.
19. With R.H. Hurt, "Structure-Based Predictive Model for Coal Char Combustion," DE-FG22-96PC96249-Final, Final Technical Report submitted to the National Energy Technology Laboratory, Pittsburgh, PA, on DOE Grant No. DE-FG22-96PC96249, June, 2001.
  20. "Development of High Activity, Catalytic Systems for NO<sub>x</sub> Reduction." Final Technical Report submitted to the National Energy Technology Laboratory, Pittsburgh, PA, on DOE Grant No. DE-FG26-97FT97267, December 2001.
  21. "Spouted Bed Electrolytic Recovery of Metals for Source Reduction and Waste Minimization," Final Technical Report submitted to National Center For Environmental Research And Quality Assurance, United States Environmental Protection Agency, Washington, D.C., on GRANT NO.: R82-6165, April 2003.
  22. "Continuous Micro-Sorting of Complex Plastic Particle Mixtures *Via* Liquid-Fluidized Bed Classification (LFBC) For Waste Minimization And Recycling," Final Technical Report submitted to National Center For Environmental Research and Quality Assurance, United States Environmental Protection Agency, Washington, D.C., on Grant No. R82-6165, and to the National Science Foundation under Grant No. CTS900965, November 2003.

## 6. **Research in Progress:**

- (1) Superfund Research Program (SBRP) - participant in a Biomed/Engineering consortium, "Reuse in RI – A State-Based Approach to Complex Exposures," Dr. Kim Boekelheide, Director; funded by the National Institute of Environmental Health Sciences. Leader of Project 5, "Development of Novel Electrochemical Techniques for Heavy Metals Removal, Remediation, and Recovery." This research involves the application of particulate electrode systems to the removal of multiple metals from contaminated waters from Superfund and Brownfields sites. Involves the development/application of novel electrochemical techniques to the adsorption/desorption of heavy metal compounds onto porous adsorbents to enhance pollutant capture and adsorbent regeneration.
- (2) Hydrodynamic Direct Carbon Fuel Cell (H-DCFC). Under the auspices of a seed grant from the OVPR, a project was initiated on the development of a prototype of a novel Direct Carbon Fuel Cell to produce electricity directly from carbonaceous materials like coal and biomass without thermal combustion. This work was initially conducted in collaboration with: Dr. Euan Bain, as a former Postdoctoral Research Associate from the University of Strathclyde (Glasgow, Scotland), and then as a Lecturer in the Chemical Engineering Program at the University of Aberdeen (Aberdeen, Scotland); Ms. Elizabeth Dicocco, first as a Senior Engineering Concentrator, and then as a Graduate Student at Brown; Dr. T. Burchell from ORNL; and Prof. D. Cazorla as a Summer Visitor from the Universidad de Alicante, (Alicante, Spain - see below).  
Draper Laboratory has become interested in this work and funded a current URAD project on this topic. We are currently conducting work at Brown and performing collaborative research with Draper personnel to develop a full working prototype of an H-DCFC.

- (3) Coal Characterization for CO<sub>2</sub> Sequestration Using Small Angle Scattering Techniques. Collaborations continue with Dr. R.E. Winans of the Advanced Photon Source (APS-XSD) at Argonne National Laboratory, who I visited on my sabbatical leave in 2006, and with A. Clemens from CRD Energy Ltd., New Zealand. This work is focused on improving the understanding the interactions of coal samples (both U.S. and New Zealand) with high pressure CO<sub>2</sub>, using small angle scattering techniques, to enable the prediction/assessment of CO<sub>2</sub> sequestration/storage in coal seams. Two papers on this work were presented at the National American Chemical Society Meetings in New Orleans in April, 2008, and Salt Lake City in March, 2009.
- (4) Continued collaborations with the University of Alicante, Spain. Profs. Diego Cazorla Amorós and Emilia Morallon Nuñez from the Universidad de Alicante, spent the months of June-August 2007 as Visiting Faculty in our group. Among the various projects to which they contributed are: (a) the electrochemical behavior of arsenic compounds on various working electrode materials, including gold, platinum, vitreous carbon and graphite, as well as particulate carbons; (b) the direct carbon fuel cell; (c) the application of cyclic voltammetric techniques to the removal of catalytic metals from of single wall nanotube samples. These collaborations will continue with a visit to Alicante in January 2008, and the Summer of 2008. A paper on this work has been published in 2009 in *Electrochimica Acta*.

## 7. Service:

### **(i). To the University and the Division of Engineering:**

Member of Promotion Review Committee for Prof. Anubhav Tripathi, FTCP Group, Division of Engineering, 2008-2009.

Member of Search Committee for “Target of Opportunity” hire in the FTCP Group, Division of Engineering, 2008.

Division of Engineering Executive Committee Representative for the Fluid Mechanics, Thermodynamics, and Chemical Processes Group, 2007-2008.

Member of Search Committee for Hazeltine Distinguished University Professorship in Technology Innovation and Entrepreneurship, 2006.

ABET Accreditation Visit Assistant Coordinator (to R.H. Hurt) for the Chemical and Biochemical Engineering Program, November, 2008.

Development of New Chemical and Biochemical Engineering Program.

Developed and launched plan to add Biochemical Engineering dimension to existing Chemical Engineering Program. The program name change was approved, and two courses have been redesigned to accommodate the program changes – ENGN1110, *Chemical and Biochemical Transport Processes*, and ENGN1120, *Chemical and Biochemical Reactor Design*.

Planned and presided over Advisory Committee meeting for new Chemical and Biochemical Engineering program. (November, 2005).

• Director of Undergraduate Programs in Engineering, 2004-2005.

Chemical and Biochemical Engineering Concentration Advisor; 1981 – 2010 (on a continuing basis).

• AIChE Student Chapter Advisor; 1981 – 2010 (on a continuing basis, except for sabbatical

leaves).

- Freshman and Sophomore Engineering Advisor through 2010 (on a continuing basis).
- SBRP, Superfund Basic Research Program Consortium, Seminar Committee, 2005 -
- Division of Engineering Executive Committee Representative for the Fluid Mechanics, Thermodynamics, and Chemical Processes Group, 2004 – 2005.
- Affirmative Action Representative for the Division of Engineering, 2003 -.2004.
- Member of Faculty Search Committee, Position in “Soft Materials,” 2004.
- Coordinator and Author of “Volume II” for the Chemical Engineering Program for the accreditation visits of The Accreditation Board for Engineering and Technology, 1984, 1987, 1990, 1996, 2002.
- Division of Engineering Laboratory Safety Committee, 2000 – 2003.
- Chairman of the Edward A. Mason Lectureship Committee, 1997, 1998-99, 2000.
- Seminar Coordinator, FTCP Group, 1997-98.
- Member of the Executive Committee of the Center for Environmental Studies, 1996 – 2000.
- Member of the Board of Environmental Studies, 1991 – 2000.
- Brown University Representative to the Pollution Prevention Consortium of New England Universities, 1994 - 1998.
- Co-Chairman and organizer of Faculty Search Committee for FTCP Group, 1993-1994.
- Member of Faculty Search Committee for Solid Mechanics Group, 1992-1993.
- Chairman of the Concentration Committee of the Division of Engineering, 1991-1995.
- Member of the Committee on Academic Computing, 1988-1990.
- Member of the University Laboratory Safety Committee and Hazardous Waste Reduction Subcommittee, 1987-1990; 1996 (Sem. I).
- Division of Engineering Executive Committee Representative for the Fluid Mechanics, Thermodynamics, and Chemical Processes Group, 1985-1988.
- Otis E. Randall Counselor, 1986-1990.
- Graduate Representative for the Fluid Mechanics, Thermodynamics, and Chemical Processes Group, and Member of the Graduate Committee of the Division of Engineering, 1983-85; 1990.
- Member of Committee on Admission and Financial Aid, 1981-1983.  
(\* = Academic Advising)

**(ii) To the Profession:**

- Miembro del Tribunal Doctorado (Member, Doctoral Thesis Committee) de Juan Carratalá Abril, “Estudio a Escala Semiplanta Piloto de la Preparación de Carbones Activados, de la Adsorción de Compuestos Orgánicos Volátiles y Regeneración de los Adsorbentes,” (“Semi-pilot Plant Study of the Prepatration of Activated Carbons, the Adsorption of Volatile Organic Compounds and Regeneration of the Adsorbents”), Departamento de Química Inorgánica, Universidad de Alicante, Spain, January, 2008.
- Councilor, Division of Fuel Chemistry of the American Chemical Society (elected 2005; term - 2006-2009); re-elected 2008; term – 2009-2011).
- Technical Program Secretary, Division of Fuel Chemistry of the American Chemical Society; 2004 - present.
- Member of the Executive Committee of the Division of Fuel Chemistry of the American Chemical Society; 2001 - present.
- Member of the Executive Committee of the American Carbon Society, 2001- 2010.

Member, Divisional Activities Committee (DAC) of the American Chemical Society, 2007-2011.

Co-organizer (with Prof. P.J. Hall, University of Strathclyde, Glasgow, UK) of joint ACS-Supergen Symposium on Energy Storage at the 224<sup>th</sup> National ACS Meeting in Boston, MA, August, 2007.

Advisor and Consultant, EPSRC Supergen University Consortium on Energy Storage, Scotland, UK; 2006 – 2007.

Session Chair at Carbon2006, Session 9C, Thursday, 20 July 2006, Aberdeen Scotland, UK.

Conference Chairman, “Carbon 2004 - An International Conference on Carbon,” sponsored by the American Carbon Society; July 2004, Brown University, Providence, RI.

Treasurer, Division of Fuel Chemistry, American Chemical Society (elected 2000); term - 2001-2004.

Miembro del Tribunal Doctorado (Member, Doctoral Thesis Committee) de Dolores Lozano Castelló, “Preparación y Caracterización de Materiales Carbonosos Avanzados para la Separación de Gases y el Almacenamiento de Gases y Energía” (“Preparation and characterization of advanced carbon materials for gas separation and storage of gases and energy”), Departamento de Química Inorgánica, Universidad de Alicante, Spain, May, 2001.

Member of the Advisory Committee of the American Carbon Society, 1997-2001.

Participant, ACS Division Leaders Conference, Treasurers Track, Galveston, TX, February 2-4, 2001.

Organizer and Chairman of sessions on “Chemical and Catalytic Reaction Engineering,” for the Third Joint China/USA Chemical Engineering Conference, Beijing, China, September, 2000.

Industrial Sponsor Committee Chair for the Third Joint China/USA Chemical Engineering Conference, Beijing, China, September, 2000.

Organizer and Chairman of “Reactivity” Topical Area for the Twenty Third Biennial Conference on Carbon, American Carbon Society, Penn State University, July 1997.

Organizer and Chairman of session on “Chemical and Catalytic Reaction Engineering,” for Second Joint China/USA Chemical Engineering Conference, Beijing, China, May 1997.

Co-editor (with N. N. Li) of the book, Recent Developments in Separation Science, Vol. IX, CRC Press, Inc., 1986.

Chairman of Session on Trace Elements/Emissions at the Environmental Aspects of Coal Utilization & Carbon Science Meeting, University of Newcastle, Newcastle, UK, 2 April 1992.

Program Chairman of Area 7J, Combustion, for the American Institute of Chemical Engineers.

Chairman and organizer of sessions on the “Fundamentals of Heterogeneous Reactions on Carbons and Chars,” American Institute of Chemical Engineers Annual Meeting, Chicago, Illinois, November 1990.

Chairman and organizer of the session on “Mathematical and Statistical Modeling of Separation Processes,” at the AIChE Summer National Meeting, Denver, CO, August 1988.

Chairman of the session on “Mathematical and Statistical Modeling of Separation Processes,” at the Annual AIChE Meeting in New York, November 1987.

Chairman and organizer of “Symposium on the Chemistry of Coal and Char Combustion and

Gasification,” in the Division of Fuel Chemistry, at the American Chemical Society National Meeting, New Orleans, August 1987.

Reviewer for DOE University Coal Research Program Proposals, Pittsburgh, PA, April 1983, April 1985, April 1987, April, 1990.

Invited Review Panel Member for EPA National Center for Intermedia Transport Research, UCLA, July 8-10, 1985.

Organizer of four sessions (25 papers) on “Recent Developments in Separation Technology,” for National AIChE Meeting, Anaheim, CA, May 1984; and served as Chairman for each.

Member of Advisory Committee of NATO Advanced Study Institute in “Multiphase Chemical Reactors,” Vimeiro, Portugal, August 18-31, 1980 (with A. E. Rodrigues and N. H. Sweed).

ASEE Meeting, Amherst, MA, June 22-27, 1980; Chairman of session entitled, "The ChEMI Project-Update and Preliminary Results"; also serving on panel concerning the General Examination for the Ph.D. in Chemical Engineering.

Co-editor (with E. J. Henley) of the Stagewise and Mass Transfer Operations Volume of the Chemical Engineering Modular Instruction Project (ChEMI), AIChE, NY, 1977-1979.

Invited member of discussion panel for Chemical Engineering Series of the McGraw-Hill Book Co., November 26, 1979, at the San Francisco AIChE Meeting.

Executive Committee Member of the Central Jersey Section of the AIChE, 1978-1981.

Lecturer for Review Courses A and C for the Professional Engineer's Examination for the State of New Jersey; given by the Center for Continuing Engineering Studies, Rutgers University (1978-1981).

Lecturer on a periodic basis for the following Chemical Engineering courses organized by the Center for Professional Advancement, East Brunswick, NJ:

- Basic Principles of Chemical Engineering,
- Separation Process Technology
- Scale-Up in the Chemical Process Industries
- Mathematical Modeling in Chemistry and Chemical Engineering

**(iii) To the Community:**

Soccer Coach for the Smithfield Youth Soccer Association, Competitive Soccer Division, 1985-1996.

Rhode Island Soccer Association, Under 23 League Representative and Coach, 1990 - 1996.

**8. Awards:**

**a. Research Grants:**

“Gas-Surface Interactions in Cryogenic Whole Air Sampling,” Air Force Geophysics Laboratory, Hanscom AFB, MA; \$80,000, 1976-1979.

“Photoionization of Molecular Clusters,” Air Force Office of Scientific Research, Bolling AFB, Washington, DC; \$152,212, 1977-1980.

“Chemical Reactions and Molecular Aggregation in Cryogenic Whole Air Sample Matrices,” Air Force Geophysics Laboratory, Hanscom AFB, MA; \$59,888, 1979-1981.

“The Heterogeneous Kinetics of Coal Gasification,” Department of Energy, Pittsburgh Energy Technology Center, Pittsburgh, PA; DE-FG22-81PC40786; \$112,760, 1981-1983.



- [Initially awarded at Princeton University: DE-FG22-80PC30211 \$162,036; 1980-83. (160-6086)]
- “Experimental Studies of the Infrared Spectroscopy of Atmospheric and Other Molecular Complexes,” National Science Foundation, Washington, DC, \$438,435, 1981-1984.
- “Active Sites in Char Gasification,” Department of Energy, Pittsburgh Energy Technology Center, Pittsburgh, PA; DE-FG22-83PC60800; \$200,000, 1983-1986. (Joint with E. M. Suuberg.)
- Exxon Education Foundation Unrestricted Research Grant, \$5,000, 1985-86.
- “FTIR Spectroscopy in Solids Characterization, Pyrolytic Chemistry, and Gasification Chemistry,” DOE University Research Instrumentation Grant, DOE, Washington, DC; DE-FG05-84ER-75154; Joint with E.M. Suuberg, \$95,582, 1986-88. (URI Grant)
- “A Study of Micropore Diffusion in Coal Chars Under Reactive Conditions,” Department of Energy, Pittsburgh Energy Technology Center, Pittsburgh, PA; DE-FG22-86PC90529; \$175,000, 1986-1989. (5-28552)
- “A Mechanistic Study of the Energetic Heterogeneity of Coal Chars,” Department of Energy, Morgantown Energy Technology Center, Morgantown, WV; DE-AC21-87MC23284; \$221,644; 1987-1989. (5-28630).
- “The Application of Percolation Theory to Modeling the Hydrodynamics of an Acid Hydrolysis Percolation Reactor,” Solar Energy Research Institute, Golden, CO; SERI Subcontract No. XK-7-07031-8; \$98,310, 1987-1990.
- “NO<sub>x</sub>-Char Reactions: Kinetics and Transport Aspects,” Department of Energy, Pittsburgh Energy Technology Center, Pittsburgh, PA; DE-FG22-87PC79929; \$200,000, 1988-1991. (Joint with E. M. Suuberg)
- “The Development of Laboratory Ion Sources for Mass Spectrometer Calibration,” Air Force Geophysics Laboratory, Hanscom AFB, MA; F19628-91-K-0015; \$10,000, 1991-93. (5-28801)
- “Continuous Micro-sorting of Plastic Particles *Via* Liquid-Fluidized Classification (LFBC),” Plastics Recycling Foundation, Washington, D.C.; \$69,000, 1993-1994; (Joint with E.M. Suuberg).
- “Reactivity of 'Young Chars' *Via* Energetic Distribution Measurements,” Department of Energy, Pittsburgh Energy Technology Center, Pittsburgh, PA; DE-FG22-90PC90307; \$217,550, 1990-1993. (5-21606)
- “Characterization of Coal Char Porosity *Via* Secondary Reactions,” Department of Energy, Pittsburgh Energy Technology Center, Pittsburgh, PA; DE-FG22-91AC91305; \$217,550, 1991-1994.
- “A Novel Course in Industrial Ecology,” DoD *via* the Pollution Prevention Consortium of New England Universities, \$21,000, 1995-96.
- “High Temperature/High Pressure TGA,” DOE University Research Instrumentation Grant, DOE, Washington, DC; DE-FG-02-95TE00059; \$212,040, 1995-97.
- “The Removal of Technetium From Radiocontaminated Nickel,” Covofinish Co., Inc., \$35,000, 1995-97.
- 1996 AT&T and Lucent Technologies Industrial Ecology Faculty Fellowship Award, \$50,000, 1996-97.
- “Structure-Based Predictive Models for Coal Char Combustion,” Department of Energy, Federal Energy Technology Center, Pittsburgh, PA; DE-FG22-96PC96249; \$656,000, 1996-1999. (Joint with R.H. Hurt) and Ohio State University). (5-21632)

- “Transient Studies of the Effects of Fire Suppressants in a Well-Stirred Combustor,” AFOSR *via* RDL, \$25,000, 1997.
- 1997 AT&T and Lucent Technologies Industrial Ecology Faculty Fellowship Award, \$50,000, 1997-98.
- “Development of High Activity, Coal-Derived, Promoted Catalytic Systems for NO<sub>x</sub> Reduction at Low Temperatures,” Department of Energy, Federal Energy Technology Center, Pittsburgh, PA; \$220,000, 1997-2001. (5-21633)
- “Spouted Bed Electrolytic Recovery of Metals for Source Reduction and Waste Minimization,” U.S.E.P.A., ORD; R82-6165; 1997-2002; \$316,619.
- “Coal Cleaning *Via* Liquid-Fluidized Bed Classification (LFBC) With Selective Solvent Swelling,” Department of Energy, Federal Energy Technology Center, Pittsburgh, PA; DE-FG26-98FT40121; \$55,000, 1998-2000. (5-21636)
- “Continuous Micro-sorting of Complex Waste Plastic Particle Mixtures *Via* Liquid-Fluidized Bed Classification (LFBC) for Waste Minimization and Recycling,” jointly funded by the NSF and EPA, \$260,000, 1999-2002.
- “Fundamental Investigation of Fuel Transformations in Advanced Coal Combustion and Gasification Technologies,” Department of Energy, National Energy Technology Laboratory, Pittsburgh, PA; \$534,190, 2000-2004. (Joint with R.H. Hurt and Brigham Young University).
- “Characterization of Carbon Monolith Materials for Fuel Gas Storage *Via* Small Angle Neutron Scattering,” UT-Battelle, LLC, Oak Ridge National Laboratory, Oak Ridge, Tennessee; \$20,000, 2001-2004.
- “Spouted Bed Electrodes (SBE) for Direct Utilization of Carbon in Fuel Cells,” Department of Energy, National Energy Technology Laboratory, Pittsburgh, PA; DE-FG26-03NT41802; \$55,000 2003-2004. (5-21648)
- “Development of a “Hydrodynamic Direct Carbon Fuel Cell (SB/DCFC), OVPR Seed Grant, Brown University, Providence, RI; \$50,000, 2007-2009.
- “Metals Removal *Via* Spouted Bed Electrolytic Reactors (SBER),” Project 5, Superfund Research Program (SRP), National Institute of Environmental Health Sciences, Washington, DC; ~\$600,000 (direct cost), 2005-2009. Renewed for 2009-2014, “Development of Novel Electrochemical Techniques for Heavy Metals Removal and Remediation,” Project 5, Superfund Research Program (SRP); ~\$140,000 (direct cost)/yr.
- “Development of a Hydrodynamic Direct Carbon Fuel Cell (H/DCFC),” Charles Stark Draper Laboratory, Cambridge, MA. URAD Grant, \$300,000, 2010-2013.

**b. Fellowships and Honors:**

- Union Carbide Corporation Scholarship at Newark College of Engineering, 1962-1966.
- United States Atomic Energy Commission Special Fellowship in Nuclear Science and Engineering at Princeton University, 1966-1969.
- United States Air Force Commendation Medal (for research contributions at the Air Force Cambridge Research Laboratories), 1974.
- NATO Travel Grant for scientific exchange with Centre de Recherches sur la Physico-Chimie des Surfaces Solides, CNRS, Mulhouse, France, 1990.
- NSF stipend awarded through the American Society of Mechanical Engineers (ASME) to attend Bioprocess Technology Course at the Center for Bioprocess Technology, University of Virginia, October, 1991.

Sabbatical leave stipend from the Department of Pure & Applied Chemistry, University of Strathclyde, Scotland, UK, Spring 1992.

Sabbatical leave stipend (SAB92-0234) from the Ministerio de Educacion y Ciencia of Spain to visit the Departamento de Química Inorgánica of the Universidad de Alicante, 1992.

Lucent Technologies Industrial Ecology Faculty Fellow, 1996-97, 1997-98.

Outstanding Service Award (Treasurer), American Chemical Society Division of Fuel Chemistry, 2004.

Outstanding Service Award (Conference Chair), American Carbon Society, 2004.

Fellow of the American Chemical Society, 2012.

**c. Honorary Societies:**

Phi Eta Sigma, National Freshmen Engineering Honor Society, Newark College of Engineering, 1963.

Tau Beta Pi, N. J. Gamma Chapter, Newark College of Engineering, 1965.

Omega Chi Epsilon, National Chemical Engineering Honor Society, Newark College of Engineering, 1965.

Society of the Sigma Xi/Research Society of North America, elected at Princeton University, 1969; current member.

Who's Who in the East

Who's Who in Rhode Island

Who's Who in Science & Engineering

Who's Who in America

Strathmore's Who's Who

American Men & Women of Science

**Professional Societies:**

American Institute of Chemical Engineers

American Chemical Society

American Carbon Society

**9. Teaching: (last three years)**

	<b>Spring</b>	<b>Fall</b>
2010	ENGN1710, Heat and Mass Transfer	ENGN1120, Chemical and Biochemical Reactor Design
2011	ENGN0720, Thermodynamics	
2012	ENGN0720, Thermodynamics	

**Graduate Students Advised: (at Brown University)**

Oluwasegun Ige

Daniel Pavlou

Ramakrishnan Ganapathi, MSE, 1985.

F.J. Bottari (Ph.D. Dissertation Reader), Ph.D., Chemistry, 1985.

R. Helfner (co-advisor with N. M. Lawandy), MSE (Biomedical), 1986.

M. Wojtowicz (co-advisor with E. M. Suuberg), Ph.D. (Engineering), 1987.

M.T. Perkins, Ph.D. (Engineering), May, 1990.  
G. Hradil, Ph.D. (Engineering), May, 1991.  
H. Teng (co-advised with E.M. Suuberg); Ph.D. (Engineering), 1992.  
W.G. Rachel, MSE, 1993.  
L. Zhang, Ph.D. (Engineering), 1996.  
W. Lu, Ph.D. (Engineering), 1996.  
Ruta Kshirsagar, A.M., Environmental Studies, 1996.  
Alicia Burnett, MSE, 2000.  
Diana Patricia Lopez, Ph.D. (Chemistry), 2003.  
Pezhman Alireza Shirvanian, Ph.D. (Engineering), 2004.  
Xinhui Hu, Ph.D. (Engineering), 2004.  
Pengpeng Yao, Ph.D. (Chemistry), 2010.  
Elizabeth DiCocco, M.S.E., 2010.  
Johannes Kirchner, M.S.E., 2010.  
Ruben Spitz-Steinberg, M.S.E., 2010.

### **Graduate Student Dissertations**

#### **Ph.D. Dissertations:**

Yao, Pengpeng, "The Removal of Heavy Metal Pollutants With Electrowinning Techniques, October, 2009, Ph.D. Dissertation, Department of Chemistry, Brown University, Providence, RI.

Xinhui Hu, "Segregation and Dispersion in Liquid-Fluidized Beds – Applications to Particle Separation," 2004. Ph.D. Dissertation, Division of Engineering, Brown University, Providence, RI.

Pezhman Alireza Shirvanian, "Electrolytic Recovery of Metals in a Spouted Vessel Reactor: An Experimental and Simulation Approach," 2003. Ph.D. Dissertation, Division of Engineering, Brown University, Providence, RI.

Diana P. Lopez, "Catalytic Reduction of NO<sub>x</sub> on Carbonaceous Systems and CO<sub>2</sub> Gasification at Elevated Pressures," 2003. Ph.D. Dissertation, Department of Chemistry, Brown University, Providence, RI.

Linghong Zhang, "Studies on the Reactivity and Porosity Development in Chars, and the Carbon-CO<sub>2</sub> Reaction *Via* Temperature Programmed Desorption," 1996. Ph.D. Dissertation, Division of Engineering, Brown University, Providence, RI.

Weijie Lu, "Oxygen Surface Complexes in Steam Gasification and the Catalytic Effects of Calcium and Iron," 1996. Ph.D. Dissertation, Division of Engineering, Brown University, Providence, RI.

Hsisheng Teng, "The Reactions of Nitric Oxide With Carbon," 1992. Ph.D. Dissertation, Division of Engineering, Brown University, Providence, RI.

George Hradil, "A Study of Liquid-Fluidized Reactors for the Enzymatic Hydrolysis of Biomass." 1991. Ph.D. Dissertation, Division of Engineering, Brown University, Providence, RI.

Matthew Thomas Perkins. "The Measurement of Activated Diffusion Times in Coal Chars at Elevated Temperatures and Pressures," 1990. Ph.D. Dissertation, Division of Engineering, Brown University, Providence, RI.

- Marek Wójtowicz, "Thermogravimetric Study of Active Sites in the Process of Low Temperature Oxidation of Char," 1988. Ph.D. Dissertation, Division of Engineering, Brown University, Providence, RI.
- Jeffrey John Kolstad, "Growth Kinetics of Water Clusters," 1983. Ph.D. Dissertation, Department of Chemical Engineering, School of Engineering and Applied Science, Princeton University, Princeton, NJ.
- Mark Albert Kramer, "Parametric Sensitivity Analysis of Ordinary Differential Equations: Mathematical Methods and Applications," 1983. Ph.D. Dissertation, Department of Chemical Engineering, School of Engineering and Applied Science, Princeton University, Princeton, NJ.
- Richard Fezza "Cryogenic Deposition, Desorption, and Reaction Studies of Stratospherically Relevant Species," 1981. Ph.D. Dissertation, Department of Chemical Engineering, School of Engineering and Applied Science, Princeton University, Princeton, NJ.
- Dennis Clifton Williams, "Steady-State and Dynamic Analysis of Single and Coupled General, Two-Phase, Lumped Parameter Chemical Reactor Cells With Multiple Reactions," 1980. Ph.D. Thesis Dissertation, Department of Chemical Engineering, School of Engineering and Applied Science, Princeton University, Princeton, NJ.
- Hsueh-Chia Chjang, "The Application of Singularity and Perturbation Techniques to Nonlinear Chemical Reaction Systems, 1979. Ph.D. Dissertation, Department of Chemical Engineering, School of Engineering and Applied Science, Princeton University, Princeton, NJ.

#### **Masters Dissertations:**

- Johannes Richard Kirchner, "Arsenic Removal With Zero-Valent Iron Particles in a Spouted Vessel," 2010. Division of Engineering, Brown University, Providence, RI.
- Elizabeth DiCocco, "Batch Particulate Carbon Fuel Cells: Towards a Hydrodynamic Direct Carbon Fuel Cell (H-DCFC)," 2010. Division of Engineering, Brown University, Providence, RI.
- Alicia Kareen. Burnett, "A Study of the Role of CO in the NO-Carbon Reaction," 2000. Dissertation, Master of Science in Engineering, Division of Engineering, Brown University, Providence, RI.
- Ruta Kshirsagar, "Toxics Use Reduction Planning - The Fate of Pollution Prevention in Massachusetts' Metal Finishing Industry," 1996. Dissertation, Master of Arts, Environmental Studies Program, Brown University, Providence, RI.
- Robert Helfner, "Laser-Inhibited Diffusion in a Rhodamine/Methanol System and the Demonstration of a Liquid Phase Optical Piston," 1986. Dissertation, Master of Science in Engineering (Biomedical), Division of Engineering, Brown University, Providence, RI.
- Ramakrishnan Ganapathi, "Transient Kinetic Studies of Char Gasification in Steam-Argon Mixtures," 1985. Dissertation, Master of Science in Engineering, Division of Engineering, Brown University, Providence, RI.
- Oscar Sy, "Transient Kinetic Studies of Char Reactions in a Gradientless Reactor System – CO<sub>2</sub> Gasification," 1984. Dissertation, Master of Science in Engineering, Department of Chemical Engineering, School of Engineering and Applied Science, Princeton University, Princeton, NJ.

- Joel Yarmush, “Modelling of Entrained Flow Coal Gasifiers,” 1981. Dissertation, Master of Science in Engineering, Department of Chemical Engineering, School of Engineering and Applied Science, Princeton University, Princeton, NJ.
- Edward J. Dineen, “Cryofrost Deposition and Desorption as Related to Cryogenic Whole-Air Sampling of the Stratosphere,” 1977. Dissertation, Master of Science in Engineering, Department of Chemical Engineering, School of Engineering and Applied Science, Princeton University, Princeton, NJ.

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**Undergraduates Advised: (at Brown University)**

- George Hradil, Sc.B. candidate; Honors Thesis student, 1986.
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- Andrew Shapiro, Sc.B. candidate; Honors Thesis Student, 1988.
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- Brett Snyder, Sc.B. candidate; Independent Work, 1991.
- Michael Harrison, Sc.B. candidate; UTRA, 1993.
- Jennifer Winn, Sc.B. candidate; UTRA, 1993.
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- Eric Chen Lu, Sc.B. candidate; Honors Thesis student, 1995-1996.
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