

# RESUME

Updated 6/22/2021

**R. Shankar Subramanian**

Website: <http://web2.clarkson.edu/projects/subramanian/>

P. O. Box 5705  
Department of Chemical Engineering  
Clarkson University  
Potsdam, New York 13699-5705

**Birth Date: 8/10/47**  
Married, two daughters

subramanian@clarkson.edu  
Phone: (315) 268-6648

United States Citizen

## EDUCATION

Ph.D.	in Chemical Engineering, Clarkson University Thesis: "Unsteady Convective Diffusion -- A Study of Miscible Dispersion" Advisor: Professor William N. Gill	1972
M.S.	in Chemical Engineering, Clarkson University	1969
B.Tech.	in Chemical Engineering, University of Madras (A.C. College of Technology), India	1968

## EXPERIENCE

Professor of Chemical Engineering, Clarkson University (Professor Emeritus, 2016-present)	1982-2016
Visiting Scholar, Harvard University, and Visiting Scientist, MIT	8-12/2004
Chair, Department of Chemical Engineering, Clarkson University (first six months as Acting Chair)	1986-96
Associate Professor of Chemical Engineering, Clarkson	1979-82
Member Technical Staff, Jet Propulsion Laboratory, and Visiting Associate, California Institute of Technology	1979-80
Assistant Professor of Chemical Engineering, Clarkson	1973-79
Part-time Instructor, Faculty of Engineering and Applied Sciences, State University of New York at Buffalo	1972-73

## AWARDS AND HONORS

Dr. Alagappa Chettiar Gold Medal (No. 1 in Senior Class), Dr. M.A. Govinda Rao Memorial Prize, Mrs. Kanakammal Krishnaswamy Memorial Prize, and G. Srinivasan Memorial Prize	1968
John Graham, Jr. Faculty Award (Research Prize, Clarkson)	1978
Dow Outstanding Young Faculty Award (ASEE)	1980
Distinguished Teaching Award (Clarkson)	1981
Certificate of Recognition (NASA Jet Propulsion Laboratory)	1982
Member, Editorial Advisory Board, Journal of Colloid and Interface Science	1984-86
Outstanding Adviser Award (Clarkson)	1996
Omega Chi Epsilon Chemical Engineering Professor of the Year (Clarkson)	2008, 2011

Invited Speaker, COSPAR Meetings, Ottawa, Canada (1982); Graz, Austria (1984); AIAA Meeting, Reno, Nevada (1990); NASA Microgravity Fluid Mechanics Workshop, Cleveland, Ohio (1990); Gordon Conference, Plymouth, New Hampshire (1991); IUTAM Symposium on Microgravity Fluid Mechanics, Bremen, Germany (1991), American Ceramic Society Meeting, Indianapolis, Indiana (1994), Fine Particle Society Meeting, Chicago, Illinois (1995), Second European Symposium on Fluids in Space, Naples, Italy (1996), UIMP Summer School on Drops, Bubbles, and Particles, Santander, Spain (1996), APS meeting, Kansas City, Kansas (1997), ASME/STLE International Joint Tribology Conference, Seattle, Washington (2000), Fine Particle Society Meeting, San Diego, California (2006).

## PROFESSIONAL SERVICE

### Symposium Chair

13 at AIChE Meetings (1977 to 2000), 3 at ACS meetings (1980, 1984, 2005),  
1 at COSPAR meeting, Graz, Austria (1984), 1 at NSF Workshop (1986),  
2 at Gordon Conferences (1987,1989), 2 at NASA Workshops (1990, 1994)

### Service on Committees

National Technical Committee on Space Processing, AIAA	1979-1982
Science Working Group for Containerless Processing at High Temperature, NASA	1979-1983
AIChE Area 1c, Interfacial Phenomena Group	1982-1996
Review Panel, NASA, 1990, 1993	

### Memberships

AIChE (Fellow, 2005 to present)	1973-present
AAAS (Fellow, 1989 to present)	1977-present
ASEE (Life Member, 2016 – present)	1977-present
American Physical Society (Senior Member, 2016 to present)	1994-present
Sigma Xi	1976-2014
Tau Beta Pi	2001-present
Institute of Colloid and Surface Science, Clarkson, Member	1976-93
ASSOCIATE DIRECTOR	1981-87

## SUMMARY OF PUBLICATIONS AND PRESENTATIONS

Author or Co-author of

- 1 book, 3 invited reviews
- 82 refereed journal publications
- 33 contributions to proceedings and books
- 91 contributed oral presentations
- 40 contributed poster presentations
- 79 invited oral presentations elsewhere

**Citation by Others up to 2019** (from Web of Science): 2586 ; Yearly average over past 5 years: 115  
**H-Index as of 2019:** 26

Details are given below.

### BOOK

R. S. Subramanian and R. Balasubramaniam, "The Motion of Bubbles and Drops in Reduced Gravity," Cambridge University Press, Cambridge, UK, 2001 (Hardcover); Paperback issued in 2005.

### REVIEWS

R.S. Subramanian, "The Motion of Bubbles and Drops in Reduced Gravity," in **Transport Processes in Bubbles, Drops and Particles**, (Eds. R.P. Chhabra and D. De Kee), Hemisphere Publishing Corporation, 1992, pp. 1-42.

R. S. Subramanian, R. Balasubramaniam, and G. Wozniak, "Fluid Mechanics of Bubbles and Drops," in **Physics of Fluids in Microgravity** (Ed. R. Monti), Taylor & Francis, London, 2002, pp. 149-177.

R.S. Subramanian, "Motion of Drops on Gradient Surfaces," in "**Soft Matter Gradient Surfaces: Methods and Applications**," (Ed. J. Genzer), Wiley, New Jersey, 2012, pp. 407-429.

### PUBLICATIONS IN JOURNALS

1. W.N. Gill and R. Sankarasubramanian\*, "Exact Analysis of Unsteady Convective Diffusion," Proc. R. Soc. London Ser. A **316**, 341-350 (1970).
2. W.N. Gill and R. Sankarasubramanian, "Dispersion of a Non-Uniform Slug in Time- Dependent Flow," Proc. R. Soc. London Ser. A **322**, 101-117 (1971).
3. R. Sankarasubramanian and W.N. Gill, "Taylor Diffusion in Laminar Flow in an Eccentric Annulus," Int. J. Heat and Mass Transfer **14**, 905-919 (1971).
4. W.N. Gill and R. Sankarasubramanian, "Dispersion of Non-Uniformly Distributed Time-Variable Continuous Sources in Time-Dependent Flow," Proc. R. Soc. London Ser. A **327**, 191-208 (1972).

---

\*R. Sankarasubramanian was the name prior to legal change to R. Shankar Subramanian in 1973.

5. R. Sankarasubramanian and W.N. Gill, "Dispersion from a Prescribed Concentration Distribution in Time-Variable Flow," Proc. R. Soc. London Ser. A **329**, 479-492 (1972).
6. M.R. Doshi, R. Sankarasubramanian, and W.N. Gill, "A Comment on Radial Mass Transfer Effects in a Porous Wall Tubular Reactor," Int. J. Heat Mass Transfer **16**, 525-526 (1973).
7. R. Sankarasubramanian and W.N. Gill, "Unsteady Convective Diffusion with Interphase Mass Transfer," Proc. R. Soc. London Ser. A **333**, 115-132 (1973); "Correction to 'Unsteady Convective Diffusion with Interphase Mass Transfer'," Proc. R. Soc. London Ser. A **341**, 407-408 (1974).
8. R.S. Subramanian and J.R. Zimmerman, "A Program for Preparing and Printing Examinations," ERM (of the ASEE) **6**, No. 4, 111-112 (1974).
9. R.S. Subramanian, W.N. Gill, and R.A. Marra, "Dispersion Models of Unsteady Tubular Reactors," Can. J. Chem. Eng. **52**, 563-568 (1974).
10. R.S. Subramanian, "Unsteady Convective Diffusion in Capillary Chromatography," J. Chromatogr. **101**, No. 2, 253-270 (1974).
11. R.S. Subramanian, "Gas Absorption Into a Turbulent Liquid Film," Int. J. Heat Mass Transfer **18**, 334-336 (1975).
12. M.R. Doshi, W.N. Gill, and R.S. Subramanian, "Unsteady Reverse Osmosis or Ultrafiltration in a Tube," Chem. Eng. Sci. **30**, 1467-1476 (1975).
13. R.S. Subramanian and W.N. Gill, "Unsteady Convective Diffusion in Non-Newtonian Flows," Can. J. Chem. Eng. **54**, 121-125 (1976).
14. R.S. Subramanian and S. Berhe, "Unsteady Convective Diffusion in an Annular Catalytic Reactor," Chem. Eng. Sci. **31**, 1005-1017 (1976).
15. P. Rengarajan and R.S. Subramanian, "Atmospheric Dispersion of an Instantaneous Source," Int. J. Heat Mass Transfer **20**, 1090-1092 (1977).
16. S. Krishnamurthy and R.S. Subramanian, "Exact Analysis of Field-Flow Fractionation," Sep. Sci. **12** (4), 347-379 (1977).
17. R.S. Subramanian, "On Generalized Dispersion Theory," Chem. Eng. Sci. **32**, 788-789 (1977).
18. R.S. Subramanian, "On the Hydrodynamic Amplification of Field Separations," J. Colloid Interface Sci. **63** (1), 49-60 (1978).
19. R.S. Subramanian, K. Jayaraj, and S. Krishnamurthy, "On the Interpretation of Some Field-Flow Fractionation Experiments," Sep. Sci. Technol. **13** (3), 273-276 (1978).
20. K. Jayaraj and R.S. Subramanian, "On Relaxation Phenomena in Field-Flow Fractionation," Sep. Sci. Technol. **13** (9), 791-817 (1978).

21. W.R. Wilcox, R.S. Subramanian, J.M. Papazian, H.D. Smith, and D.M. Mattox, "Screening of Liquids for Thermocapillary Bubble Movement," *AIAA J.* **17**, No. 9, 1022-1024 (1979).
22. R.S. Subramanian and B. Chi, "Bubble Dissolution with Chemical Reaction," *Chem. Eng. Sci.* **35**, 2185-2194 (1980).
23. M.C. Weinberg and R.S. Subramanian, "Dissolution of Multicomponent Bubbles," *J. Am. Ceram. Soc.* **63**, No. 9-10, 527-531 (1980).
24. R.S. Subramanian and M.C. Weinberg, "The Role of Convective Transport in the Dissolution or Growth of a Gas Bubble," *J. Chem. Phys.* **72**, No. 12, 6811-6813 (1980).
25. W.N. Gill and R.S. Subramanian, "Discussion of 'On Laminar Dispersion For Flow Through Round Tubes'," *ASME J. Appl. Mech.* **47**, 975-976 (1980).
26. R.S. Subramanian, "Slow Migration of a Gas Bubble in a Thermal Gradient," *AIChE J.* **27**, No. 4, 646-654 (1981).
27. R.S. Subramanian and M.C. Weinberg, "Asymptotic Expansions for the Description of Gas Bubble Dissolution and Growth," *AIChE J.* **27**, No. 5, 739-748 (1981).
28. M.C. Weinberg and R.S. Subramanian, "The Dissolution of a Stationary Bubble Enhanced By Chemical Reaction," *Chem. Eng. Sci.* **36**, No. 12, 1955-1965 (1981).
29. M. Meyyappan, W.R. Wilcox, and R.S. Subramanian, "Thermocapillary Migration of a Bubble Normal to a Plane Surface," *J. Colloid Interface Sci.* **83**, No. 1, 199-208 (1981).
30. N. Shankar, R. Cole, and R.S. Subramanian, "Thermocapillary Migration of a Fluid Droplet Inside a Drop in a Space Laboratory," *Int. J. Multiphase Flow* **7**, No. 6, 581-594 (1981).
31. K. Jayaraj, R. Cole, and R.S. Subramanian, "Combined Thermocapillary and Buoyant Flow in a Drop in a Space Laboratory," *J. Colloid Interface Sci.* **85**, No. 1, 66-77 (1982).
32. P. Annamalai, R.S. Subramanian, and R. Cole, "Bubble Migration in a Rotating Liquid-Filled Sphere," *Phys. Fluids* **25**, No. 7, 1121-1126 (1982).
33. R.B. Jucha, D. Powers, T.J. McNeil, R.S. Subramanian, and R. Cole, "Bubble Rise in Glass Melts," *J. Am. Ceram. Soc.* **65**, No. 6, 289-292 (1982).
34. M.C. Weinberg, and R.S. Subramanian, "Thermophoretic Deposition in a Tube with Variable Wall Temperature," *J. Colloid Interface Sci.* **87**, No. 2, 579-580 (1982).
35. D.M. Mattox, H.D. Smith, W.R. Wilcox, and R.S. Subramanian, "Thermal Gradient Induced Migration of Bubbles in Molten Glass," *J. Am. Ceram. Soc.* **65**, No. 9, 437-442 (1982).

36. N. Shankar, and R.S. Subramanian, "The Slow Axisymmetric Thermocapillary Migration of an Eccentrically Placed Bubble Inside a Drop in Zero Gravity," *J. Colloid Interface Sci.* **94**, No. 1, 258-275 (1983).
37. M. Meyyappan, W.R. Wilcox, and R.S. Subramanian, "The Slow Axisymmetric Motion of Two Bubbles in a Thermal Gradient," *J. Colloid Interface Sci.* **94**, No. 1, 243-257 (1983).
38. M. Meyyappan and R.S. Subramanian, "The Thermocapillary Motion of Two Bubbles Oriented Arbitrarily in a Thermal Gradient," *J. Colloid Interface Sci.* **97**, No. 1, 291-294 (1984).
39. T.J. McNeil, R. Cole, and R.S. Subramanian, "Thermocapillary Convection in a Liquid Bridge," *J. Colloid Interface Sci.* **98**, No. 1, 210-222 (1984).
40. N. Shankar, T.J. Wiltshire, and R.S. Subramanian, "The Dissolution or Growth of a Sphere," *Chem. Eng. Commun.* **27**, 263-281 (1984).
41. R.S. Subramanian, "The Stokes Force on a Droplet in an Unbounded Fluid Medium Due to Capillary Effects," *J. Fluid Mech.* **153**, 389-400 (1985).
42. T.J. McNeil, R. Cole, and R.S. Subramanian, "Surface Tension Driven Flow in a Glass Melt," *J. Am. Ceram. Soc.* **68**, No. 5, 254-259 (1985).
43. M. Meyyappan and R.S. Subramanian, "Thermocapillary Migration of a Gas Bubble in an Arbitrary Direction With Respect to a Plane Surface," *J. Colloid Interface Sci.* **115**, No. 1, 206-219 (1987).
44. N.P. Balsara and R.S. Subramanian, "The Influence of Buoyancy on the Thermophoretic Deposition of Aerosol Particles in a Horizontal Tube," *J. Colloid Interface Sci.* **118**, No. 1, 3-14 (1987).
45. N. Shankar and R.S. Subramanian, "The Stokes Motion of a Gas Bubble Due to Interfacial Tension Gradients at Low to Moderate Marangoni Numbers," *J. Colloid Interface Sci.* **123**, No. 2, 512-522 (1988).
46. R.M. Merritt and R.S. Subramanian, "The Migration of Isolated Gas Bubbles in a Vertical Temperature Gradient," *J. Colloid Interface Sci.* **125**, No. 1, 333-339 (1988).
47. H.S. Kim and R.S. Subramanian, "Thermocapillary Migration of a Droplet with Insoluble Surfactant Part 1. Surfactant Cap," *J. Colloid Interface Sci.* **127**, No. 2, 417-428 (1989).
48. H.S. Kim and R.S. Subramanian, "The Thermocapillary Migration of a Droplet with Insoluble Surfactant Part II. General Case," *J. Colloid Interface Sci.* **130**, No. 1, 112-129 (1989).
49. R.M. Merritt and R.S. Subramanian, "Migration of a Gas Bubble Normal to a Plane Horizontal Surface in a Vertical Temperature Gradient," *J. Colloid Interface Sci.* **131**, No. 2, 514-525 (1989).
50. K.D. Barton and R.S. Subramanian, "The Migration of Liquid Drops in a Vertical Temperature Gradient," *J. Colloid Interface Sci.* **133**, No. 1, 211-222 (1989).

51. K.D. Barton and R.S. Subramanian, "Thermocapillary Migration of a Liquid Drop Normal to a Plane Surface," *J. Colloid Interface Sci.* **137**, No. 1, 170-182 (1990).
52. M.C. Weinberg, P.A. Kondos, and R.S. Subramanian, "The Shrinkage of a Rising Gas Bubble Containing a Diffusing and Non-Diffusing Gas," *Glass Technol.* **31**, No. 2, 72-76 (1990).
53. D.S. Morton, R.S. Subramanian, and R. Balasubramaniam, "The Migration of a Compound Drop Due to Thermocapillarity," *Phys. Fluids* **A2**, No. 12, 2119-2133 (1990).
54. K.D. Barton and R.S. Subramanian, "Migration of Liquid Drops in a Vertical Temperature Gradient - Interaction Effects Near a Horizontal Surface," *J. Colloid Interface Sci.* **141**, No. 1, 146-156 (1991).
55. M.C. Weinberg and R.S. Subramanian, "Containerless Measurement of Liquid-Liquid Surface Tension of a Demixing Lead Borate Composition in Space," *J. Non-Cryst. Solids* **129**, 206-212 (1991).
56. R.M. Merritt, D.S. Morton, and R.S. Subramanian, "Flow Structures in Bubble Migration Under the Combined Action of Buoyancy and Thermocapillarity," *J. Colloid Interface Sci.* **155**, 200-209 (1993).
57. M. Nallani and R.S. Subramanian, "Migration of Methanol Drops in a Vertical Temperature Gradient in a Silicone Oil," *J. Colloid Interface Sci.* **157**, 24-31 (1993).
58. H. Wei and R.S. Subramanian, "Thermocapillary Migration of a Small Chain of Bubbles," *Phys. Fluids A* **5**, No. 7, 1583-1595 (1993).
59. H. Wei and R.S. Subramanian, "Interactions Between a Pair of Bubbles Under Isothermal Conditions and in the Presence of a Downward Temperature Gradient," *Phys. Fluids A* **6**, No.9, 2971-2978 (1994).
60. H. Wei and R.S. Subramanian, "Migration of a Pair of Bubbles Under the Combined Action of Gravity and Thermocapillarity," *J. Colloid Interface Sci.* **172**, 395-406 (1995).
61. R.S. Subramanian, "The Motion of Drops and Bubbles in Reduced Gravity," *Ind. Eng. Chem. Res.* **34**, 3411-3416 (1995).
62. R. Balasubramaniam and R.S. Subramanian, "Thermocapillary Bubble Migration - Thermal Boundary Layers for Large Marangoni Numbers," *Int. J. Multiphase Flow* **22**, No. 3, 593-612 (1996).
63. R. Balasubramaniam, C.E. Lacy, G. Wozniak, and R.S. Subramanian, "Thermocapillary Migration of Bubbles and Drops at Moderate Values of the Marangoni Number in Reduced Gravity," *Phys. Fluids* **8**, No. 4, 872-880 (1996).
64. P.A. Kondos, R.S. Subramanian, R. Cole, and M.C. Weinberg, "The Dissolution of Rising Helium Bubbles in a Soda - Lime - Silica Glass Melt," *J. Amer. Ceram. Soc.* **79**, 1899-1906 (1996).
65. P.A. Kondos and R.S. Subramanian, "Buoyant Flow in a Two-Dimensional Cavity Due to a Sinusoidal Gravitational Field," *Microgravity Sci. Technol.* **IX/3**, 143-151 (1996).

66. M. Hariharaputhiran, R.S. Subramanian, G.A. Campbell, and R.P. Chhabra, "The Settling of Spheres in a Viscoplastic Fluid," *J. Non-Newtonian Fluid Mech.* **79**, 87-97 (1998).
67. P.H. Hadland, R. Balasubramaniam, G. Wozniak, and R.S. Subramanian, "Thermocapillary Migration of Bubbles and Drops at Moderate to Large Marangoni Number and Moderate Reynolds Number in Reduced Gravity," *Exp. Fluids* **26**, 240-248 (1999).
68. X. Ma, R. Balasubramaniam, and R. S. Subramanian, "Numerical Simulation of Thermocapillary Drop Motion with Internal Circulation," *Numer. Heat Transfer Part A*, **35**, 291-309 (1999).
69. R. Balasubramaniam and R. S. Subramanian, "Axisymmetric Thermal Wake Interaction of Two Bubbles in a Uniform Temperature Gradient at Large Reynolds and Marangoni numbers," *Phys. Fluids* **11**, No. 10, 2856-2864 (1999).
70. R.S. Subramanian, L. Zhang, and S.V. Babu, "Transport Phenomena in Chemical-Mechanical Polishing," *J. Electrochem. Soc.* **146**, No. 11, 4263-4272 (1999).
71. R. Balasubramaniam and R. S. Subramanian, "The Migration of a Drop in a Uniform Temperature Gradient at Large Marangoni Numbers," *Phys. Fluids* **12**, No.4, 733-743 (2000).
72. G. Wozniak, R. Balasubramaniam, P.H. Hadland, and R.S. Subramanian, "Temperature Fields in a Liquid due to the Thermocapillary Motion of Bubbles and Drops," *Exp. Fluids* **31**, 84-89 (2001).
73. R. S. Subramanian, L. Zhang, and R. Balasubramaniam, "Mass Transport from a Drop Executing Thermocapillary Motion," *Microgravity Sci. Technol.* **XII**, No. 3/4, 107-115 (1999), published in 2001.
74. L. Zhang and R.S. Subramanian, "A Model of Abrasive-Free Removal of Copper Films Using an Aqueous Hydrogen Peroxide-Glycine Solution," *Thin Solid Films* **397**, 143-151 (2001).
75. L. Zhang, R. S. Subramanian, and R. Balasubramaniam, "Motion of a Drop in a Vertical Temperature Gradient at Small Marangoni Number – the Critical Role of Inertia," *J. Fluid Mech.* **448**, 197-211 (2001).
76. R. S. Subramanian and R. Appat, "A Model of Chemical-Mechanical Planarization of Patterned Wafers with a Fixed Abrasive Pad," *Electrochem. Solid-State Lett.* **4**, No. 12, G115-G118 (2001).
77. L. Guo and R. S. Subramanian, "Mechanical Removal in CMP of Copper Using Alumina Abrasives," *J. Electrochem. Soc.* **151**, No. 2, G104-G108 (2004).
78. R. Balasubramaniam and R. S. Subramanian, "Thermocapillary Convection due to a Stationary Bubble," *Phys. Fluids* **16**, No.8, 3131-3137 (2004).
79. R.S. Subramanian, R.J. Larsen, and H.A. Stone, "Stability of a Flat Gas-Liquid Interface Containing Non-Identical Spheres to Gas Transport: Toward an Explanation of Particle Stabilization of Gas Bubbles," *Langmuir* **21**, 4526-4531 (2005).
80. R.S. Subramanian, N. Moumen, and J.B. McLaughlin, "Motion of a Drop on a Solid Surface Due to a Wettability Gradient," *Langmuir*, **21**, 11844-11849 (2005).



81. N. Moumen, R.S. Subramanian, and J.B. McLaughlin, "Experiments on the Motion of Drops on a Horizontal Solid Surface Due to a Wettability Gradient," *Langmuir*, **22**, 2682-2690 (2006).

82. V. Pratap, N. Moumen, and R.S. Subramanian, "Thermocapillary Motion of a Liquid Drop on a Horizontal Solid Surface," *Langmuir*, **24**, 5185-5193 (2008).

## CONTRIBUTIONS TO BOOKS AND CONFERENCE PROCEEDINGS

1. R.J. Nunge, and R.S. Subramanian, "Atmospheric Dispersion of Gaseous Pollutants From a Continuous Source -- A Model of An Industrial City," in Atmospheric Emissions and Energy-Source Pollution, AIChE Symposium Series No. 165, **73**, 10-24 (1977).<sup>#</sup>
2. R.S. Subramanian and W.R. Wilcox, "The Migration of Fluid Droplets and Their Interaction in a Thermal Gradient," Proceedings of the UAH/NASA Workshop on the Fluids Experiment System (Ed. J. Hendricks and B. Askins), The University of Alabama in Huntsville, 1979, pp. 53-57. <sup>#</sup>
3. T.J. McNeil, R. Cole, W.R. Wilcox, and R.S. Subramanian, "Thermocapillary Convection in a Cylindrical Zone," Proceedings of the Second World Congress of Chemical Engineering, Volume **V**, pp. 277-280, October 1981, Montreal, Canada. <sup>#</sup>
4. R.B. Jucha, D. Powers, T.J. McNeil, R.S. Subramanian, and R. Cole, "Bubble Rise in Molten Glasses," *ibid*, pp. 294-296. <sup>#</sup>
5. M. Meyyappan, W.R. Wilcox, and R.S. Subramanian, "The Migration of Gas Bubbles in a Thermal Gradient -- Interaction Effects," *ibid*, pp. 218-221. <sup>#</sup>
6. K. Jayaraj, R. Cole, and R.S. Subramanian, "Thermocapillary Convection in Pendant Drops," *ibid*, pp. 222-224. <sup>#</sup>
7. N. Shankar, R. Cole, and R.S. Subramanian, "Thermocapillary Migration of a Gas Bubble Inside a Liquid Drop in a Space Laboratory," *ibid*, pp. 225-227. <sup>#</sup>
8. P. Annamalai, R. Cole, and R.S. Subramanian, "Bubble Migration in a Rotating Liquid-Filled Sphere: Application to the Formation of Hollow Glass Laser Fusion Targets," *ibid*, pp. 175-178. <sup>#</sup>
9. P. Annamalai, N. Shankar, R. Cole, and R.S. Subramanian, "Bubble Migration Inside a Liquid Drop in a Space Laboratory," in Mechanics and Physics of Bubbles in Liquids, Ed. L. Van Wijngaarden, Martinus Nijhoff, The Hague, 1982, pp. 179-186 (Reprinted in Appl. Sci. Res. **38**, 179-186 (1982)). <sup>#</sup>
10. N. Shankar, P. Annamalai, R. Cole, and R.S. Subramanian, "The Motion of Bubbles Inside Drops in Containerless Processing," Proceedings of the Second International Colloquium on Drops and Bubbles, Jet Propulsion Laboratory Publication 82-7, Editor: D.H. Le Croisette, Pasadena, California, March 1982, pp. 26-30. <sup>#</sup>
11. M. Meyyappan, W.R. Wilcox, and R.S. Subramanian, "Interaction Effects in Thermocapillary Bubble Migration," *ibid*, pp. 15-16. <sup>#</sup>
12. T.J. McNeil, R. Cole, and R.S. Subramanian, "Surface Tension Driven Flow in Glass Melts and Model Fluids," in **Materials Processing in the Reduced Gravity Environment of Space**, Ed. G. Rindone, Elsevier, North Holland, 1982, pp. 289-299. <sup>#</sup>

---

<sup>#</sup> Also presented orally, and hence duplicated in the next section.

13. M. Meyyappan, R.S. Subramanian, W.R. Wilcox, and H.D. Smith, "Bubble Behavior in a Molten Glass in a Temperature Gradient," *ibid*, pp. 311-314. #
14. N. Shankar, R. Cole, and R.S. Subramanian, "Thermocapillary Motion of Bubbles Inside Drops," *ibid*, pp. 249-253. #
15. P. Annamalai, R.S. Subramanian, and R. Cole, "Bubble Motion in a Rotating Liquid Body," *ibid*, pp.187-189. #
16. H.D. Smith, D.M. Mattox, W.R. Wilcox, R.S. Subramanian, and M. Meyyappan, "Experimental Observation of the Thermocapillary Driven Motion of Bubbles in a Molten Glass Under Zero Gravity Conditions," *ibid*, pp. 279-288. #
17. R.S. Subramanian, "Thermocapillary Migration of Bubbles and Droplets," in *Adv. Space Res.* **3**, No. 5, 145-153 (1983).# (invited)
18. R.S. Subramanian, "Mathematical Techniques I - Separation of Variables," Module C4.1, **AIChEMI Modular Instruction Series C: TRANSPORT** (Ed. R.J. Gordon), Vol. **4. Mathematical Techniques and Energy Transport**, American Institute of Chemical Engineers, New York, 1983 (released in 1984).
19. R.S. Subramanian, "Mathematical Techniques II - Combination of Variables," Module C4.2, **AIChEMI Modular Instruction Series C: TRANSPORT** (Ed. R.J. Gordon), Vol. **4. Mathematical Techniques and Energy Transport**, American Institute of Chemical Engineers, New York, 1983 (released in 1984).
20. R.S. Subramanian, "Miscible Dispersion," Module C6.2, **AIChEMI Modular Instruction Series C: TRANSPORT** (Ed. R.J. Gordon), Vol. **6. Transport Phenomena -- Special Topics**, American Institute of Chemical Engineers, New York, 1986.
21. R.S. Subramanian and M.C. Weinberg, "The Role of Surface Tension in Glass Refining," *Glastech. Berichte*, **56K**, Bd. 1., 76-81 (1983). #
22. K. Jayaraj, R. Cole, and R.S. Subramanian, "Motion Driven by the Interface," Proceedings of the 15th National SAMPE (Society for Advancement of Materials and Process Engineering) Technical Conference, October 1983. #
23. R.S. Subramanian, "Of Drops and Bubbles -- The Technology of Space Processing," *Perspectives in Computing*, **4**, No. 2/3, 4-19 (1984) (invited).
24. P.A. Kondos, R.S. Subramanian, and M.C. Weinberg, "The Dissolution or Growth of a Gas Bubble Inside a Drop in Zero Gravity," in **Materials Processing in the Reduced Gravity Environment of Space** (Eds. R.H. Doremus, P.C. Nordine), Materials Research Society Symposium Proceedings, Vol. **87**, 1987, pp. 261-269. #
25. R.S. Subramanian, "The Behavior of Multiphase Systems in Low Gravity," in **Low Gravity Sciences** (Ed. J.N. Koster), American Astronautical Society, 1987, pp. 69-76.

26. R.M. Merritt and R.S. Subramanian, "Bubble Migration Under the Combined Action of Buoyancy and Thermocapillarity," **Microgravity Fluid Mechanics**, IUTAM Symposium, Bremen 1991, Springer-Verlag, 1992, pp. 237-244. #
27. R.S. Subramanian, "Thermocapillary Motion of Bubbles and Drops," **Microgravity Fluid Mechanics**, IUTAM Symposium, Bremen 1991, Springer-Verlag, 1992, pp. 393-403 (invited). #
28. S.V. Babu, R. A. Mackay, R.S. Subramanian, and A.A. Busnaina, "Some Fundamental and Technological Aspects of Chemical-Mechanical Polishing of Copper Films - a Brief Review," Proceedings of CMP-MIC conference, Santa Clara, CA, 1998. #
29. G. Wozniak, R. Balasubramaniam, P.H. Hadland, and R.S. Subramanian, "Temperature Fields in a Liquid due to the Thermocapillary Motion of Bubbles and Drops," Proc. International Conference on Microgravity Fluid Physics and Heat Transfer (Ed. V. Dhir, J. Straub, Y. Fujita), Oahu, Hawaii, September 1999, Begell House, Inc. New York, 2000. #
30. P. Ch. Zielke, R.S. Subramanian, J.A. Szymczyk, and J.B. McLaughlin, "Movement of Drops on a Solid Surface due to a Contact Angle Gradient," PAMM (Proc. in Applied Math. Mech) **2**, No. 1, 390-391 (2003). #
31. R. Balasubramaniam and R. S. Subramanian, "Thermocapillary Convection in a Spherical Container due to a Stationary Bubble," Adv. Space Res. **32**, No. 2, 137-142 (2003). #
32. R. Balasubramaniam and R. S. Subramanian, "Thermocapillary Migration of a Drop: An Exact Solution with Newtonian Interfacial Rheology and Stretching/Shrinkage of Interfacial Area for Small Marangoni Numbers," in **Transport Phenomena in Microgravity** (Ed. S. S. Sadhal), Ann. N. Y. Acad. Sci. **1027**, 303-310 (2004). #
33. J.B. McLaughlin, S. S. Saravanan, N. Moumen, and R.S. Subramanian, "Molecular Dynamics Simulations of Drop Motion on Uniform and Non-Uniform Solid Surfaces," in **IUTAM Symposium on Computational Approaches to Multiphase Flow** (Eds. S. Balachandar and A. Prosperetti), Springer, 2006, pp. 109-118. #

## CONTRIBUTED ORAL PRESENTATIONS

1. W.N. Gill, G.Y. Lee, P. Hsieh, and R. Sankarasubramanian\*, "Dispersion of Material and Thermal Pollutants and Oxygenation in Open Channel Systems," 5th Northeast Regional Meeting of the American Chemical Society, Rochester, New York, October 1973.
2. R.S. Subramanian and W.N. Gill\*, "Unsteady Convective Diffusion in Non-Newtonian Flows," Conference on Chemical Engineering Rheology, University of Salford, Salford, England, September 1974.
3. R.J. Nunge and R.S. Subramanian\*, "Dispersion From a Continuous Source Into the Atmosphere -- Pollution Model of a City," AIChE National Meeting, Houston, Texas, March 1975.
4. R.S. Subramanian, "Hydrodynamic Amplification of Field Separations," 51st Annual Colloid and Surface Science Symposium, Grand Island, New York, June 1977.
5. R.S. Subramanian, "Hydrodynamic Amplification of Colloid Separations," short talk, Gordon Conference on Separation and Purification, New London, New Hampshire, August 1977.
6. M.D. Mattox, H.D. Smith\*, W.R. Wilcox, and R.S. Subramanian, "The Migration of Bubbles in Molten Glass due to Thermal Gradients," American Ceramic Society Spring Meeting, Detroit, Michigan, May 1978.
7. K. Jayaraj and R.S. Subramanian\*, "Relaxation Phenomena in Field-Flow Fractionation," 52nd Annual Colloid and Surface Science Symposium, Knoxville, Tennessee, June 1978.
8. R.S. Subramanian\* and R. Cole, "Space Shuttle Experiments in Glass Processing," AIChE 71st Annual Meeting, Miami Beach, Florida, November 1978.
9. R.S. Subramanian\* and R. Cole, "A Study of Physical Phenomena in Containerless Glass Processing," AIAA 17th Aerospace Sciences Meeting, New Orleans, Louisiana, January 1979.
10. R.S. Subramanian\* and R. Cole, "Space Shuttle Experiments on Containerless Glass Processing," American Ceramic Society 81st Annual Meeting, Cincinnati Ohio, May 1979.
11. R.S. Subramanian\* and W.R. Wilcox, "The Migration of Fluid Droplets and Their Interaction in a Thermal Gradient," UAH/NASA Workshop on the Fluids Experiment System, Huntsville, Alabama, July 1979.
12. P. Annamalai, R.S. Subramanian, and R. Cole\*, "Rotation as a Centering Mechanism for Microballoon Fusion Targets," Topical Meeting on Inertial Confinement Fusion, c/o Optical Society of America, San Diego, California, February 1980.
13. M.C. Weinberg\* and R.S. Subramanian, "Dissolution of Multicomponent Bubbles in Glass Melts," American Ceramic Society 82nd Annual Meeting, Chicago, Illinois, April 1980.

---

\* Author presenting paper

14. R.B. Jucha, R. Cole\*, and R.S. Subramanian, "Bubble Rise in Low-Melting Glasses," American Ceramic Society Glass Division Meeting, Bedford Springs, Pennsylvania, October 1980.
15. M.C. Weinberg\* and R.S. Subramanian, "Gas Bubble Dissolution with a Chemically Reactive Gas," American Ceramic Society 33rd Pacific Coast Regional Meeting, San Francisco, California, October 1980.
16. R.S. Subramanian and R. Cole\*, "Glass Processing in Space," Workshop on Containerless Processing, General Electric Space Center, Valley Forge, Pennsylvania, October 1980.
17. P. Annamalai, R.S. Subramanian, and R. Cole\*, "Bubble Migration in a Rotating Liquid-Filled Sphere," AIChE 73rd Annual Meeting, Chicago, Illinois, November 1980.
18. R.S. Subramanian\* and M.C. Weinberg, "Asymptotic Expansions for Gas Bubble Dissolution," AIChE 73rd Annual Meeting, Chicago, Illinois, November 1980.
19. M. Meyyappan\*, W.R. Wilcox, and R.S. Subramanian, "Interaction Effects in Thermocapillary Bubble Migration in a Space Laboratory," AIChE 73rd Annual Meeting, Chicago, Illinois, November 1980.
20. R.S. Subramanian, "The Thermocapillary Migration of a Bubble in a Large Body of Liquid," European Mechanics Colloquium 138, Karlsruhe, West Germany, March 1981.
21. T.J. McNeil, R. Cole, W.R. Wilcox, and R.S. Subramanian\*, "An Investigation of Surface Tension Driven Flows in Glassmelts," American Ceramic Society 83rd Annual Meeting, Washington, D.C., May 1981.
22. P. Annamalai, N. Shankar, R. Cole\*, and R.S. Subramanian, "Bubble Migration Inside a Liquid Drop," Symposium on Mechanics and Physics of Bubbles in Liquids, California Institute of Technology, Pasadena, California, June 1981.
23. R.S. Subramanian and R. Cole\*, "Transport Phenomena in Space Processing," Society of Engineering Science 18th Annual Meeting, Brown University, Rhode Island, September 1981.
24. T.J. McNeil\*, R. Cole, W.R. Wilcox, and R.S. Subramanian, "Thermocapillary Convection in a Cylindrical Zone," 2nd World Congress of Chemical Engineering, Montreal, Canada, October 1981.
25. R.B. Jucha, D. Powers, T. McNeil, R.S. Subramanian, and R. Cole\*, "Bubble Rise in Molten Glasses," 2nd World Congress of Chemical Engineering, Montreal, Canada, October 1981.
26. N. Shankar\*, R. Cole, and R.S. Subramanian, "Thermocapillary Migration of a Gas Bubble Eccentrically Located Inside a Liquid Drop," AIChE 74th Annual Meeting, New Orleans, Louisiana, November 1981.
27. R.B. Jucha, D. Powers, T.J. McNeil, R.S. Subramanian, and R. Cole\*, "Bubble Rise in Glass Melts," AIChE 74th Annual Meeting, New Orleans, Louisiana, November 1981.

28. M. Meyyappan, W.R. Wilcox, and R.S. Subramanian\*, "Interaction Effects in Thermocapillary Bubble Migration," International Colloquium on Drops and Bubbles, Monterey, California, November 1981.
29. T.J. McNeil, R. Cole, and R.S. Subramanian\*, "Surface-Tension Driven Flow in Glassmelts and Model Fluids," Materials Research Society Annual Meeting, Boston, Massachusetts, November 1981.
30. P. Annamalai, R.S. Subramanian, and R. Cole\*, "Bubble Motion in a Rotating Liquid Body," Materials Research Society Annual Meeting, Boston, Massachusetts, November 1981.
31. M. Meyyappan, R.S. Subramanian, W.R. Wilcox\*, and H.D. Smith, "Bubble Behavior in Molten Glass in a Temperature Gradient," Materials Research Society Annual Meeting, Boston, Massachusetts, November 1981.
32. N. Shankar, R. Cole, and R.S. Subramanian\*, "Thermocapillary Motion of Bubbles Inside Drops," Materials Research Society Annual Meeting, Boston, Massachusetts, November 1981.
33. H.D. Smith\*, D.M. Mattox, W.R. Wilcox, R.S. Subramanian, and M. Meyyappan, "Experimental Observation of the Thermocapillary Driven Motion of Bubbles in a Molten Glass under Zero Gravity Conditions," Materials Research Society Annual Meeting, Boston, Massachusetts, November 1981.
34. T. Wiltshire, N. Shankar\*, and R.S. Subramanian, "Dissolution or Growth of a Sphere," AIChE 75th Annual Meeting, Los Angeles, CA, November 1982.
35. T.J. McNeil, R. Cole\*, and R.S. Subramanian, "Surface Tension Driven Flow in Glass Melts and Model Fluids," AIChE 75th Annual Meeting, Los Angeles, CA, November 1982.
36. R.S. Subramanian\* and M.C. Weinberg, "Surface Tension Effects in Glass Refining," International Congress on Glass, Hamburg, West Germany, July 1983.
37. K. Jayaraj, R. Cole, and R.S. Subramanian\*, "Motion Driven by the Interface," 15th National SAMPE Technical Conference, Cincinnati, Ohio, October 1983.
38. N. Balsara and R.S. Subramanian\*, "The Role of Buoyancy Driven Flows in the MCVD Process for Optical Fiber Preparation," 86th Annual Meeting of the American Ceramic Society, Pittsburgh, Pennsylvania, May 1984.
39. J.E. Peluso and R.S. Subramanian\*, "Buoyancy Induced De-centering of Hollow Glass Microballoons," 86th Annual Meeting of the American Ceramic Society, Pittsburgh, Pennsylvania, May 1984.
40. N. Balsara and R.S. Subramanian\*, "Buoyancy Effects in the Transport and Deposition of Aerosol Particles in a Tube," 58th Colloid and Surface Science Symposium, Pittsburgh, Pennsylvania, June 1984.
41. K. Jayaraj, R. Cole, and R.S. Subramanian\*, "Thermocapillary Convection in a Pendant Drop," 58th Colloid and Surface Science Symposium, Pittsburgh, Pennsylvania, June 1984.

42. N. Shankar\* and R.S. Subramanian, "The Stokes Motion of a Gas Bubble in a Thermal Gradient -- Low to Moderate Marangoni Numbers," AIChE 77th Annual Meeting, San Francisco, California, November 1984.
43. R.S. Subramanian, "The Behavior of Drops and Bubbles in Low Gravity," AIChE National Meeting, Houston, Texas, March 1985.
44. D.L. Seefeldt and R.S. Subramanian\*, "The Migration of Droplets in a Thermal Gradient," AIChE 78th Annual Meeting, Chicago, Illinois, November 1985.
45. R.M. Merritt\* and R.S. Subramanian, "The Migration of a Gas Bubble in a Temperature Gradient," 3rd Annual Iroquois Fluids Conference, Syracuse University, Syracuse, New York, March 1986.
46. K.D. Barton, D.L. Seefeldt, and R.S. Subramanian\*, "Effect of Surface Tension Gradients on Droplet Motion," 191st ACS National Meeting, New York, New York, April 1986.
47. R.M. Merritt\* and R.S. Subramanian, "The Migration of a Gas Bubble Under the Combined Influence of Buoyancy and Thermocapillarity," AIChE 79th Annual Meeting, Miami Beach, Florida, November 1986.
48. P.A. Kondos, R.S. Subramanian\* and M.C. Weinberg, "The Dissolution or Growth of a Gas Bubble Inside a Drop in Zero Gravity," Materials Research Society Meeting, Boston, MA, December 1986.
49. R.M. Merritt and R.S. Subramanian\*, "The Migration of a Gas Bubble in a Vertical Temperature Gradient," AIAA Aerospace Sciences Meeting, Reno, Nevada, January 1987.
50. H.S. Kim and R.S. Subramanian\*, "The Influence of an Insoluble Surfactant on the Thermocapillary Migration of a Droplet," AIAA Aerospace Sciences Meeting, Reno, Nevada, January 1987.
51. R.M. Merritt\* and R.S. Subramanian, "The Migration of a Gas Bubble Normal to a Horizontal Surface in a Vertical Temperature Gradient," AIChE 80th Annual Meeting, New York, NY, November 1987.
52. K.D. Barton\* and R.S. Subramanian, "Thermocapillary Migration of Droplets," AIAA Aerospace Sciences Meeting, Reno, Nevada, January 1988.
53. D.S. Morton\* and R.S. Subramanian, "The Migration of a Compound Drop Under the Combined Influence of Gravity and Thermocapillarity," AIAA Aerospace Sciences Meeting, Reno, Nevada, January 1988.
54. K.D. Barton\* and R.S. Subramanian, "Droplet Motion in a Vertical Temperature Gradient," AIChE 81st Annual Meeting, Washington, DC, December 1988.
55. P.A. Kondos\*, R.S. Subramanian and M.C. Weinberg, "The Influence of an Insoluble Gas on the Dissolution or Growth of a Gas Bubble Inside a Drop in Zero Gravity," AIAA Aerospace Sciences Meeting, Reno, Nevada, January 1989.



56. K.D. Barton\* and R.S. Subramanian, "Migration of a Liquid Drop in a Vertical Temperature Gradient -- Interaction Effects Near a Horizontal Surface," Physicochemical Hydrodynamics (PCH-7) International Conference, Cambridge, Massachusetts, June 1989.
57. D.S. Morton\* and R.S. Subramanian, "The Thermocapillary Migration of a Compound Drop," Physicochemical Hydrodynamics (PCH-7) International Conference, Cambridge, Massachusetts, June 1989.
58. D.S. Morton\* and R.S. Subramanian, "Settling Compound Drops," AIChE 82nd Annual Meeting, San Francisco, California, November 1989.
59. M.C. Weinberg\* and R.S. Subramanian, "Measurement of Liquid-Liquid Surface Tension in Space," 4th International Otto Schott Colloquium, Jena, Germany, July 1990.
60. R.S. Subramanian\*, R.M. Merritt, and D.S. Morton, "Some Interesting Flow Structures in Thermocapillary Bubble Migration," AIChE 83rd Annual Meeting, Chicago, Illinois, November 1990.
61. H. Wei and R.S. Subramanian\*, "Interactions of Gas Bubbles in a Vertical Temperature Gradient," COSPAR/IAF Symposium, World Space Congress, Washington, D.C., September 1992.
62. H. Wei and R.S. Subramanian\*, "Interaction Effects Among Bubbles in Thermocapillary Migration," AIChE 85th Annual Meeting, Miami Beach, Florida, November 1992.
63. I. Rampall\* and R.S. Subramanian, "Flow Driven by Oscillatory Gravitational Fields in a Vertical Channel - Side Wall Effects," First International Conference on g-jitter, Potsdam, New York, June 1993.
64. R. Balasubramaniam\* and R.S. Subramanian, "Thermocapillary Bubble Migration -- The Asymptotic Problems for Large Marangoni Numbers," AIChE 86th Annual Meeting, St. Louis, Missouri, November 1993.
65. C.E. Lacy\* and R.S. Subramanian, "The Behavior of Drops in a Vertical Temperature Gradient -- Influence of Convective Transport of Energy," AIChE 87th Annual Meeting, San Francisco, California, November 1994.
66. P.A. Kondos\* and R.S. Subramanian, "Buoyant Flow Driven by a Time-Dependent Gravitational Field in a Two-Dimensional Cavity," AIChE 87th Annual Meeting, San Francisco, California, November 1994.
67. R. Balasubramaniam\*, C.E. Lacy, G. Wozniak, and R.S. Subramanian, "Experiments in Reduced Gravity on the Thermocapillary Motion of Bubbles and Drops," AIChE 88th Annual Meeting, Miami Beach, Florida, November 1995.
68. R. Balasubramaniam\* and R.S. Subramanian, "Thermocapillary Motion of Drops with Strong Internal Circulation," AIChE 90th Annual Meeting, Los Angeles, California, November 1997.
69. S.V. Babu\*, R. A. Mackay, R.S. Subramanian, and A.A. Busnaina, "Some Fundamental and Technological Aspects of Chemical-Mechanical Polishing of Copper Films - a Brief Review," CMP-MIC conference, Santa Clara, California, February 1998.

70. R.S. Subramanian\* and L. Zhang, "Some Transport Phenomena Issues in Chemical-Mechanical Polishing," Third Annual Chemical-Mechanical Polishing Conference, Lake Placid, New York, August 1998.
71. R.S. Subramanian\* and L. Zhang, "Transport Phenomena Issues in Chemical-Mechanical Polishing," Materials Research Society Spring meeting, San Francisco, California, April 1999.
72. G. Wozniak\*, R. Balasubramaniam, P.H. Hadland, and R.S. Subramanian, "Temperature Fields in a Liquid due to the Thermocapillary Motion of Bubbles and Drops," Microgravity Fluid Physics and Heat Transfer Conference, Oahu, Hawaii, September 1999.
73. R.S. Subramanian, "Motion of Drops and Bubbles due to Interfacial Tension Gradients," Howard Brenner Seventieth Birthday Symposium, Boston, MA, September 1999.
74. L. Zhang\*, R.S. Subramanian, and R. Balasubramaniam, "Asymptotic Analysis of the Motion of a Drop in a Vertical Temperature Gradient at Small Marangoni Number: The Critical Role of Inertia," AIChE 92<sup>nd</sup> Annual Meeting, Dallas, Texas, November 1999.
75. R.S. Subramanian\* and L. Zhang, "A Model of Transport Phenomena in Chemical-Mechanical Polishing," AIChE 92<sup>nd</sup> Annual Meeting, Dallas, Texas, November 1999.
76. R.S. Subramanian\*, R. Balasubramaniam, and G. Wozniak, "Thermocapillary Migration of Bubbles and Drops in Reduced Gravity," Symposium to Honor Eli Ruckenstein, AIChE 92<sup>nd</sup> Annual Meeting, Dallas, Texas, November 1999.
77. G. Wozniak\*, R. Balasubramaniam, and R.S. Subramanian, "Thermocapillary Bubble and Drop Motion – experiments versus Theory," 20<sup>th</sup> International Congress of Theoretical and Applied Mechanics, Chicago, August 2000.
78. P. Ch. Zielke\*, R.S. Subramanian, J.B. McLaughlin, and J.A. Szymczyk, "Movement of Liquid Drops due to a Contact Angle Gradient," Annual Scientific Conference GAMM 2002, Augsburg, Germany, March 2002.
79. R. Balasubramaniam\* and R.S. Subramanian, "Thermocapillary Convection Around a Stationary Bubble," 34<sup>th</sup> Scientific Assembly of COSPAR, Houston, Texas, October 2002.
80. N. Moumen\*, R.S. Subramanian, and J.B. McLaughlin, "Motion of drops on horizontal surfaces with wettability gradients," Thousand Islands Fluid Mechanics Meeting 2003, Alexandria Bay, New York, May 2003.
81. R. Balasubramaniam\* and R.S. Subramanian, "Thermocapillary Convection in Bubbles and Drops," Microgravity Transport Processes in Fluid, Thermal, Biological, and Material Sciences III, Davos, Switzerland, September 2003.
82. R. Balasubramaniam\* and R.S. Subramanian, "Thermocapillary Convection Around Moving and Stationary Bubbles in Reduced Gravity," ASM Annual Meeting, Pittsburgh, PA, October 2003.

83. N. Moumen\*, R. S. Subramanian, and J. B. McLaughlin, "The Motion of a Drop on a Solid Surface due to a Wettability Gradient," AIChE 96<sup>th</sup> Annual Meeting, San Francisco, California, November 2003.
84. R. Balasubramaniam\* and R. S. Subramanian, "Thermocapillary Convection due to a Stationary Bubble – A Paradox," AIChE 96<sup>th</sup> Annual Meeting, San Francisco, California, November 2003.
85. J.B. McLaughlin\*, R.S. Subramanian, and S. S. Saravanan, "Molecular Dynamics Simulations of Drop Migration on Wettability Gradients," APS Meeting, Montreal, March 2004.
86. R. Balasubramaniam\* and R.S. Subramanian, "On the Translation of Bubbles and Drops with Heat Sinks in an Unbounded Isothermal Liquid," International Marangoni Association Congress-2, Brussels, Belgium, July 2004.
87. J.B. McLaughlin\*, Sp. S. Saravanan, N. Moumen, and R.S. Subramanian, "Modeling of Drop Motion on Solid Surfaces with Wettability Gradients," 12<sup>th</sup> International Coating Society and Technology Symposium, Rochester, September 2004.
88. J.B. McLaughlin\*, S. S. Saravanan, N. Moumen, and R.S. Subramanian, "Molecular Dynamics Simulations of Drop Motion on Uniform and Non-Uniform Solid Surfaces," IUTAM Symposium on "Computational Approaches to Disperse Multiphase Flow", Argonne National Laboratory, Illinois, October 2004.
89. J.B. McLaughlin\*, S. S. Saravanan, N. Moumen, and R.S. Subramanian, "Molecular Dynamics Simulations of Drop Motion on Surfaces with Wettability Gradients ," AIChE 97<sup>th</sup> Annual Meeting, Austin, Texas, November 2004.
90. N. Moumen\*, R. S. Subramanian, and J. B. McLaughlin, "Motion of Liquid Drops on a Horizontal Surface with a Wettability Gradient," 79<sup>th</sup> ACS Colloid and Surface Science Symposium, Clarkson University, Potsdam, New York, June 2005.
91. S. S. Saravanan\*, J. B. McLaughlin, and R.S. Subramanian, "Molecular Dynamics Simulations of Nanodrop Motion on Uniform and non-Uniform Surfaces," 79<sup>th</sup> ACS Colloid and Surface Science Symposium, Clarkson University, Potsdam, New York, June 2005.

## Poster Presentations

1. N. Shankar, M. Meyyappan, R. Cole, W.R. Wilcox, and R.S. Subramanian\*, "Some Interaction Effects in Thermocapillary Bubble Migration," European Mechanics Colloquium 138, Karlsruhe, West Germany, March 1981.
2. K. Jayaraj\*, R. Cole, and R.S. Subramanian, "Thermocapillary Convection in Pendant Drops," 2nd World Congress of Chemical Engineering, Montreal, Canada, October 1981.
3. M. Meyyappan\*, W.R. Wilcox, and R.S. Subramanian, "The Migration of Gas Bubbles in a Thermal Gradient -- Interaction Effects," 2nd World Congress of Chemical Engineering, Montreal, Canada, October 1981.
4. N. Shankar\*, R. Cole, and R.S. Subramanian, "Thermocapillary Migration of a Gas Bubble Inside a Liquid Drop in a Space Laboratory," 2nd World Congress of Chemical Engineering, Montreal, Canada, October 1981.
5. P. Annamalai, R.S. Subramanian, and R. Cole\*, "Bubble Migration in a Rotating, Liquid-Filled Sphere: Application to the Formation of Hollow Glass Laser Fusion Targets," 2nd World Congress of Chemical Engineering, Montreal, Canada, October 1981.
6. N. Shankar, P. Annamalai, R. Cole, and R.S. Subramanian\*, "The Motion of Bubbles Inside Drops in Containerless Processing," International Colloquium on Drops and Bubbles, Monterey, California, November 1981.
7. K.D. Barton\* and R.S. Subramanian, "Experimental Study of Droplet Motion in a Temperature Gradient," Gordon Research Conference on Gravitational Effects in Materials and Separation Processes, New London, New Hampshire, August 1987.
8. H.S. Kim\* and R.S. Subramanian, "Surfactant Effects on the Thermocapillary Motion of a Drop," Gordon Research Conference on Gravitational Effects in Materials and Separation Processes, New London, New Hampshire, August 1987.
9. D.S. Morton\* and R.S. Subramanian, "Compound Drop Motion," Gordon Research Conference on Gravitational Effects in Materials and Processes, Plymouth, New Hampshire, August 1989.
10. K.D. Barton\* and R.S. Subramanian, "Thermocapillary Migration of Drops," Gordon Research Conference on Gravitational Effects in Materials and Processes, Plymouth, New Hampshire, August 1989.
11. H. Wei\* and R.S. Subramanian, "Hydrodynamic Interaction Effects Between Gas Bubbles," AIChE 83rd Annual Meeting, Chicago, Illinois, November 1990.

---

\* Author presenting paper

12. P.A. Kondos\* and R.S. Subramanian, "The Effect of Buoyant Rise on the Dissolution of Gas Bubbles," Gordon Research Conference on Gravitational Effects in Physico-Chemical Systems, Plymouth, New Hampshire, June 1991.
13. H. Wei\* and R.S. Subramanian, "Bubble-Bubble Interactions," Gordon Research Conference on Gravitational Effects in Physico-Chemical Systems, Plymouth, New Hampshire, June 1991.
14. R.M. Merritt\* and R.S. Subramanian, "Bubble Migration Under the Combined Action of Buoyancy and Thermocapillarity," IUTAM Symposium on Microgravity Fluid Mechanics, Bremen, Germany, September 1991.
15. P.A. Kondos\*, R. Cole, R.S. Subramanian, and M.C. Weinberg, "The Dissolution of Gas Bubbles in a Glass Melt," AIChE 84th Annual Meeting, Los Angeles, California, November 1991.
16. N. Mallika and R.S. Subramanian\*, "Drop Motion in a Vertical Temperature Gradient," AIChE 84th Annual Meeting, Los Angeles, California, November 1991.
17. P.A. Kondos, R.S. Subramanian\*, R. Cole, and M.C. Weinberg, "The Effect of Gravitational Rise on the Dissolution of Helium Bubbles in a Glass Melt," Gordon Research Conference on Gravitational Effects in Materials and Processes, Henniker, New Hampshire, July 1993.
18. H. Wei\* and R.S. Subramanian, "The Migration of a Pair of Bubbles Due to the Combined Action of Gravity and Thermocapillarity," Gordon Research Conference on Gravitational Effects in Materials and Processes, Henniker, New Hampshire, July 1993.
19. S.K. Menon\* and R.S. Subramanian, "Stability of Compound Rotating Drops," AIChE 87th Annual Meeting, San Francisco, California, November 1994.
20. X. Ma\*, C.E. Lacy, R.S. Subramanian, and R. Balasubramaniam, "Behavior of Drops in a Vertical Temperature Gradient in a Fluid of Nearly the Same Density," Gordon Research Conference on Gravitational Effects in Physicochemical Systems, Henniker, New Hampshire, July 1995.
21. P.A. Kondos\* and R.S. Subramanian, "Natural Convection Inside a Rectangular Cavity Under the Influence of a Sinusoidal Gravity Signal," Gordon Research Conference on Gravitational Effects in Physicochemical Systems, Henniker, New Hampshire, July 1995.
22. X. Ma\*, R.S. Subramanian, and R. Balasubramaniam, "Numerical Simulation of the Thermocapillary Motion of a Drop," Gordon Research Conference on Gravitational Effects in Physicochemical Systems, Henniker, New Hampshire, July 1997.
23. P.H. Hadland\*, R. Balasubramaniam, G. Wozniak, and R.S. Subramanian, "Thermocapillary Migration of Drops and Bubbles in Reduced Gravity -- Preliminary Results from LMS Flight Experiments," Gordon Research Conference on Gravitational Effects in Physicochemical Systems, Henniker, New Hampshire, July 1997.

24. X. Ma\*, R.S. Subramanian, and R. Balasubramaniam, "Behavior of Drops in a Vertical Temperature Gradient in Near-Neutrally Buoyant Systems," AIChE 90th Annual Meeting, Los Angeles, California, November 1997.
25. L. Zhang\*, R.S. Subramanian, and R. Balasubramaniam, "The Motion of a Gas Bubble Under the Combined Influence of Gravity and Thermocapillarity," Gordon Research Conference on Gravitational Effects in Physicochemical Systems, Henniker, New Hampshire, July 1999.
26. L. Zhang\* and R. S. Subramanian, "Heat Transfer Issues in Chemical-Mechanical Polishing," Fourth Annual International Conference on Chemical-Mechanical Polishing, Lake Placid, New York, August 1999.
27. L. Zhang and R. S. Subramanian\*, "A Model of Chemical-Mechanical Planarization of Copper Films in Hydrogen Peroxide Slurries Containing Glycine," Fifth Annual International Conference on Chemical-Mechanical Polishing, Lake Placid, New York, August 2000.
28. L. Guo\* and R. S. Subramanian, "Mechanical Removal Rates in CMP of Copper Using an Alumina Slurry -- Preliminary Results," Fifth Annual International Conference on Chemical-Mechanical Polishing, Lake Placid, New York, August 2000.
29. S. Jain\*, D. Rasmussen, R.S. Subramanian, and D. B. James, "Characterization of Surface Properties of Polishing Pads," Fifth Annual International Conference on Chemical-Mechanical Polishing, Lake Placid, New York, August 2000.
30. L. Guo\* and R. S. Subramanian, "Mechanical Removal Rates in CMP of Copper Using an Alumina Slurry," Sixth Annual International Conference on Chemical-Mechanical Polishing, Lake Placid, New York, August 2001.
31. S. Jain, D. Rasmussen, R.S. Subramanian\*, and D. B. James, "Characterization of the Surface Properties of Polishing Pads," Sixth Annual International Conference on Chemical-Mechanical Polishing, Lake Placid, New York, August 2001.
32. R. S. Subramanian and R. Appat\*, "A Preliminary Model of Chemical-Mechanical Polishing of Patterned Wafers with a Fixed Abrasive Pad," Sixth Annual International Conference on Chemical-Mechanical Polishing, Lake Placid, New York, August 2001.
33. Q. Qin\* and R. S. Subramanian, "Some Issues in Modeling Chemical -Mechanical Planarization in an Orbital Tool," Seventh Annual International Conference on Chemical-Mechanical Polishing, Lake Placid, New York, August 2002.
34. R. Appat and R. S. Subramanian\*, "Chemical-Mechanical Polishing of Patterned Wafers with a Fixed Abrasive Pad," Seventh Annual International Conference on Chemical-Mechanical Polishing, Lake Placid, New York, August 2002.
35. Q. Qin\* and R. S. Subramanian, "Mechanical Removal Mechanism in Chemical-Mechanical Polishing," Eighth Annual International Conference on Chemical-Mechanical Polishing, Lake Placid, New York, August 2003.

36. H. Shodiev\*, R. S. Subramanian, I. Yu. Sokolov, N. Chechik, D. James, and M. Oliver, "Study of Forces Between Silica/Silicon Nitride AFM Tips and Polyurethane," Eighth Annual International Conference on Chemical-Mechanical Polishing, Lake Placid, New York, August 2003.
37. Q. Qin\* and R. S. Subramanian, "Experiments on Mechanical Removal in Chemical-Mechanical Polishing and a Model of the Removal Process," Ninth Annual International Conference on Chemical-Mechanical Polishing, Lake Placid, New York, August 2004.
38. Q. Qin\* and R. S. Subramanian, "Abrasive-free Chemical-Mechanical Polishing in an Orbital Tool," Ninth Annual International Conference on Chemical-Mechanical Polishing, Lake Placid, New York, August 2004.
39. N.G. Chechik, B. Mueller, D.B. James, Q. K. Ong, R.S. Subramanian, and I. Yu Sokolov, "Study of interaction between ceria particles and pad/wafers used in CMP polishing," Ninth Annual International Conference on Chemical-Mechanical Polishing, Lake Placid, New York, August 2004.
40. Q. Qin\* and R. S. Subramanian, "Experiments on Mechanical Removal of Teflon in a Bench-Top Polisher," Tenth Annual International Conference on Chemical-Mechanical Polishing, Lake Placid, New York, August 2005.

## **INVITED ORAL PRESENTATIONS ELSEWHERE**

American Ceramic Society Meeting, Indianapolis, Indiana, April 1994.

American Physical Society Annual Meeting, Kansas City, Kansas, March 1997

American Society of Mechanical Engineers International Joint Tribology Conference, Seattle, Washington, October 2000

Anna University, A.C. College of Technology, Madras, India, December 1987, January 1992, January 1996.

AIAA Meeting, Reno, Nevada, 1990.

ALCOA Technical Center, Pittsburgh, April 1993.

ATMI, Inc., Danbury, Connecticut, July 2001.

Bell Laboratories, Murray Hill, New Jersey, August 1984.

California Institute of Technology, February 1980, July 1980.

Carnegie-Mellon University, October 1978, April 1993.

Cornell University, September 1978, October 1984.

Corning Glass Works, Corning, New York, March 1978.

COSPAR XXIV Meeting, Symposium on Fundamental Aspects of Materials Sciences in Space, Ottawa, Canada, May 1982.

COSPAR XXV Meeting, Topical Meeting on Recent Scientific Results and Developments of Materials Science in Space, Graz, Austria, July 1984.

DFVLR, Goettingen, West Germany, July 1983.

Eastman Kodak Company, October 1980.

ESTEC (European Space Research and Technology Center), Noordwijk, The Netherlands, June 1984.

Fine Particle Society Meeting, Symposium on Multiphase Flow V, Chicago, August 1995

Fine Particle Society Meeting, Symposium on Intersections Between Transport Phenomena, Microfluidics, Biological Systems, and Biomed/Pharm Technology, San Diego, December 2006

Fluids in Space, Second European Symposium, Naples, Italy, April 1996

Gordon Conference, Plymouth, New Hampshire, June 1991.

Harvard University, September 2004, December 2004.

Indian Institute of Science, Bangalore, India, December 1987, January 1996.

Indian Institute of Technology, Kanpur, India, January 1988, January 1992.

Indian Institute of Technology, Madras, India, December 1987.

Indian Institute of Technology, New Delhi, India, January 1988.

IUTAM Symposium on Microgravity Fluid Mechanics, Bremen, Germany, September 1991.

Jet Propulsion Laboratory, January 1980.

KMS Fusion, Ann Arbor, Michigan, August 1981.

Lehigh University, March 1978, November 1990.

Levich Institute, City College of New York, September 1994

Los Alamos Scientific Laboratory, June 1978.

McGill University, Pulp and Paper Research Institute, July 1978.



NASA Lewis Research Center, Cleveland, Ohio, April 1989.

NASA Microgravity Fluids Workshop, Cleveland, Ohio, August 1990.

National Bureau of Standards, Boulder, Colorado, October 1986, April 1990.

National Bureau of Standards, Gaithersburg, Maryland, May 1981, May 1986.

Northwestern University, March 1984.

Pennsylvania State University, March 1984, April 1993.

Queens University, Canada, April 1986.

Rensselaer Polytechnic Institute, April 1983, June 2009.

Stanford University, March 1980.

Syracuse University, April 1984.

Tufts University, November 2004.

UIMP Summer School on Drops, Bubbles, and Particles, Santander, Spain, September 1996.

Universidad Politecnica de Madrid, October 1995.

Universitat Giessen, West Germany, March 1981, July 1983.

University College London, England, June 1984.

University of Arizona, April 1991.

University of California at Santa Barbara, June 1980.

University of Colorado, October 1986, April 1990.

University of Essen, West Germany, July 1983.

University of Florida, February 1977, November 1986.

University of Groningen, The Netherlands, October 1993.

University of Madras, A.C. College of Technology, India, January 1976.

University of Rhode Island, April 1985.

University of Rochester, June 1979, June 1980.

University of Washington, May 1980.

Virginia Polytechnic Institute and State University, December 1979.

Washington State University, April 1987.

Worcester Polytechnic Institute, April 1991.

Yale University, October 1981.

## **CONSULTING EXPERIENCE**

Westinghouse Research Laboratories, Pittsburgh, PA

Universities Space Research Association, Advisory Body to NASA

University of Alabama, Huntsville, AL (for NASA)

GTE Laboratories, Waltham, MA

GTE Sylvania Inc., Greenland, NH

Jet Propulsion Laboratory, Pasadena, CA

Battelle Columbus Division, Columbus, OH

## RESEARCH GRANTS AND CONTRACTS

	<b>Title</b>	<b>Source</b>	<b>Amount</b>	<b>Period</b>
R.S. Subramanian	A Study of Capillary Chromatography	PRF	\$9,000	1975-78
R.S. Subramanian	Undergraduate Research Participation	NSF	\$29,000	1977-78
R.S. Subramanian	Electrophoretic Separations	NSF	\$57,070	1976-78
R.S. Subramanian and R. Cole	Physical Phenomena in Containerless Glass Processing	NASA	\$1,259,973	1978-90
W.R. Wilcox and R.S. Subramanian	Glass Fining in Zero Gravity	Westinghouse Research, NASA Subcontract	\$72,950	1978-81
R.S. Subramanian and R. Cole	Experimental Studies of Glass Refining	Jet Propulsion Laboratory	\$135,000	1983-87
R.S. Subramanian	Capillary Effects in Droplet/Bubble Migration and Interactions	NSF	\$104,000	1984-87
R.S. Subramanian	GSRP*: Bubble Motion in a Temperature Gradient	NASA	\$54,000	1985-88
R. S. Subramanian	GSRP: Droplet Migration in a Temperature Gradient	NASA	\$54,000	1987-90
R.S. Subramanian	GSRP: Thermocapillary Bubble Migration in a Non-Uniformly Heated Drop	NASA	\$54,000	1987-90
R.S. Subramanian	Thermocapillary Migration and Interaction of Bubbles and Drops	NASA	\$1,378,490	1990-98

---

\* Graduate Student Researchers Program

	<b>Title</b>	<b>Source</b>	<b>Amount</b>	<b>Period</b>
R.S. Subramanian	Measurement of Liquid-Liquid Interfacial Tension and Phase Separation Kinetics of Glass Melts	U. Arizona/JPL	\$221,478	1990-94
R.S. Subramanian	Interactions of Bubbles and Drops in a Temperature Gradient	NASA	\$150,000	1993-96
R.S. Subramanian	Modeling of Chemical-Mechanical Polishing CAMP		\$ 30,000	1998-99
D.H. Rasmussen and R. S. Subramanian	Characterization of the Surface Properties of Polishing Pads	RODEL	\$40,300	1999-2000
R.S. Subramanian	Chemical-Mechanical Polishing	CAMP	\$15,000	2000
R.S. Subramanian	Synergy between Chemical and Mechanical Removal in CMP	CAMP	\$25,000	2000-2001
R.S. Subramanian	Some Fundamental Issues in Chemical-Mechanical Planarization	CAMP	\$93,000	2001-2005
R.S. Subramanian and J.B. McLaughlin	Motion of Drops on Surfaces with Wettability Gradients	NASA	\$394,700	2002-2006
I. Yu. Sokolov and R. S. Subramanian	Interactions Between CMP Slurry Particles and Polishing Pad/Wafer Surfaces	RODEL	\$160,000	2002-2004
I. Yu. Sokolov and R. S. Subramanian	Study of Nanoscale Physical and Mechanical Properties of Polishing Pads	ROHM & HAAS	\$65,000	2005

## THESES DIRECTED

15 Ph.D. and 19 M.S. completed. Details are given below.

### Ph.D. Theses

<b>Student</b>	<b>Title</b>	<b>Date of Completion</b>
T.J. McNeil	Thermocapillary Convection in Glass Melts and Model Fluids	1982
M. Meyyappan	Interaction Effects in Thermocapillary Bubble Migration	1984
K. Jayaraj	Thermocapillary Convection in Liquid Drops	1984
N. Shankar	Motion of Bubbles Due to Thermocapillary Effects	1984
R.M. Merritt	Bubble Migration and Interactions in a Vertical Temperature Gradient	1988
H.S Kim	Surfactant Effects on the Thermocapillary Migration of a Droplet	1988
K.D. Barton	Thermocapillary Migration of Drops	1990
D.S. Morton	The Behavior of Compound Drops	1990
P.A. Kondos	Bubble Behavior in Glass Melts	1993
H. Wei	Thermocapillary Bubble Migration and Interactions	1994
S.K. Menon	Shapes of Rotating Compound Drops and Their Stability	1995
X. Ma	Numerical Simulation and Experiments on Liquid Drops in a Vertical Temperature Gradient in a Liquid of Nearly the Same Density	1998

**Ph.D. Theses (continued)**

<b>Student</b>	<b>Title</b>	<b>Date of Completion</b>
L. Zhang	Motion of Drops Under the Combined Influence of Gravity and Thermocapillarity	2000
Q. Qin	Mechanical Removal Mechanism in CMP and Abrasive-free Copper CMP in an Orbital Polisher	2006
N. Moumen (jointly with J. B. McLaughlin)	Motion of Drops on a Solid Surface due to a Wettability Gradient	2006

**M.S. Theses**

R.Hemadri	Dispersion from a Short-Term Discharge into a Time-Variable Flow	1974
S. Berhe	Unsteady Convection Diffusion in an Annular Catalytic Reactor	1974
P. Renga Rajan	Atmospheric Dispersion of an Instantaneous Pollutant Release--A Three Dimensional Model	1975
S. Krishnamurthy	Exact Analysis of Field-Flow Fractionation	1976
T.J. McNeil	Hydrodynamic Amplification of Colloidal Separations	1978
K. Jayaraj	Relaxation Phenomena in Field-Flow Fractionation	1978
R.B. Jucha	Bubble Rise in Molten Glasses	1980
N.P. Balsara	The Transport and Deposition of Aerosol Particles in a Tube	1984
J.E. Peluso	The Motion a Bubble Executes Inside a Falling Liquid Drop	1984

**M.S. Theses (continued)**

<b>Student</b>	<b>Title</b>	<b>Date of Completion</b>
D.L. Fusco	Thermocapillary Droplet Migration	1986
M. Nallani	Droplet Migration in a Temperature Gradient	1991
C.V. Srividya	Migration of Fluorinert FC-75 Drops in a Silicone Oil in a Temperature Gradient	1993
H. Mariappan	Settling of Spheres in Viscoplastic Media	1997
P. Fekete	Time-Dependence of the Terminal Settling Velocity of Spheres in Carbopol Dispersions	1999
S. Jain (jointly with D.H. Rasmussen)	Characterization of the Surface Properties of Polishing pads	2001
L. Guo	Mechanical Removal in CMP of Copper using Alumina Abrasives	2003
R. Appat	Chemical-Mechanical Polishing of Patterned Wafers with a Fixed Abrasive Pad	2004
S. Saravanan (jointly with J. B. McLaughlin)	Molecular Dynamics Simulations of Motion of Liquid Drops on Horizontal Smooth Solid Surfaces	2005
V. Pratap	Thermocapillary Drop Motion on a Horizontal Solid Surface	2007

## **POST-DOCTORAL RESEARCH ASSOCIATES**

I. Rampall	Convection Induced by Transient Gravitational Fields	1992-93
C.E. Lacy	Thermocapillary Migration and Interactions in IML-2 Space Shuttle Experiments	1993-95
P.A. Kondos	Residual Convection Effects in Space Experiments	1993-95
K.R. Sharma	Thermocapillary Migration and Interactions	1995
P.H. Hadland	Thermocapillary Interactions in LMS Space Shuttle Experiments	1996-97



# CONTRIBUTIONS TO EDUCATION

## Courses Taught

### Undergraduate

Separation Processes  
Fluid Mechanics  
Heat Transfer  
Mass Transfer  
Transfer Process Fundamentals  
Advanced Fluid Dynamics and  
Heat Transfer  
Computer Programming  
Air Pollution Control  
Elementary Transport Phenomena

### Graduate

Transport Phenomena  
Advanced Transport Phenomena  
Advanced Mathematical Methods  
Advanced Fluid Mechanics  
Special Topics in Mass Transfer  
Special Topics in Fluid Mechanics  
Special Topics in Heat Transfer  
Transport Phenomena in Low  
Reynolds Number Flows

Coordinated the Chemical Engineering Graduate Seminar Program,  
1977-78, 81-82, 83-84, 85-86, 2001-02, 2004-07, Spring 2009, Spring 2010, Spring 2015,  
Fall 2015

## Special Course

“Transport Phenomena” -- a 15-hour Course Taught at NASA Marshall Space Flight Center,  
Huntsville, Alabama, August 1981.

## Developed notes for some topics in courses -- Web Sites for Notes

<http://web2.clarkson.edu/projects/subramanian/ch301/>

<http://web2.clarkson.edu/projects/subramanian/ch302/>

<http://web2.clarkson.edu/projects/subramanian/ch330/>

<http://web2.clarkson.edu/projects/subramanian/ch490/>

<http://web2.clarkson.edu/projects/subramanian/ch527/>

<http://web2.clarkson.edu/projects/subramanian/ch560/>

<http://web2.clarkson.edu/projects/subramanian/ch561/>

## DEPARTMENT AND UNIVERSITY SERVICE

Chemical Engineering Graduate Committee, 1975-79, 1982-86, 96-2000, 05-08  
(Chair, 78-79, 85-86, 98-99, 06-07, spring 08)

Chemical Engineering Undergraduate Curriculum Committee, 1973-76

Chemical Engineering Awards Committee, 1973-75, 1999-2000

Chemical Engineering Public Relations Committee, 1975-76

Faculty Committee for the compilation of the tenure file of Ian Ivar Suni, Chair, 1998

Advisor to Omega Chi Epsilon, 2000-02

Centennial Celebration Committee, Chair, 2002-03

Chemical Engineering web pages in-charge, 2008-16

Vice-Chairman, Environmental Science and Engineering Group, Clarkson, 1980-81

Advertising and Recruiting Sub-committee, Engineering (Chair, 1984-85)

Administrative Committee for Engineering Graduate Programs, 1985-1994

School of Engineering Task Force for the Middle States Association Self Study, 1986-87

School of Engineering Curriculum Revision Committee, 1995-96

Advisor to Tau Beta Pi, 2001- (Chief Advisor 2001-05)

School of Engineering Faculty Recruiting Committee, Chair, 2004

School of Engineering Faculty Advisory Committee to the Dean, 2008

Graduate and Research Committee of the Faculty Senate, 1976-78

Computing Advisory Committee of the Faculty Senate, 1974-76, 1980-82

Awards Committee of the Faculty Senate, 1981-85 (Chair, 83-84)

Ad Hoc Committee on Technologically Aided Instruction, 1977-79

Ad Hoc Committee on "Writing Across the Curriculum" Program, 1990-91

Ad Hoc Committee on Tenure and Promotions Policy, 1994-95

Ad Hoc Committee on Resources Allocation & Strategic Alliances, 1994-95

Administrative Council, 1986-1996

Honorary Degree Committee 2003-2004

Search Committee for Chair of Physics, 1983-85

Search Committee for Dean of Science, 1984-85

Search Committee for Chair of Chemistry, 1986-87

Search Committee for Dean of Engineering, 1986-87, 2000-01, 2002-03, 2006-07

Search Committee for Director of the Center for Advanced Materials  
Processing, 1989-91

Search Committee for Chair of Biology, 1993-94

Search Committee for Barney Clarkson Chair, 1995-96

Search Committee for Vice-President for Academic Affairs, 1996-97

Search Committee for Victor K. LaMer Chair (Chair), 1997-98

Search Committee for Milton Kerker Chair, 2005-06