Curriculum Vitae

Roberto Mauri

Professor of Chemical Engineering
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Biographical Data

Education

- Laurea (M.S.), Politecnico di Milano, Italy, 1976, Nuclear Engineering (cum laude).
- Ph.D., Technion, Haifa, Israel, 1984, Mechanical Engineering.

Academic and Professional Experience

- 1976-1977 - Politecnico di Milano, Italy, Institute of Quantum Electronics, Research Associate.
- 1977-1980 - Breda Termomeccanica and C.N.E.N. (Italian Committee for Nuclear Energy), Milano, Italy, Senior Scientist.
- 1980-1984 - Technion, Haifa, Israel, Department of Mechanical Engineering, Instructor.
- 1984-1986 - M.I.T., Cambridge, MA, Department of Chemical Engineering, Post-Doctoral Fellow.
- 1986-1999 - City College of CUNY, Department of Chemical Engineering. Assistant Professor, 1986-92; Associate Professor, 1993-97; Professor, 1997-99.
- 1999-Present - Università di Pisa, Italy, Department of Civil and Industrial Engineering, Laboratory of Reactive Multiphase Flows, Associate Professor, 1999-2004; Professor, 2004-Present. 2004-2012 – Director of the joint B.S.-M.S. Chemical Engineering program.

Main Scientific Interests

a) Modeling of multiphase flows and phase transition processes at the meso-scale. A wide program has been developed to provide a fundamental understanding of phenomena occurring within distances that are comparable to the thickness of the interfacial region, such as drop coalescence and break up. Using the so called phase field, or diffuse interface, model, we find that convective effects are induced by the Korteweg force, that is proportional to the chemical potential gradient. Accordingly, this force is null at thermodynamic equilibrium, while it becomes dominant out of

equilibrium, such as during phase transition processes. Results from numerical simulations based on this model are in excellent agreement with experimental data.

b) Study of macroscale effective properties of multiphase systems. In this research, we study the transport of mass, energy and momentum in systems that are multiphase at a microscopic level, although they are macroscopically homogeneous. From a theoretical point of view, the objective of this research is to determine effective parameters that can describe the systems macroscopically, even when the exact microscopic morphology is unknown. Using methods of statistical analysis, the following quantities have been determined: effective viscosity od suspensions; effective diffusivity and reactivity of a solute flowing in a pipe or through a porous material; thermal diffusion of bubbles; shear-induced diffusion in suspensions. In its experimental part, this research effort uses LDA techniques to determine the stochastic fluctuations of suspension morphology. In addition, effects such as viscous resuspension and accelerated sedimentation are studied, where shear-induced diffusion is used to solve industrial problems.

c) Developing a liquid-liquid extraction process using phase transition of liquid mixtures. In this research, we study the phase transition of liquid mixtures, induced by changes of temperature or composition. The research, both theoretical/numerical and experimental, led to the discovery that the separation following a phase transition is very rapid, even when the presence of surface active compounds could cause the formation of stable emulsions. This indicates that, contrary to common belief, phase segregation is not necessarily due to nucleation, with nuclei growing due to diffusion, but instead it can be driven by convection. This phenomenon was applied to develop two extraction processes, one to extract active compounds from fermentation broths, the other to extract metal ions from contaminated soils. Both applications have been patented in the U.S.A.

Teaching Experience

Instructor for the following courses:

- Chemical Engineering Thermodynamics
- Transport Phenomena
- Advanced Mass Transport (graduate)
- Nonequilibrium Thermodynamics in Complex Fluids (graduate)

Awards

- 1984 - Landau Prize, Tel Aviv.
- 1991 - Visiting Assistant Professor, Caltech, Pasadena, CA.
- 1997 - Visiting Professor, University of Milano.
- 1998 - The National Science Foundation included research on phase transition among activities of Primary National Interests in the U.S.A.
- 2009 - Visiting Professor, City University of New York.

Grants Awarded

1. National coordinator of the project: Theoretical, Computational and Experimental Study for the Development of Micromixers, MIUR, PRIN2009. Performance period: 2 years, from 2010 to 2012. Research Units: University of Brescia (Prof. GianPaolo Beretta); University of Udine (Prof. Alfredo Soldati); University of Pisa (Prof. Roberto Mauri). Amount of the Pisa research unit: € 62,700.

2. Co-responsible for the Pisa Research Unit of the project: Fluid-dynamic Study of Stirred Gas-Liquid Systems, MIUR, PRIN2005. Performance period: 2 years, from 2006 to 2008. National coordinator: Prof. Franco Magelli, University of Bologna. Amount of the Pisa research unit: € 60,000.

3. Responsible for the Pisa Research Unit of the project: Theoretical and Experimental Study of the Suspensions of Rigid Particles in Viscous Liquids, MIUR, PRIN2003. Performance period: 2 years, from 2004 to 2006. National coordinator: Prof. Lorenzo G. Gibilaro, University of l'Aquila. Amount of the Pisa research unit: € 50,200.

4. Co-Principal Investigator (together with Prof. R. Shinnar at the City College of CUNY, New York) of the project: Accelerated Coalescence in Phase Separation of Partially Miscible Solvents. U.S.A. National Science Foundation.
a. Performance Period: 2 years, from 2002 to 2004. Amount: $340,000.
b. Performance Period: 2 years, from 1999 to 2001. Amount: $223,433.
c. Performance Period: 3 years, from 1997 to 1999. Amount: $366,699.
d. Performance Period: 3 years, from 1993 to 1996. Amount: $234,874.

5. Co-Principal Investigator (together with Prof. A. Acrivos at the City College of CUNY, New York) of the project: The Rheology of Concentrated Suspensions, U.S.A. Department of Energy. Performance Period: 5 years, from 1995 to 1999. Amount: $564,345.

6. Co-Principal Investigator (together with Prof. A. Acrivos at the City College of CUNY, New York) of the project: Transport Processes in Two-Phase Macroscopically Homogeneous Systems, U.S.A. National Science Foundation.
a. Performance Period: 3 years, from 1994 to 1997. Amount: $292,805.
b. Performance Period: 2 years, from 1990 to 1992. Amount: $160,000.

7. Co-Principal Investigator (together with Prof. A. Acrivos, C. Maldarelli and C. Steiner at the City College of CUNY, New York) of the project: Rheometrics Fluid Spectrometer, National Science Foundation, Engineering Research Equipment Grant. 1992. Amount: $133,936.

List of Publication

Books

1. R. Mauri, Transport Phenomena in Multiphase Flows. Springer, Berlin (2015).
2. R. Mauri, Non-Equilibrium Thermodynamics in Multiphase Flows, Springer (2013).
3. R. Mauri, Ed., Multiphase Microfluidics: the Diffuse Interface Model. CISM International Centre for Mechanical Sciences, vol. 538, Springer (2012).
4. R. Mauri, Fenomeni di Trasporto (III ed.). PLUS, Pisa University Press (2014).
5. C. Rizzo and R. Mauri, Termodinamica per l'Ingegneria Chimica. DICCISM, Pisa (2000).

Articles

1. A. Bertei, B. Tellini, and R. Mauri, Dynamic transition of dendrite orientation in the diffusive spinodal decomposition of binary mixtures under a thermal gradient. Chem. Eng. Sci. 203, 450-463 (2019).
2. C. Galletti, A. Mariotti, L. Siconolfi, R. Mauri, and E. Brunazzi, Numerical investigation of flow regimes in T-shaped micromixers: benchmark between finite volume and spectral element methods. Can. J. Chem. Eng. 97, 528-541 (2019).
3. F. Califano, and R. Mauri, Phase segregation of metastable quenched liquid mixtures and the effect of quenching rate. Phys. Chem. Liq. 57, 251-258 (2019).
4. A. Lamorgese, and R. Mauri, Triphase separation of a ternary symmetric highly viscous mixture. Entropy 20 (12), 936 (2018).
5. A. Lamorgese, R. Mauri, and B. Tellini, Elettrochemical-thermal P2D aging model of a LiCoO2/graphite cell: capacity fade simulations. J. Energy Storage 20, 289-297 (2018).
6. F. Califano, and R. Mauri, Retardation of the phase segregation of liquid mixtures with a critical point of miscibilty. A.I.Ch.E. J. 64 (11), 4047-4052 (2018).
7. A. Mariotti, C. Galletti, R. Mauri, M.V. Salvetti, and E. Brunazzi, Steady and unsteady regimes in a T-shaped micro-mixer: synergic experimental and numerical investigation. Chem. Eng. J. 341, 414-431 (2018).
8. A. Lamorgese, and R. Mauri, Dissolution or Growth of a Liquid Drop via Phase-Field Ternary Mixture Model Based on the Non-Random, Two-Liquid Equation. Entropy 20 (2), 125 (2018).
9. A. Lamorgese, W. Ambrosini, and R. Mauri, Widom line prediction by the Soave-Redlich-Kwong and Peng-Robinson equations of state. J. Supercrit. Fluids 133, 367-371 (2018).
10. C. Galletti, A. Mariotti, L. Siconolfi, R. Mauri, and E. Brunazzi, Numerical investigation of flow regimes in T-shaped micromixers: benchmark between finite volume and spectral element methods. Can. J. Chem. Eng. (2018).

11. A. Lamorgese, and R. Mauri, Diffusion-Driven Dissolution or Growth of a Liquid Drop Embedded in a Continuous Phase of Another Liquid via Phase-Field Ternary Mixture Model. Langmuir, 33, 13125-13132 (2017).
12. R. Mauri, Flow through porous media: a momentum tracer approach. Meccanica 52, 2715-2734 (2017).
13. A. Lamorgese, and R. Mauri, Effect of viscosity ratio on structure evolution during mixing/demixing of regular binary mixtures. Chem. Eng. Trans. 57, 1225-1230 (2017).
14. C. Galletti, E. Brunazzi, L. Siconolfi, D. Spaltro, and R. Mauri, Mixing performance of arrow-shaped micro-devices. Chem. Eng. Trans. 57, 1309-1314 (2017).
15. A. Lamorgese, R. Mauri, and L. Sagis, Modeling soft interface dominated systems: A comparison of phase field and Gibbs dividing surface models. Phys. Rep. 675, 1-54 (2017).
16. A. Lamorgese, and R. Mauri, Phase-field modeling of mixing/demixing of regular binary mixtures with a composition-dependent viscosity. J. Appl. Phys. 121, 134302 (2017).
17. C. Galletti, E. Brunazzi, and R. Mauri, Unsteady mixing of binary liquid mixtures with composition-dependent viscosity. Chem. Eng. Sci. 164, 333-343 (2017).
18. A. Lamorgese, and R. Mauri, Spinodal decomposition of chemically reactive binary mixtures. Phys. Rev. E 94, 022605 (2016).
19. A. Lamorgese, and R. Mauri, Phase-field modeling of interfacial dynamics in emulsion flows: nonequilibrium surface tension. Int. J. Multiphase Flow 85, 167-172 (2016).
20. A. Lamorgese, and R. Mauri, Critical conditions for the buoyancy-driven detachment of a wall-bound pendant drop. Phys. Fluids 28, 032103 (2016).
21. R. Mauri, The principle of minimum resistance in non-equilibrium thermodynamics. Found. Phys. 46, 393-408 (2016).
22. A. Lamorgese, and R. Mauri, On the buoyancy-driven detachment of a wall-bound pendant drop: results of phase-field simulations. Chem. Eng. Trans. 43, 1849-1854 (2015).
23. A. Lamorgese, and R. Mauri, Buoyancy-driven detachment of a wall-bound pendant drop: interface shape at pinchoff and nonequilibrium surface tension. Phys. Rev. E 92, 032401 (2015).
24. A. Lamorgese, and R. Mauri, Nonequilibrium surface tension. AIP Conference Proceedings 1695, 020034 (2015).
25. C. Galletti, E. Brunazzi, and R. Mauri, Effect of composition-dependent viscosity of liquids on the performance of micro-mixers. Chem. Eng. Trans. 43, 1645-1650 (2015).
26. T. Andreussi, C. Galletti, R. Mauri, S. Camarri, and M.V. Salvetti, Flow regimes in T-shaped micro-mixers. Comput. Chem. Eng. 76, 150-159 (2015).
27. C. Galletti, G. Arcolini, E. Brunazzi, and R. Mauri, Mixing of binary fluids with composition-dependent viscosity in a T-shaped micro-device. Chem. Eng. Sci. 123, 300–310 (2015).
28. G. Orsi, and R. Mauri, Volume of mixing effect on fluid counter-diffusion. Phys. Fluids 25, 082101 (2013).
29. G. Orsi, C. Galletti, E. Brunazzi, and R. Mauri, Mixing of two miscible liquids in T-shaped microdevices. Chem. Eng. Trans. 23, 1471-1476 (2013).

30. G. Orsi, M. Roudgar, E. Brunazzi, C. Galletti, and R. Mauri, Water–ethanol mixing in T-shaped microdevices. Chem. Eng. Sci. 95, 174–183 (2013).
31. M. Roudgar, E. Brunazzi, C. Galletti, and R. Mauri, Numerical study of split T-micromixers. Chem. Eng. Technol. 35, 1291-1299 (2012).
32. J.M. Park, R. Mauri, and P.D. Anderson, Phase separation of viscous ternary liquid mixtures. Chem. Engng. Sci. 80, 270-278 (2012).
33. Galletti, M. Roudgar, E. Brunazzi, and R. Mauri, Effect of inlet conditions on the engulfment pattern in a T-shaped micro-mixer. Chem. Eng. J. 185-186, 330-313 (2012).
34. A. Lamorgese, D. Molin, and R. Mauri, Diffuse interface (D.I.) model for multiphase flows. In: Multiphase Microfluidics: the Diffuse Interface Model. CISM Courses and Lectures, vol. 538, Springer, p. 1-72 (2012).
35. J.M. Park, R. Mauri, and P.D. Anderson, Morphology of phase separating ternary liquid mixtures. In: Multiphase Microfluidics: the Diffuse Interface Model. CISM Courses and Lectures, vol. 538, Springer, p. 73-92 (2012).
36. A. Lamorgese, D. Molin, and R. Mauri, Phase field approach to multiphase flow modeling. Milan J. Math 79, 597-642 (2011).
37. A. Lamorgese, and R. Mauri, Liquid mixture convection during phase separation in a temperature gradient. Phys. Fluids 23, 034102 (2011).
38. A. Lamorgese, and R. Mauri, Diffuse-interface modeling of liquid-vapor phase separation in a Van der Waals fluid. Phys. Fluids 21, 044107 (2009).
39. A. Lamorgese, and R. Mauri, Spinodal decomposition of a Van der Waals fluid. Chem. Eng. Trans. 17, 549-554 (2009).
40. D. Molin, and R. Mauri, Spinodal decomposition of binary mixtures with composition-dependent heat conductivities. Chem. Eng. Sci. 63, 2402-2407 (2008).
41. A. Lamorgese, and R. Mauri, Diffuse-interface modeling of phase segregation in liquid mixtures. Int. J. Multiphase Flow, 34, 987-995 (2008).
42. D. Molin, and R. Mauri, Enhanced heat transport during phase separation of liquid binary mixtures. Phys. Fluids 19, 074102-1-10 (2007).
43. D. Molin, R. Mauri, and V. Tricoli, Experimental evidence of the motion of a single out-of-equilibrium drop. Langmuir 23, 7459-7461 (2007).
44. D. Leporini, and R. Mauri, Fluctuations of non-conservative systems. J. Stat. Mech. P03002 (2007).
45. R. Mauri, and D. Leporini, Violation of the fluctuation-dissipation theorem in confined driven colloids. Europhys. Lett. 76, 1022-1028 (2006).
46. P. Poesio, G. Cominardi, M. Lezzi, R. Mauri, and G.P. Beretta, Effects of quenching rate and viscosity on spinodal decomposition. Phys. Rev. E 74, 011507 (2006).
47. A. Lamorgese, and R. Mauri, Mixing of macroscopically quiescent liquid mixtures. Phys. Fluids 18, 044107 (2006).
48. C. Vannozzi, D. Fiorentino, M. D'Amore, D.S. Rumshitzki, A. Dress, and R. Mauri, A Cellular automata model of phase transition in binary mixtures. Ind. Eng. Chem. Res. 45, 2892-2896 (2006).
49. F. Califano, R. Mauri, and R. Shinnar, Large scale, unidirectional convection during phase separation of a density matched liquid mixture. Phys. Fluids 17, 094109-1-5 (2005).
50. G. Lamorgese, and R. Mauri, "Nucleation and spinodal decomposition of liquid mixtures. Phys. Fluids 17, 034107 (2005).

51. M.L. Coluccio, N. Barbani, A. Bianchini, D. Silvestri, and R. Mauri, Transport properties of EVA1-starch-α amylase membranes. Biomacromolecules 6, 1389-1396 (2005).
52. N. Vladimirova, and R. Mauri, Mixing of viscous liquid mixtures. Chem. Eng. Sci. 59, 2065-2069 (2004).
53. F. Califano, and R. Mauri, Drop size evolution during the phase separation of liquid mixtures. Ind. Eng. Chem. Res. 43, 349-353 (2004).
54. R. Mauri, Heat and mass transport in nonhomogeneous random velocity fields. Phys. Rev. E 68, 066306 (2003).
55. R. Mauri, The constitutive relation of suspensions of noncolloidal particles in viscous fluids. Phys. Fluids 15, 1888-1896 (2003).
56. R. Mauri, F. Califano, E, Calvi, R. Gupta, and R. Shinnar, Convection-driven phase segregation of deeply quenched liquid mixtures. J. Chem. Phys. 118, 8841-8846 (2003).
57. A.G. Lamorgese, and R. Mauri, Phase separation of liquid mixtures. In Nonlinear Dynamics and Control in Process Engineering – Recent Advances. G. Continillo, S. Crescitelli, M. Giona, eds., Springer, pp. 139-152 (2002).
58. R. Mauri, and D. T. Papageorgiou, The onset of particle segregation in plane Couette flows of concentrated suspensions. Int. J. Multiphase Flow 28, 127-136 (2002).
59. G. Santonicola, R. Mauri, and R. Shinnar, Phase separation of initially non-homogeneous liquid mixtures. Ind. Eng. Chem. Res. 40, 2004-2010 (2001).
60. Y. Wang, C. Rizzo, and R. Mauri, Thermocapillary migration in dilute polydisperse suspensions of bubbles. Chem. Eng. Commun. 185, 17-22 (2001).
61. R. Mauri, R. Shinnar, R. Gupta, Z. Ludmer, M. D'Amore, P. Ciambelli, and A. Volpe, Solvent extraction of metal ions from contaminated soils. AIChE. J. 47, 509-512 (2001).
62. N. Vladimirova, A. Malagoli, and R. Mauri, Two-dimensional model of phase segregation in liquid binary mixtures with an initial concentration gradient. Chem. Eng. Sci. 55, 6109-6118 (2000).
63. N. Vladimirova, A. Malagoli, and R. Mauri, "Two-dimensional model of phase segregation in liquid binary mixtures. Phys. Rev. E 60, 6968-6977 (1999).
64. Y. Wang, and R. Mauri, "The longitudinal drift velocity of a sheared dilute suspension of spheres. Int. J. Multiphase Flow 25, 875-885 (1999).
65. N. Vladimirova, A. Malagoli, and R. Mauri, Diffusio-phoresis of two-dimensional liquid droplets in a phase-separating system. Phys. Rev. E 60, 2037-2044 (1999).
66. R. Gupta, R. Mauri, and R. Shinnar, Phase separation of liquid mixtures in the presence of surfactants. Ind. Eng. Chem. Res. 38, 2418-2424 (1999).
67. N. Vladimirova, A. Malagoli, and R. Mauri, Diffusion-driven phase separation of deeply quenched mixtures. Phys. Rev. E 58, 7691-7699 (1998).
68. Y. Wang, R. Mauri, and A. Acrivos, Transverse shear-induced gradient diffusion in a dilute suspension of spheres. J. Fluid Mech. 357, 279-287 (1998).
69. R. Mauri, A new application of the reciprocity relations to the study of fluid flow through fixed beds. J. Engn. Math., 33, 103-112 (1998).
70. E. Apicella, M. D'Amore, G. Tardos, and R. Mauri, Onset of instability in sheared gas fluidized beds. AIChE J., 43, 1362-1365 (1997).

71. Y. Wang, R. Mauri, and A. Acrivos, A., Transverse shear-induced diffusion of spheres in a dilute suspension. J. Fluid Mech. 327, 255-272 (1996).
72. R. Gupta, R. Mauri, and R. Shinnar, Liquid-liquid extraction using the composition induced phase separation process. Ind. Eng. Chem. Res. 35, 2360-2368 (1996).
73. R. Mauri, and J. Rubinstein, On the propagator of the Stokes equation and a dynamical definition of viscosity. Chem. Eng. Comm. 148, 385-390 (1996).
74. S. Haber, and R. Mauri, "Brownian motion of continuous deformable bodies. Chem. Eng. Comm. 148, 73-84 (1996).
75. R. Mauri, R. Shinnar, and G. Triantafyllou, Spinodal decomposition in binary mixtures. Phys. Rev. E 53, 2613-2623 (1996).
76. R. Mauri, Heat and mass transport in random velocity fields with application to dispersion in porous media. J. Engn. Math 29, 77-89 (1995).
77. R. Mauri, Lagrangian self-diffusion of Brownian particles in periodic flow fields. Phys. Fluids 7, 275-284 (1995).
78. Acrivos, R. Mauri, and Y. Wang, Shear-induced particle diffusion in dilute suspensions: some recent theoretical results. In Mobile Particulate Systems. E. Guazzelli and L. Oger, eds., Kluwer, pp. 69-72 (1995).
79. Y. Wang, R. Mauri and A. Acrivos, Thermocapillary migration of a bidisperse suspension of bubbles. J. Fluid Mech. 261, 47-64 (1994).
80. Acrivos, X.C. Fan, and R. Mauri, "On the measurement of the relative viscosity of suspensions. J. Rheol. 38, 1285-1292 (1994).
81. Acrivos, R. Mauri, and X.C. Fan, "Shear-induced resuspension in a Couette device. Int. J. Multiphase Flow 19, 797-802 (1993).
82. Acrivos, G.K. Batchelor, E.J. Hinch, D.L. Koch, and R. Mauri, Longitudinal shear-induced diffusion of spheres in a dilute suspension. J. Fluid Mech. 240, 651-657 (1992).
83. R. Mauri, Dispersion, convection and reaction in periodic porous media. Phys. Fluids A 3, 743-756 (1991).
84. R. Mauri, and S. Haber, Time-dependent dispersion of small particles in rectangular conduits. SIAM J. Appl. Math. 51, 1538-1555 (1991).
85. S. Haber, and R. Mauri, Lagrangian approach to laminar dispersion in rectangular conduits. J. Fluid Mech. 190, 201-215 (1988).
86. J. Rubinstein, and R. Mauri, Dispersion and convection in periodic porous media. SIAM J. Appl. Math. 46, 1018-1023 (1986).
87. R. Mauri, and S. Haber, Applications of Wiener's path integral for the diffusion of Brownian particles in shear flows. SIAM J. Appl. Math. 46, 49-55 (1986).
88. S. Haber, and R. Mauri, "Boundary conditions for Darcy's flow through porous media", Int. J. Multiphase Flow 9, 561-574 (1983).

Technical Reports

1. R. Mauri, "Flow-Induced Vibrations in Heat Exchangers," CNEN Report 02-020 (1980).
2. R. Mauri, "Muspell: a Numerical Simulation of Shell-and-Tube Heat Exchangers," CNEN Report 02-015 (1979).
3. R. Mauri, "Film Condensation," CNEN Report 02-012 (1979).

4. R. Mauri and M. Sala, “Transit: a Computer Simulation for the Design of Spray Condensers,” CNEN Report 02-005 (1978).

Theses

- Ph.D. R. Mauri, On the Brownian Motion of Discrete and Continuous Bodies, Ph.D. Thesis, Technion, Israel (1984).

- Laurea. R. Mauri, Design of a Laser Microspectrofluorimeter for Fluorescence Decay Measurements in Biology, Tesi, Politecnico di Milano, Italy (1976).