CURRICULUM VITA
of
GANESAN NARSIMHAN

Education

Ph D	Chemical Eng.	1980	Indian Institute of Technology, Kanpur, India
M.S .	Chemical Eng.	1972	Indian Institute of Technology, Kanpur, India
B.S.	Chemical Eng.	1969	Indian Institute of Technology, Kharagpur, India

Professional Experience

Professor	Department of Agricultural & Biological Engineering, Purdue University, West Lafayette, IN 47907	1996-
Associate Professor	Department of Agricultural & Biological Engineering, Purdue University, West Lafayette, IN 47907	1992-1996
Assistant Professor	Department of Agricultural & Biological Engineering, Purdue University, West Lafayette, IN 47907	1986-1992
Lecturer	Department of Chemical Engineering, State University of New York at Buffalo, Buffalo, NY 14260	1983-1986
Visiting Assistant Professor	Department of Chemical Engineering, University of Notre Dame, Notre Dame, IN 46556	1982-1983
Visiting Assistant Professor	School of Chemical Engineering, Purdue University, West Lafayette, IN 47907	1979-1982

Awards and Honors

Outstanding Graduate Mentor – ABE Department	2016
Fellow, American Institute of Chemical Engineers	2010
Outstanding Engineering Teacher - ABE Department	1995
Outstanding Engineering Teacher - ABE Department	1997

Membership in Academic, Professional and Scholarly Societies

American Institute of Chemical Engineers	1982-present
American Society of Agricultural Engineers	1986-present
Institute of Food Technology	1989-present
Sigma Xi	1983-present
American Chemical Society	1992-present

CREATIVE ENDEAVOR, RESEARCH, SCHOLARSHIP

Research Accomplishments:

Dr. Narsimhan's main area of research is in Colloidal and Interfacial Phenomena with emphasis on the formation and stability of protein stabilized foams, emulsions and dispersions.
He has

- developed comprehensive mechanistic models for the formation, drainage and stability of foams.
- developed a model to relate the adsorption behavior of proteins at interfaces to their size, shape, structure and other molecular properties and has employed them to quantify the recovery of proteins from dilute solutions using foam fractionation.
- developed a model for stability of thin films to thermal and mechanical perturbations and has applied these to the prediction of foam stability.
- Characterized syneresis and collapse of food foams
- investigated the role of proteins and polysaccharides on the shelf life of emulsions
- has quantified the effect of conformation of globular proteins on interfacial rheological properties and emulsion stability
- investigated the effect of sterilization on the loss of rheology of polysaccharide solutions
- investigated the effect of thermal treatment on interfacial rheological properties of globular proteins
- investigated the effect of interdroplet forces on drop coalescence during high pressure homogenization
- investigated the gelation behavior of protein/polysaccharide mixtures
- characterized the adhesion of particles on food surfaces
- characterized the wettability of food surfaces modified by food emulsifiers
- characterized the secondary and tertiary conformational changes of globular proteins adsorbed on silica nanoparticle surfaces
- developed coarse grain algorithm molecular dynamics simulation for the prediction of tertiary conformation of globular proteins adsorbed on surfaces
- currently investigating the conformation of peptides tethered to surfaces using molecular dynamics simulation
- currently investigating pore formation of antimicrobial peptides on lipid bilayers
- currently investigating the effect of conformation of proteins on their ability to provide oxidative stability to food emulsions
- currently investigating pasting behavior of cross linked starch

Research Statement:

Dr. Narsimhan's main area of research is in Colloidal and Interfacial Phenomena with emphasis on the formation and stability of protein stabilized foams, emulsions and dispersions. He has developed comprehensive mechanistic models (i) for the formation, drainage and stability of foams (ii) to relate the adsorption behavior of proteins at interfaces to their size, shape, structure and other molecular properties and has employed them to quantify the recovery of proteins from dilute solutions using foam fractionation. He has also developed models for stability of thin films to thermal and mechanical perturbations and has applied these to the prediction of foam stability. In addition, he has also examined the role of proteins on the formation and shelf life of emulsions and is currently involved in the study of the secondary and tertiary conformational changes of proteins/enzymes adsorbed on nanoparticle surfaces using spectroscopy as well as molecular dynamics simulation.

He is one of the first to develop accurate models to predict complex interfacial phenomena in biological systems. His research has been the first to predict the kinetics of adsorption of proteins at air/liquid interfaces and its connection to the shape and structure of proteins (a.19, a.24, a.30, a.35, a.38, a.40, a.41, d.1). This is the first plausible quantitative description of protein adsorption in terms of its structure and composition. He has also investigated secondary and tertiary conformations of proteins (a.45, a.51) as well as competitive adsorption of proteins and surfactants (a.39, a.42). Dr. Narsimhan is also the first to develop a comprehensive model for the formation, drainage and stability of protein stabilized foams (a.17, a.25, a.50, a.53, a.54, a.55, a.57-a.60, c.1, c.2, c.7). He has developed a methodology for the analysis of rupture of thin films exposed to mechanical perturbations (a.54, a.59, a.60) which will be extremely useful in the prediction of loss of shelf life of foams due to transportation. His research on foam drainage and stability is important for (a) the prediction of the effect of formulation on the shelf life of food foams and (b) development of antifoaming agents in pharmaceutical and brewing industries. His research on the behavior of proteins at air/liquid interfaces and foam drainage has further led Dr. Narsimhan to develop foam fractionation for the recovery of proteins from dilute solutions. (a.7, a.8, a.13, a.14, a.15, a.22, a.28, a.32, c.6). Dr. Narsimhan's research on concentration/fractionation of proteins using foams has resulted in the development of a novel technique for the recovery of proteins from very dilute streams resulting in up to a 30% savings in process costs. Advantages of this technology over others are its high separation efficiency when used for dilute solutions (such as whey and potato wastewater) and its low capital and energy requirements.

Dr. Narsimhan has investigated the role of proteins and gums on the shelf life of emulsions (c.3, c.5). His research has quantified the effect of conformation of globular proteins on interfacial rheological properties and emulsion stability (a.44, a.53). He has also investigated the effect of processing conditions on the formation and shelf life of emulsions (a.26, a.27, a.29, a.45, b.1). Dr. Narsimhan is the first to quantify the effect of random mechanical perturbations on thin film stability (a.54, a.55, a.57, a.58, a.60) in order to simulate the effect of transportation on shelf life of emulsion and foam products. The results of these investigations will be essential for the development of new formulations and process strategies for the manufacture of emulsions with higher quality and texture. Based on his significant contributions to research on emulsions and foams, Dr. Narsimhan was invited to write four book chapters (b3, b6, b7, b8) giving an overview of the state of the art of research in these areas. His research has also quantified the effect of protein-polysaccharide interactions on the solubility of proteins (a.18), which has been applied to yield important information on the precipitation of proteins using polysaccharides (a.31, a.33, d.2). This research will help describe protein functionality in foods and will also be useful in the development of processes for the recovery of enzymes through precipitation in downstream bioprocessing.

Dr. Narsimhan has established collaborative research programs on emulsions and protein adsorption with professors D. Ramkrishna and E.I. Franses of the Department of Chemical Engineering. He has also collaborated with professor Stanley Hem of Industrial and Physical Pharmacy on shelf life of pharmaceutical emulsions(a.46) as well as on the rheology of polymer solutions(a. 47). His research has also served as the basis of two new graduate level courses, namely, *Colloidal Phenomena in Bioprocessing* and *Transport Phenomena in Food and Bioprocess Engineering*.

Professor Narsimhan is one of the five eminent engineers who were elected as *Fellow* of *American Institute of Chemical Engineers* on Jan 22, 2010. This award recognizes his attainments in the profession of Chemical Engineering as above those of his peers on the basis of his significant advances in the education of students, significant advances in Chemical Engineering research and significant service to the profession of Chemical Engineering. Dr. Narsimhan has organized an international conference of food engineers, which was attended by the majority of food engineers worldwide from 25 countries. He has organized several technical sessions on "Emulsions and Foams" and "Colloidal and Interfacial Phenomena in Foods" at the American Institute of Chemical Engineers Annual Meetings and was symposia chair for "Proteins at Interfaces" at the 2002 American Chemical Society Meeting. He also organized two sessions on "Food and Pharmaceuticals" at the joint Indian Institute of Chemical Engineers(IIChE)-AIChE joint meeting in Mumbai in Dec. 2004.

1. Publications

a. Refereed Journal Publications

1. Narsimhan G.; Gupta, J.P.; and Ramkrishna, D., A Model for Transitional Breakage Probability of Droplets in Agitated Lean Liquid-Liquid Dispersions. *Chem. Eng. Sci*., 34(2); 257-265, 1979.
2. Narsimhan, G.; Ramkrishna, D.; and Gupta, J.P., Analysis of Drop Size Distributions in Lean Liquid-Liquid Dispersions. *A.I.Ch.E. J*., 26(6); 991-1000, 1980.
3. Ramkrishna, D.; Narsimhan, G.; and Amundson, N, Boundary Value Problems in Transport with Oblique and Mixed Derivative Boundary Conditions. More on Steady State Solutions. *Chem. Eng. Sci.*, 36(1); 199-207, 1981.
4. Narsimhan, G.; Nejfelt, G.; and Ramkrishna, D., Breakage Functions for Droplets in Agitated Liquid-Liquid Dispersions. *A.I.Ch.E. J*., 30(3); 457-467, 1984.
5. Narsimhan, G. and Ruckenstein, E., The Brownian Coagulation of Aerosols Over the Entire Range of Knudsen Numbers: Connection between the Sticking Probability and the Interaction Forces. *J. Colloid Interface Sci*., 104(2); 344-369, 1985.
6. Narsimhan, G. and Ruckenstein, E., Monte Carlo Simulation of Brownian Coagulation Over the Entire Range of Particle Sizes from Near Molecular to Colloidal: Connection Between Collision Efficiency and Interparticle Forces. *J. Colloid Interface Sci*., 107(1); 174-193, 1985.
7. Narsimhan, G. and Ruckenstein, E., Hydrodynamics, Enrichment, and Collapse in Foams. *Langmuir,* 2(2); 230-238, 1986.
8. Narsimhan, G. and Ruckenstein, E., Effect of Bubble Size Distribution on the Enrichment and Collapse in Foams. *Langmuir*, 2(4); 494-508, 1986.
9. Narsimhan, G. and Ruckenstein, E., Dissociation Kinetics of Doublets of Aerosol Particles. *J. Colloid Interface Sci*., 116(1); 278-287, 1987.
10. Narsimhan, G. and Ruckenstein, E. A Possible Nucleation Type of Mechanism for the Growth of Small Aerosol Particles. *J. Colloid Interface Sci*., 116(1); 288-295, 1987.
11. Das, P.; Ramkrishna, D.; and Narsimhan, G., Effect of Mass Transfer on Droplet Breakup in Stirred Liquid-Liquid Dispersions. *A.I.Ch.E. J*., 33(11); 1899-1902, 1987.
12. Narsimhan, G. and Ruckenstein, E., A New Approach for the Prediction of the Rate of Nucleation in Liquids. *J. Colloid Interface Sci.,* 128(2); 549-565, 1989.
13. Brown, L.; Narsimhan, G.; and Wankat, P., Foam Fractionation of Globular Proteins. *Biotechnology and Bioengineering,* 36(9); 947-959, 1990.
14. Uraizee, F. and Narsimhan, G., Foam Fractionation of Proteins and Enzymes I. - Applications. *Enzyme Microbial Technology*, 12(3); 232-233, 1990.
15. Uraizee, F. and Narsimhan, G., Foam Fractionation of Proteins and Enzymes. II. - Performance and Modeling. *Enzyme Microbial Technology,* 12(4); 315-316, 1990
16. Narsimhan, G. and Ruckenstein, E., On the Smoluchowski Limit in Brownian Coagulation. *J. Colloid Interface Sci.*, 138(1); 294, 1990.

17. Narsimhan, G., A Model for Unsteady State Drainage of a Static Foam. *J. Food Eng*., 14(2); 139-165, 1991.

18. Guo, M. and Narsimhan, G., Solubility of Globular Proteins in Polysaccharide Solutions. *Biotechnology Progress*, 7(1); 54-59, 1991.

19. Uraizee, F. and Narsimhan, G., A Surface Equation of State for Globular Proteins at Air-Water Interface. *J. Colloid Interface Sci.*, 146(1); 169-178, 1991.

20. Xiong, X.; Narsimhan, G.; and Okos, M.R., Effect of Composition and Pore Structure on Binding Energy and Effective Diffusivity of Moisture in Porous Food. *J. Food Eng.*, 15(3); 187-208, 1991.

21. Narsimhan, G. Maximum Disjoining Pressure in Protein Stabilized Concentrated Oil-in-Water Emulsions. *Colloids and Surfaces*, 62(1); 41-55, 1992.

22. Uraizee, F. and Narsimhan, G., Effect of Coalescence on the Performance of Continuous Foam Fractionation Column. *Separations Sci. Tech.*, 27(7); 937-953, 1992.

23. Sathyagal, A. and Narsimhan, G., On Rupture of Thinning Film of Non Newtonian Power Law Liquid. *Chem. Eng. Comm*. 111; 161-175, 1992.

24. Narsimhan, G. and Uraizee, F., Kinetics of Adsorption of Globular Proteins at Air-Water Interface. *Biotechnology Progress,* 8(3); 187-196, 1992.

25. Germick, R.; Rehill, A.S.; and Narsimhan, G., Experimental Investigation of Static Drainage of Protein Stabilized Foams - Comparison with Model. *J. Food Eng*., 23(4); 555-578, 1994.

26. Sathyagal, A.; Ramkrishna, D.; and Narsimhan, G., Solution of Inverse Problems in Population Balances II; Particle Breakup. *Computers in Chemical Eng*. 19(4); 437-451, 1995.

27. Ramkrishna, D.; Sathyagal, A.; and Narsimhan, G., Analysis of Dispersed Phase Systems; A Fresh Perspective. *A.I.Ch.E. J*., 41(1); 35-44, 1995.

28. Uraizee, F. and Narsimhan, G., A Model for Continuous Foam Concentration of Proteins; Effects of Kinetics of Adsorption and Coalescence of Foam. *Separation Science and Technology,* 30(6); 847-881, 1995.

29. Sathyagal, A.N.; Ramkrishna, D.; and Narsimhan, G., Droplet Breakage in Stirred Dispersions. Breakage Functions from Experimental Drop Sized Distributions. *Chemical Engineering Science*, 51(9); 1377-1391, 1996.

30. Cho, D.; Narsimhan, G.; and Frances, E.I., Adsorption Dynamics of Native and Alkylated Derivatives of Bovine Serum Albumin at Air-Water Interfaces. *J. Colloid Interface Science*, 178(1); 348-357, 1996.

31. Guo, M. and Narsimhan, G., A Model for the Prediction of Precipitation Curves for Globular Proteins with Non-ionic Polymers as the Precipitating Agent. *Separation Science and Technology*, 31(13); 1777-1804, 1996.

32. ‡ Uraizee*, F. and Narsimhan*, G., Effects of Kinetics of Adsorption and Coalescence of Continuous Foam Concentration of Proteins. Comparison of

Experimental Results with Model Predictions. *Biotechnology and Bioengineering*, 51(4); 384-398, 1996.

33. Guo, R.; Guo, M.; and Narsimhan, G., Thermodynamics of Precipitation of Globular Proteins Using Non-Ionic Polymers. *Ind. Eng. Chem. Research*, 35(9); 3015-3026, 1996.
34. Kumar, S.; Narsimhan, G.; and Ramkrishna, D., Coalescence in Creaming Emulsions. Existence of a Pure Coalescence Zone. *Ind. Eng. Chem. Research*, 35(9); 3155-3162, 1996.
35. Cho.D.; Franses, E.I.; and Narsimhan, G., Effect of Diffusional Losses on the Formation of Monolayers of Soluble Proteins at Air/Water Interfaces with the Trunit's Method. *Colloids and Surfaces*,117(1); 45-54, 1996.
36. Narsimhan, G., Foam Formation and Stabilization. *Current Opinion in Colloid and Interface Sci*. 1(6):759-763. 1996.
37. Mohan, S., and G. Narsimhan. Coalescence of Protein Stabilized Emulsions in a High Pressure Homogenizer. *J. Colloid Interface Science*, 192, 1-15, 1997.
38. Cho, D., G. Narsimhan, and E.I. Franses. Adsorption Dynamics of Native and Pentylated Bovine Serum Albumin at Air-Water Interfaces - Surface Concentration/Surface Pressure Measurements. *J. Colloid Interface Science* **191**, 312-325, 1997.
39. Cho, D., G. Narsimhan and E.I. Franses, Interactions of Spread Lecithin Monolayers with Bovine Serum Albumin in Aqueous Solution, *Langmuir*, **13**, 4710-4715, 1997.
40. Cornec, M. and G. Narsimhan, Effect of Contaminant on Adsorption of Whey Proteins at Air-Water Interfaces. *J. Agricultural and Food Chemistry*, **46**,2490-2498, 1998.
41. Cornec, M., D. Cho and G. Narsimhan. Adsorption Dynamics of α-lactalbumin and β-lactoglobulin at Air-Water Interfaces. *J. Colloid Interface Sci*, **214**, 129-142, 1999.
42. Cornec, M. and G. Narsimhan. Adsorption and Exchange of β-lactoglobulin onto Spread Monoglyceride Monolayers at the Air-Water Interface. *Langmuir*, **16**:1216-1225, 2000.
43. Neogi, P. and G. Narsimhan, On Oswald Ripening of Oil-in-Water Microemulsion, *Chemical Engineering Sci*., **56**,4225-4231, 2001.
44. Narsimhan,G. and Goel. P., 2001. Drop Coalescence during Emulsion Formation in a High-Pressure Homogenizer for Tetradecane-in-Water Emulsion Stabilized by Sodium Dodecyl Sulfate. *J. Colloid Interface Sci*., **238**,420-432, 2001.
45. Cornec, M., Kim, D. and Narsimhan, G., Adsorption Dynamics and Interfacial Properties of α-lactalbumin in Native and Molten Globule State Conformation at Air-Water Interface. *Food Hydrocolloids*,**15**,303-313, 2001.
46. Pongcharoenkiat, N., Narsimhan, G. ,Lyons, R.T. and Hem, S., The Effect of Surface Charge and Partition Coefficient on the Chemical Stability of Solutes in O/W Emulsions. *J. Pharmaceutical Sci*., **91**, 559-570, 2002

47. Bindal, A., Narsimhan, G., Hem, S. and Kulshreshta, A., Effect of Steam Sterilization on Rheology of Polymer Solutions., *Pharmaceutical Dev. & Techn.,* **8**(3),219-228, 2003

48. Fonkwe, L., Narsimhan, G. and Cha, Alice S., Characterization of Gelation Time and Texture of Gelatin and Gelatin-Polysaccharide Mixed Gels., *Food Hydrocolloids,* **17**,871-883, 2003

49. Narsimhan, G. Model for Drop Coalescence in a Locally Isotropic Turbulent Flow Field, *J. Colloid Interface Sci.*, **272**, 197-209 (2004)

50. Wang, Z. and Narsimhan, G., Evolution of Liquid Holdup Profile in a Standing Protein Stabilized Foam, *J. Colloid Interface Sci,***280**(1),224-233(2004)

51. Kim, D., Cornec, M. and Narsimhan,G., Effect of Thermal Treatment on Interfacial Properties of β-lactoglobulin, *J. Colloid Interface Sci* ,**285** (1): 100-109 ,2005

52. Engggalhardjo,M. and Narsimhan,G. Adhesion of Dry Seasoning Particles Onto Tortilla Chip., *J. Food Sci.* ,**70** (3): E215-E222 ,2005

53. Wang ZB, and Narsimhan G, Interfacial dilatational elasticity and viscosity of beta-lactoglobulin at air-water interface using pulsating bubble tensiometry , *Langmuir,* **21** (10): 4482-4489, 2005

54. Narsimhan G Rupture of thin stagnant films on a solid surface due to random thermal and mechanical perturbations, *J. Colloid Interface Sci*, **287** (2): 624-633, 2005

55. Narsimhan G, Wang ZB, Stability of thin stagnant film on a solid surface with a viscoelastic air-liquid interface, *J. Colloid Interface Sci*, **291** (1): 296-302, 2005

56. Lim,H.S. and Narsimhan,G., Pasting and Rheological Behavior of Soy Protein-Based Pudding, Lebensmittel-Wissenschaft und Technologie/Food Science and Technology, 39(4), 344-350 , 2006

57. Narsimhan,G and Wang, Z.B, Effect of interfacial mobility on rupture of thin stagnant films on a solid surface due to random mechanical perturbations, *Journal of Colloid and Interface Science,* **298**(1), 491-496, 2006

58. Wang, Z.B. and Narsimhan, G., Model for Plateau border drainage of power law fluid with mobile interface and its application to foam drainage, *Journal of Colloid and Interface Science,* **300**(1), 327-337, 2006

59. Narsimhan,G and Wang, Z.B, Rupture of equilibrium foam films due to random thermal and mechanical perturbations, *Colloids and Surfaces A: Physicochemical and Engineering Aspects, ,* **282-283**, 24-36, 2006

60. Wang, Z.B. and Narsimhan, G., Rupture of draining foam films due to random pressure fluctuations, *Langmuir* **23**(5), 2437-2443, 2007

61. Bindal, A., Narsimhan, G., Hem, S. and Kulshreshta, A., Structural changes in xanthan gum solutions during steam sterilization for sterile preparations, *Pharmaceutical Dev. & Techn.,* **12**(2),159-168, 2007

62. Indrawati, L., Stroshine, R.L. and Narsimhan, G., Low field NMR- a tool for studying protein aggregation, *J. Food Sci. and Agriculture* **87**, 2207-2216,2007

63. Wang, Z., Narsimhan, G. and Kim, D., Characterization of the Effect of Food Emulsifiers on Contact Angle and Dispersibility of Lipid Coated Neutrally Buoyant Particles", *Lebensmittel-Wissenschaft und Technologie/Food Science and Technology* , **41**(7),1232-1238,2008
64. Wu, X, Narsimhan, G. Characterization of secondary and tertiary conformational changes of β lactoglobulin on silica nanoparticle surfaces, *Langmuir*, **24**(9),4989-4998,2008
65. Indrawati, L., Wang, Z., Narsimhan, G., Gonzalez, J., Effect of processing parameters on Foam formation using a continuous system with a mechanical whipper, *J. Food Engineering* ,**88**(1),65-74,2008
66. Indrawati, L. and Narsimhan, G., Characterization of protein stabilized foam formed in a continuous shear mixing apparatus, *J. Food Engineering*,**88**(4),456-465,2008
67. Wu, X, Narsimhan, G. Effect of surface concentration on secondary and tertiary conformational changes of lysozyme adsorbed on silica nanoparticles, *Biochimica et Biophysica Acta - Proteins and Proteomics*, **1784**(11),1694-1701,2008
68. Narsimhan, G., Stability of thin emulsion film between two oil phases with viscoelastic liquid-liquid interface, *Journal of Colloid and Interface Science*, **330**,494-500,2009
69. Wu, X, Narsimhan, G. Coarse grain molecular dynamics simulation for the prediction of tertiary conformation of Lysozyme adsorbed on silica surface, *Molecular Simulation,* **35,** 974-985,2009
70. Narsimhan, G., Analysis of creaming and formation of foam layer in aerated liquid, *Journal of Colloid and Interface Science*, **345**,566-572, 2010
71. Wu, X, Narsimhan, G. Characterization of the Effect of Electrostatic Interaction on the Structure of Trp-cage using Molecular Dynamics Simulation, *Molecular Simulation,* **36**, Issue 13, 1086 – 1095, 2010
72. Bi, L.,Yang, L.,Narsimhan, G.,Bhunia, A. K. and Yao, Y., Designing carbohydrate nanoparticles for prolonged efficacy of antimicrobial peptide, *Journal of Controlled Release*, 150(2),150-156,2011
73. Narsimhan,G., Model for growth of bubbles during proofing of viscoelastic dough, *Bubble Science Engineering and Technology*, 4(2), 63-71, (2012)
74. Wu,X, Chang, H., Mello, C, Nagarajan, R. and Narsimhan, G., Effect of interaction with coesite silica on the conformation of Cecropin P1 using explicit solvent molecular dynamics simulation, *J. Chem. Phys*., 138(4),045103 (2013)
75. Phoon, P.Y, Narsimhan, G. and San Martin-Gonzalez, M.F., Effect of Thermal Behavior of beta-Lactoglobulin on the Oxidative Stability of Menhaden Oil-in-Water Emulsions, *J. Agricultural and Food Chem*., 61(8),1954-1967 (2013)
76. Narsimhan, G., A mechanistic model for baking of unleavened aerated food, *LWT-Food Science and Technology*, 53(1), 146-155 (2013)

77. Phoon, P.Y., San Martin-Gonzalez, M.F and Narsimhan, G., Effect of hydrolysis of soy beta-conglycinin on the oxidative stability of O/W emulsions, *Food Hydrocolloids*, 35, 429-443 (2013)

78. Narsimhan, Ganesan. "A mechanistic model for baking of leavened aerated food." *Journal of Food Engineering* 143: 80-89 (2014)

79. Phoon, Pui Yeu, et al. "Effect of Cross-Linking of Interfacial Sodium Caseinate by Natural Processing on the Oxidative Stability of Oil-in-Water (O/W) Emulsions." *Journal of agricultural and food chemistry* 62.13: 2822-2829 (2014)

80. Zhou, Lu, Ganesan Narsimhan, Xiayou Wu, and Fengpei Du. "Pore formation in 1, 2-dimyristoyl-sn-glycero-3-phosphocholine/cholesterol mixed bilayers by low concentrations of antimicrobial peptide melittin." *Colloids and Surfaces B: Biointerfaces* 123, 419-428 (2014)

81. Ruckenstein, Eli, Gersh O. Berim, and Ganesan Narsimhan. "A novel approach to the theory of homogeneous and heterogeneous nucleation." *Advances in Colloid and Interface Science* ,**215**,13-27(2015)

82. Lyu,Y.,Zhu,X.,Xiang,N. and Narsimhan,G., "Molecular Dynamics Study of Pore Formation by Melittin in a 1,2-Dioleoyl-sn-glycero-3-phosphocholine and 1,2-Di(9Z-octadecenoyl)-sn-glycero-3-phospho-(1′-rac-glycerol) Mixed Lipid Bilayer" *Industrial Engineering Chemistry Research*, **54**.42 (2015): 10275-10283.

83. Chen, H., Narsimhan, G. and Yao, Y. "Particulate structure of phytoglycogen studied using beta-amylolysis, *Carbohydrate Polymers*, 132, 582-588 (2015)

84. Narsimhan, G., "Characterization of interfacial rheology of protein stabilized air-liquid interfaces", *Food Engineering Reviews*, **8**,367-392 (2016)

85. Xiang, N., Lyv, Y. and Narsimhan, G., "Characterization of fish oil in water emulsion produced by layer by layer deposition of soy β-conglycinin and high methoxyl pectin" *Food Hydrocolloids,* **52**,678-689 (2016)

86. Eren, Necla Mine, Ganesan Narsimhan, and Osvaldo H. Campanella. "Protein adsorption induced bridging flocculation: the dominant entropic pathway for nano-bio complexation." *Nanoscale* ,**8**,3326-3336 (2016).

87. Narsimhan, Ganesan. "Drainage of particle stabilized foam film." *Colloids and Surfaces A: Physicochemical and Engineering Aspects* **495** (2016): 20-29.

88. Xi Wu, Atul K. Singh, Xiaoyu Wu, Yuan Lyu, Arun K. Bhunia and Ganesan Narsimhan, "Characterization of antimicrobial activity against Listeria and cytotoxicity of native melittin and its mutant variants", *Colloids and Surfaces B Biointerfaces*, **143**,194-205 (2016)

89. Xiang, N., Lyv, Y. Zhu, X., Bhunia, A.K. and Narsimhan, G., "Methodology for identification of pore forming antimicrobial peptides from soy protein subunits β-conglycinin and glycinin", *Peptides*, **85**,27-40 (2016)

90. Wu, Xi, and Ganesan Narsimhan. "Synergistic effect of low power ultrasonication on antimicrobial activity of melittin against Listeria monocytogenes." *LWT-Food Science and Technology* 75 (2017): 578-581.

91. Wu, X., Wei, P. H., Zhu, X., Wirth, M. J., Bhunia, A., & Narsimhan, G. (2017). Effect of immobilization on the antimicrobial activity of a cysteine-terminated antimicrobial Peptide Cecropin P1 tethered to silica nanoparticle against E. coli O157: H7 EDL933. *Colloids and Surfaces B: Biointerfaces*, 156, 305-312.

92. Xiang, N., Lyu, Y., Zhu, X., Bhunia, A. K., & Narsimhan, G. (2017). Effect of physicochemical properties of peptides from soy protein on their antimicrobial activity. *Peptides*, 94, 10-18.

93. Lyu, Y., Xiang, N., Zhu, X., & Narsimhan, G. (2017). Potential of mean force for insertion of antimicrobial peptide melittin into a pore in mixed DOPC/DOPG lipid bilayer by molecular dynamics simulation. *The Journal of chemical physics*, 146(15), 155101.

94. Wang, J., Qiu, C., Narsimhan, G., & Jin, Z. (2017). Preparation and Characterization of Ternary Antimicrobial Films of β-Cyclodextrin/Allyl Isothiocyanate/Polylactic Acid for the Enhancement of Long-Term Controlled Release. *Materials*, 10(10), 1210.

95. Desam, G. P., Li, J., Chen, G., Campanella, O., & Narsimhan, G. (2018). A mechanistic model for swelling kinetics of waxy maize starch suspension. *Journal of Food Engineering*, 222, 237-249.

96. Xiang, N., Lyu, Y., Zhu, X., & Narsimhan, G. (2018). Investigation of the interaction of amyloid β peptide (11–42) oligomers with a 1-palmitoyl-2-oleoyl-sn-glycero-3-phosphocholine (POPC) membrane using molecular dynamics simulation. *Physical Chemistry Chemical Physics* .DOI: 10.1039/c7cp07148e

97. Zhang, M. K., Lyu, Y., Zhu, X., Wang, J. P., Jin, Z. Y., & Narsimhan, G. (2018). Enhanced solubility and antimicrobial activity of alamethicin in aqueous solution by complexation with γ-cyclodextrin. *Journal of Functional Foods*, 40, 700-706.

b. Book Chapters

1. Narsimhan, G. On Static Drainage of Protein Stabilized Foam in Food Polymers, Gels and Colloids, Special Publication No. 32, Royal Society of Chemistry. E. Dickinson (ed.), pp. 207-226, 1990.

2. Narsimhan, G, Unsteady State Drainage of a Standing Foam. A.I.Ch.E. Symp. Series, No. 277, 86, 76-86, 1990.

3. Narsimhan, G., Emulsions *in* Proceedings of IFT-IUFoST Basic Symposium on Physical Chemistry of Foods, ed. H.G. Schwartzberg.and R.W. Hartell, Marcel Dekker, Inc., New York, pp 307-386, 1992.

4. Okos*, M.; Narsimhan*, G.; Singh, R.; and Weitnauer, A.C., Food Dehydration *in* Handbook of Food Engineering. ed. Heldman and Lund.Marcel Dekker, Inc., New York. pp 437-562, 1992.

5. ‡Rehill*, A. and Narsimhan*, G.. Effect of Interdroplet Forces on Centrifugal Stability of Protein Stabilized Concentrated Oil-in-Water Emulsions. ACS Symposium Series on Food Flavors and Safety, Molecular Analysis and Design. #528, pp. 229-247, 1993.

6. Uraizee, F.* and Narsimhan*, G., Foam Based Separation of Proteins. In IFT-IUFoST Basic Symposium on "Bioseparation Processes in Foods". ed. R. Singh & S. Rizvi, Marcel-Dekker Inc., New York pp. 175-226, 1995.
7. Narsimhan*, G. and Ruckenstein, E., Structure, Drainage and Coalescence of Foams and Concentrated Emulsions. In: Foams: Theory, Measurements & Applications., ed. R.K. Prud'homme and S.A. Khan, Marcel Dekker, Inc., N.Y. pp. 99-188, 1995.
8. Narsimhan, G. "Foam Fractionation of Proteins" in Encyclopedia of Separation Science, Academic Press. p 1513-1520, 2000.
9. Cornec, M., D. Cho and G. Narsimhan. Adsorption and Exchange of Whey Proteins onto Spread Lipid Monolayers, in *Emulsions, Foams and thin Films*, ed. ed. K.L.Mittal and P.Kumar, Marcel Dekker, p293-311, 2000.
10. Narsimhan, G., Surface Phenomena, in Food Engineering, Barbosa-Canovas, G.V., Ed. UNESCO Publishing, 2005, pp 191-213
11. Narsimhan, G. and Wang, Z., Surface Tension, in Encyclopedia of Agricultural and Food Engineering, ed. Dennis Heldman, Taylor and Franses, DOI: 10.1081/E-EAFE-120021381, Published on 14 August 2003, Pages 982 – 986
12. Narsimhan, G. and Wang, Z., Surface Activity, in Encyclopedia of Agricultural and Food Engineering, ed. Dennis Heldman, Taylor and Franses, DOI: 10.1081/E-EAFE-120007176, Published on 14 August 2003, Pages 968 – 971
13. Narsimhan, G. and Wang, Z., Colloidal interactions and stability of food dispersions, Encyclopedia of Agricultural and Food Engineering, Heldman (ed.), Taylor and Franses, DOI: 10.1081/E-EAFE-120042367, Published on 04 April 2007, Pages 1 – 4
14. Narsimhan, G. and Wang, Z., Stability of food emulsions, Encyclopedia of Agricultural and Food Engineering, Heldman (ed.), Taylor and Franses, DOI: 10.1081/E-EAFE-120043154, Published on 20 December 2007, pp1-5
15. Narsimhan, G. and Wang, Z. , Guidelines for Processing Emulsion Based Foods, in Food Emulsiefiers and Their Applications, 2nd Edition Ed. G.L. Hasselhuitti and R.W. Hartel, Springer, pp349-394,2008
16. Narsimhan, G., & Xiang, N. (2018). Role of Proteins on Formation, Drainage, and Stability of Liquid Food Foams. Annual review of food science and technology, 9.3.1

c. Conference Proceedings

1. Cho*, D.; Narsimhan*, G.; and Franses, E.I., 1995. Effect of Surface Hydrophobicity on the Kinetics of Adsorption of Bovine Serum Albumin at Air-Water Interfaces. Proceedings of 4h Conference of Food Eng., CoFE '95 , 1-5.
2. Guo*, R. and Narsimhan*, G., 1995. Phase Diagram for the Mixture of Globular Proteins and Non-Ionic Polymers. Proceedings of 4th Conference of Food Eng., CoFE '95 ,161-167.
3. Mohan, S., M. Cornec and G. Narsimhan, 1997. Coalescence of Food Emulsions in a High Pressure Homogenizer, Proceedings of the Second World Congress on Emulsion, 1-2-136.
4. Cornec, M., D. Cho and G. Narsimhan. 1997. Dynamics of Adsorption of α-lactalbumin and β-lactoglobulin at Air-Water Interfaces. New Frontiers in Food Engineering. Proceedings of the 5th Conference of Food Engineering, 117-122.

5. Uraizee. F. and G. Narsimhan. 1997. Foam Fractionation of Protein Mixtures: BSA-Lysozyme and β-casein-Lysozyme Systems. New Frontiers in Food Engineering. Proceedings of the 5th Conference of Food Engineering, 357-362.
6. Cornec, M., D. A. Kim and G. Narsimhan. 1999. The Dynamic Adsorption of Alpha-lactalbumin in Native and Molten Globule Conformation. *Proceedings of 6th Conference of Food Engineering (CoFE 99)*. G. G. Barbosa Canovas and S. P. Lombardo (eds.), p 621-626.

2. Graduate Research Involvement

a. Major Professor

Dates	Student	Deg.	Dept.	Thesis Topic
1986-1988	L. Brown	MS	CHE	Performance of a Novel Multistage Foam Fractionation Column for the Recovery of Proteins from the Effluents in Food Industry (Co-major with Prof. P.C. Wankat)
1987-1989	X. Xiong	MS	FS	Effects of Food Composition and Structure on its Water Binding Properties (Co-major with Prof. M.R. Okos).
1987-1991	F. Uraizee	PhD	ABE	Effects of Kinetics of Adsorption and Coalescence on Continuous Foam Concentration of Proteins.
1988-1993	M. Guo	PhD	ABE	Protein Precipitation using Nonionic Polymers
1989-1994	A. Sathyagal	PhD	CHE	Studies on Dispersed Phase Mass Transfer in Liquid-Liquid Dispersions (Co-major with Prof. D. Ramkrishna).
1991-1996	R. Guo	PhD	ABE	Phase Diagrams for the Mixture of Globular Proteins and Non-Ionic Polymers.
1993-1995	S. Mohan	MS	ABE	Effect of Processing Conditions on Drop Coalescence During the Formation of Protein-Stabilized Emulsions in a High Pressure Homogenizer.
1993-1996	D. Cho	PhD	CHE	Dynamics of Adsorption of Native and Alkylated Derivatives of Bovine Serum Albumin at Air-Water Interfaces. (Co-major with Prof. E.I. Franses).
1997-1999	P. Goel	M.S.	ABE	Effect of colloidal forces on the formation of food emulsion in a high pressure homogenizer
1997-1999	A. Bindal	M.S.	ABE	Effect of Steam Sterilization on Rheology of Polymer Solutions
1999-2001	A. Ray	M.S.	ABE	Effect of Protein-Surfactant Interaction on Emulsion Stability.
1998-2001	D. Kim	M.S.	ABE	Effect of Thermal Treatment on Emulsifying Properties of β-lactoglobulin.
2001-2004	Z. Wang	Ph.D	ABE	Drainage and Stability of Protein Stabilized Foams
2003-2004	M. Engelhardjo	M.S.	ABE	Adhesion of Seasoning Onto Baked and Fried Chips
2004-2006	L.Indrawati	M.S.	ABE	Formation of Protein Stabilized Foams
2004-2009	X. Wu	Ph.D	ABE	Conformational changes of proteins adsorbed onto nanoparticle surfaces

2005-	B. Odum	Ph.D	FS	Swelling Behavior of Starch Granules
2007-2009	M.Entorf	M.S.	ABE	Characterization of texture and stability of protein stabilized foams
2009-2011	H. Chang	M.S.	ABE	Conformation of polypeptides tethered to surfaces
2009-2011	L. Zhou	Ph.D.	ABE	Pore formation in lipid bilayers by antimicrobial peptides
2008-2011	Rei Phoon	Ph.D	FS	Effect of conformation of proteins on oxidative stability of food emulsions
2012-2016	Xi Wu	Ph.D	ABE	Pore formation in bacterial cells by antimicrobial peptides
2013-2017	Y. Luy	Ph.D	ABE	Antimicrobial peptides from soy proteins
2013-2017	N. Xiang	Ph.D.	ABE	Pore formation by antimicrobial peptides in lipid bilayer
2016-	Prasuna Desam	M.S.	ABE	Swelling Behavior of Starch Granules
2016-	Jinsha Li	Ph D	ABE	Pasting Behavior of Cross Linked Starch
2016-	Maya Frityanti	Ph D	ABE	Synergistic effect of antimicrobial peptides and ultrasound

B. Post-Doctoral Associate

		Project Title
1993-96	S. Gupta	Shelf Life of Food Emulsions. (with Prof. D. Ramkrishna). 50% supervision.
1996-99	M. Cornec	Competitive Adsorption of Proteins and Emulsifiers at Air-Water Interface.
1996-98	D. Cho	Adsorption Characteristics of Meat Proteins onto Cellulose Casing.
1999--2000	L. Fownkwe	Gelation Characteristics of Gelatin and other Mixed Polysaccharide Gels.
2003-2005	H. Lim	Gelation Characteristics of Soyprotein Polysaccharide Mixed Gels
2004-2006	Z. Wang	Characterization of Neutrally Buoyant Particles in Fortified Foods
2008-2009	S. H. Kim	Characterization of foams stabilized by Biomacromolecules
2009-2012	X. Wu	Conformation of polypeptides using molecular dynamics simulation

C. Visiting Scholars

2016-	M.Zhang	Complexation of curcurmin with alamecithin
2016-2017	H.Mi	Effect of starch-lipid interactions on swelling
2016-2017	H.Hou	Identification of antimicrobial peptides from fish mucus
2017-	L.Zhu	Particle stabilized emulsions

3. Evidence of National and International Recognition

Professor Narsimhan has been active in the American Institute of Chemical Engineers and the American Chemical Society in the area of colloid and interfacial science for the last 20 years. He has organized fourteen technical sessions in the American Institute of Chemical Engineers, American Chemical Society and North American Mixing Conference (see Section 5b). He was coordinator of Food Engineering Division of the American Institute of Chemical Engineers (1994 - 1997). His duties include (i) the determination of number of sessions in the food engineering area, (ii) identification of the topics of the sessions and (iii) identification of session chairs and coordination of organization of the sessions at the American Institute of Chemical Engineers national and regional meetings. In addition to chairing and organizing numerous sessions, he was invited for technical presentations in national and international meetings (see Section 5a). He was the symposia chair for organizing a symposia consisting of several technical sessions on "Proteins at Interfaces" at the 2002 American Chemical Society meeting to be held in Orlando, FL. Professor Narsimhan was elected as *Fellow* of *American Institute of Chemical Engineers* on Jan 22, 2010 in recognition of his attainments in the profession of Chemical Engineering on the basis of his significant advances in the education of students, significant advances in Chemical Engineering research and significant service to the profession of Chemical Engineering.

Dr. Narsimhan organized the Fourth Conference in Food Engineering, an international bienniel conference held on Nov. 2-3, 1995 in Chicago. This conference was sponsored by the American Institute of Chemical Engineers and co-sponsored by (i) Institute of Food Technology (Food Engineering Division), (ii) American Society of Agricultural Engineers (Food Process Engineering Institute) and (iii) American Association of Cereal Chemistry (Engineering Division). Dr. Narsimhan was the editor of the proceedings of the conference.

Dr. Narsimhan is recognized as an expert in the area of "Food Emulsions and Foams" and was invited to write an article on "Foam Formation and Stabilization" in *Current Opinion in Colloid and Interface Science*, to present the current state of the art of research and future directions of research in that area. He was also invited to write book chapters on "Food Emulsions" (1b3), "Foam Based Separation of Proteins (1b6), "Foams and Concentrated Emulsions" (1b7) and "Foam Fractionation of Proteins" (1b8). He has also served as a consultant to several food and pharmaceutical companies such as Frito Lay, Nestle, Kraft Proctor and Gamble, Alcon and Nabisco.

Other evidence of international recognition is participation as an international expert in Engineering for the selection of research proposals sponsored by the Hong Kong University Grants Committee. Dr. Narsimhan has been invited to teach a short course on *Population Balances for Particulate Systems in Engineering* at UNS, CONCIET, Bahia Blanca, Argentina, December 2008.

a. Invited presentations include

1. *Correlating Composition and Structure to Isotherms, Diffusion Coefficients*. Department of Energy. Workshop on Drying Research Needs, June 26, 1989, Chicago.
2. *Solubility of Globular Proteins in Polysaccharide Solutions.* Royal Society of Chemistry Symposium on Food Polymers, Gels and Colloids. March 28-30, 1990. Norwich, England
3. *On Static Drainage of Protein Stabilized Foam*. Royal Society of Chemistry Symposium on Food Polymers, Gels and Colloids, March 28-30, 1990. Norwich, England.
4. *Emulsions*. At the IFT-IUFoST Basic Symposium on Physical Chemistry of Foods, May 30 - June 2, 1991. Dallas, TX
5. *Foam Based Separation of Proteins*. IFT-IUFoST Basic Symposium on Bioseparation Processes in Foods. June 24, 1994, Atlanta, GA.
6. *Droplet Breakage in Stirred Dispersions: Breakage Functions From Experimental Drop Size Distribution.* Bienniel North American Mixing Conference, June 20, 1995, Banff, Canada.

7. *Surface Phenomena in Foods*: Frito Lay, Dallas, TX, Nov 19,1999.
8. *Protein Adsorption at Interfaces*: Department of Chemical Engineering, Vanderbilt University, Nashville, TN, Nov 28,2000.
9. *Protein Adsorption and Foam Stabilization*., Society of Industrial Microbiology, St. Louis, June.2001.
10. *Protein Adsorption at Interfaces*, Joint Indian Institute of Chemical Engineers and AIChE Conference, Mumbai, Dec 2004
11. *Drainage and Stability of Foams*, seminar presentation at UNS, CONCIET, Bahia Blanca, Argentina, December 2008
12. Short course on *Population Balances for Particulate Systems in Engineering* at UNS, CONCIET, Bahia Blanca, Argentina, December 2008
13. *Characterization of Conformation of Proteins/Polypeptides Immobilized at Liquid-Solid Interfaces Using Molecular Dynamics Simulations* at Advances in bio/abio molecules at interfaces, University of Canterbury, Christchurch, New Zealand, June 2010

b. Sessions organized for professional meetings

1. "Colloids in Food and Biotechnology" at the 62nd Colloid and Surface Science Symposium sponsored by the American Chemical Society Division of Colloid and Surface Chemistry, June 19-22, 1988. The Pennsylvania State University.
2. "Colloidal and Interfacial Phenomena in Foods" at the American Institute of Chemical Engineers 1988 Summer National Meeting, August 21- 24. Denver, CO.
3. "Rheology, Stability and Dynamics of Food Foams" at the American Institute of Chemical Engineers 1989 National Meeting, November 5-10. San Francisco, CA.
4. "Colloidal and Interfacial Phenomena in Foods" at the American Institute of Chemical Engineers 1990 Summer National Meeting, August 19-22. San Diego, CA.
5. "Colloidal and Interfacial Phenomena in Foods" at the American Institute of Chemical Engineers 1991 Annual Meeting, November 17-22. Los Angeles, CA.
6. "Transport Phenomena in Dispersed Systems" at the 2nd Conference on Food Engineering, February 21-23, 1993. Chicago, IL.
7. "Food Engineering Fundamentals" at the American Institute of Chemical Engineers, 1993 Annual Meeting. St. Louis, MO.
8. "Liquid-Liquid Systems" at the Bienniel North American Mixing Conference, June 18-23, 1995. Banff, Canada.
9. Organized 4th Conference of Food Engineering, CoFE '95. The conference had 16 sessions and a poster session. Total of 92 oral presentations and 76 poster presentations were made at the conference. The proceedings of the conference is to be published with Dr. Narsimhan as the editor.
10. "Food Emulsions and Foams" at the American Institute of Chemical Engineers. 1997 Annual Meeting, Los Angeles, CA.
11. "Food Emulsions and Foams" at the American Institute of Chemical Engineers. 1998 Annual Meeting, Miami Beach, FL.
12. "Physicochemical Properties of Food Emulsions" at the 1999 IFT Annual Meeting, Chicago, IL.

13. "Food Emulsions and Foams" at the 1999 Annual AIChE Meeting, Dallas, TX.
14. "Emulsions and Foams" at the 2000 Annual AIChE Meeting, Los Angeles, CA. "Emulsions and Foams" at the 2001 Annual American Institute of Chemical Engineers Meeting, Reno, NE
15. "Rheology of Dispersions" at the 2001 Annual American Institute of Chemical Engineers Meeting, Reno, NE
16. "Food Emulsions and Foams" at the 7th Conference of Food Engineering, November 2001, Reno,NE
17. "Interfacial Effects in Mixing" at the 2002 Annual American Institute of Chemical Engineers Meeting, Indianapolis, IN
18. "Biomacromolecules at Interfaces" at the 2003 Annual American Institute of Chemical Engineers Meeting, San Fransisco, CA
19. "Interfacial Effects in Separations" at the 2003 Annual American Institute of Chemical Engineers Meeting, San Fransisco, CA
20. "Interfacial Effects in Mixing" at the 2003 Annual American Institute of Chemical Engineers Meeting, San Fransisco, CA
21. "Food and Pharmaceuticals I" at the Joint Indian Institute of Chemical Engineers and AIChE Conference, Mumbai, Dec 2004
22. "Food and Pharmaceuticals II" at the Joint Indian Institute of Chemical Engineers and AIChE Conference, Mumbai, Dec 2004

c. Papers reviewed for professional journals

1. Dr. Narsimhan has served as a technical reviewer for key journals in his research area.
    - Journal of Food Engineering
    - American Institute of Chemical Engineering Journal
    - Chemical Engineering Science
    - Biotechnology Progress
    - Journal of Food Science
    - Journal of Agricultural & Food Chemistry
    - Journal of Colloid and Interface Science
    - Langmuir
    - Separation and Purification Methods
    - Computers and Chemical Engineering
    - Cereal Chemistry
    - Biotechnology & Bioengineering)
    - Food Science & Technology International
    - Applied Engineering for Agriculture
    - American Chemical Society Symposium Series
2. Dr. Narsimhan has also served as a technical reviewer for proposals for the National Science Foundation and USDA
3. Dr. Narsimhan has reviewed a book "Measurement of Composition & Flow of Emulsions" for American Chemical Society Books Department.

4. Dr. Narsimhan has served as an international expert in Engineering for the selection of research proposals by the Hong Kong University Grants Committee.

EXCELLENCE IN TEACHING

Dr. Narsimhan's excellence in teaching was recognized by the students. Dr. Narsimhan won the departmental Outstanding Teacher (engineering) award in 1995 and 1997. In addition, he was nominated by the department for the Murphy award, a university-wide recognition of outstanding teachers.

The theoretical nature of Dr. Narsimhan's research gives him a unique ability and background to teach graduate students, principally at the Ph.D. level, on the application of advanced mathematics, engineering fundamentals, and computational methodology to solve biological engineering problems. His advanced course in *Colloidal Phenomena in Bioprocessing* is such an example. This course is unique because it is a synthesis of disparate concepts from rheology, colloids, hydrodynamics and statistical mechanics to explain the structure, stability and rheology of food and biological dispersions, emulsions and foams. This is the only course at Purdue which explains the role of macromolecules (proteins, polysaccharides and polymers) on the stability of dispersion, emulsions and foams. Graduate students from the Departments of Chemical Engineering, Food Science, as well as Agricultural and Biological Engineering have taken this course The course is invaluable in educating graduate students in the mental discipline required to carry out advanced bioengineering research. The case studies used in the course discuss various models which quantitate the complex phenomena that occur in emulsions and foams. The mathematically rigorous course gives students a unique perspective on the power of mathematics and computational techniques for utilizing mechanistic models for extrapolation of experimental data for purposes of new product development. Examples are foams which can be used to enhance the controlled release and delivery of topical pharmaceuticals, stabilization of foams which make many types of frozen food and dairy products, and the action of foams in fire fighting applications. The latter area is of considerable interest since new methods of fire control are needed as the halons currently used for fire fighting will slowly be phased out because of their potential for depleting stratospheric ozone.

Dr. Narsimhan also developed a graduate level course on "*Transport Phenomena in Food and Bioprocess Engineering*". This course deals with advanced topics in momentum, heat and mass transfer related to food and bioprocess engineering.

Dr. Narsimhan has also developed a new undergraduate course on Thermodynamics of Food and Biological Systems. This course is a synthesis of thermodynamics of multiphase systems and physical and surface chemistry with emphasis on application to food and biological systems. This course provides necessary background in physical chemistry of foods to undergraduate students in food process engineering. This new course has been one of the core required courses in the food process engineering curriculum.

Professor Narsimhan's teaching interests have also resulted in a number of special undergraduate and graduate research projects (ABE 590). Undergraduate, as well as graduate, students have been given challenging experimental and theoretical problems.

1. Courses Taught

a. ABE 627 – (Enrollment (average of around 8- taught every other year)) Colloidal Phenomena in Bioprocessing, class 3, credit 3. Elective for graduate students in Food Process Engineering.

   Based on his research, Dr. Narsimhan has developed the topics of this course which explain the role of proteins and other macromolecules on the structure and stability of food and biological systems. This course is the first of its kind in the U.S. and is unique in that it explains how the structure, stability and rheology of food dispersions, emulsions and foams can be understood in terms of the basic principles of electrostatics, hydrodynamics, thermodynamics and statistical

mechanics. Adsorption of proteins at Air-Water and Oil-Water interfaces as well as their role in the stabilization of emulsions and foams are discussed. Colloidal aspects of food systems such as milk, margarine, ice-cream and meat emulsion as well as colloidal phenomena in downstream processing such as protein precipitation, foam fractionation, membrane separations are also presented.

a. ABE 691a. (taught every other year) Transport Phenomena in Food and Bioprocess Engineering (spring 99) Class 3, Credit 3. Graduate level course.

This course discusses the analysis of momentum, heat and mass transfer operations in food and bioprocess engineering.

b. ABE 310 - (Enrollment: (average of around 20)) Thermodynamics of Food and Biological Systems, Sem. 1, class 3, cr. 3. Required course for Food Process Engineering students.

This is a new course developed by Dr. Narsimhan which is a required course in the Food Process Engineering curriculum. Dr. Narsimhan has developed topics such as liquid-liquid, solid-liquid equilibria, food emulsions that are not available in textbooks. This course is novel in that it applies the basic principles of thermodynamics of phase equilibria and physical chemistry to food and biological systems. The course introduces thermodynamics of ideal and non-ideal systems with an emphasis on phase equilibria of vapor-liquid, liquid-liquid and solid-liquid systems. The course also discusses colligative, surface properties and glass transition of food and biological systems.

c. ABE 454 – (Enrollment (average of around 20)) Transport Processes in Food and Biological Systems, class 3, lab 3, credit 4. Required course for Food Process Engineering students.

This course discusses the application of momentum, heat transfer and unit operations such as mixing, sheeting, extrusion and aseptic processing to food processing operation and design. Dr. Narsimhan has developed new laboratory and lecture materials on rheology, extrusion, sheeting and emulsification.

e. FS 610 – (Enrollment (89 - 8; 91 - 10; 93 - 12; 95 - 9)) Advanced Protein Chemistry, class 3, credit 3. Graduate course in Food Science. Instructor along with Professors S. Nielson, A.W. Kirleis, L. Chen and B. Tao, spring 1989, 1991, 1993, 1995. Dr. Narsimhan is responsible for teaching materials on functional properties of proteins and protein denaturation, which comprise approximately 20% of course content.

f. FS 631 - (Enrollment (94-12; 96-10)) Polysaccharide Structure and Function, class 3, credit 3. Graduate course in Food Science. Instructor along with professors R. Chandrasekharan, J.N. BeMiller and R.P. Millane. Dr. Narsimhan is responsible for teaching materials on emulsions and foams which comprise approximately 10% of the course content.

Special Topics

h. ABE 590 - Studies on Drainage and Stability of Protein Stabilized Foams, Fall 89, 3 credits; Spring 90, 3 credits. Student name: Robert J. Germick. This work has resulted in a publication (a.25).

i. ABE 590 – Adsorption Isotherm of Chicken. Fall 1990, 4 credits. Student name: Takashi Nakamura.

j ABE 590 - Food Emulsion Stabilizer, Fall 1994, 3 credits. Student name: Jarvis Head.

k. ABE 590 - Prediction of Drop Coalescence in a Turbulent Flow Field, Fall 94, 2 credits. Student Name: Shashi Mohan.

l. ABE 590 - Adsorption Isotherms of Protein - Lecithin Mixtures, Spring 95, 1 credit. Student Name: Paul Hoffman.

m. ABE 590 - Adsorption of Meat Proteins onto Cellulose Casing, Spring 96, 3 credits; Fall 96, 3 credits. Student Name: Brent Anderson**.**

3. Contributions in Course and Curriculum Development

❖ **Course Development:**

Dr. Narsimhan has made significant contribution to the *Food Process Engineering* curriculum in the development of both graduate and undergraduate courses. A new graduate course, ABE 627 – *Colloidal Phenomena in Bioprocessing*, developed by Dr. Narsimhan is the first of its kind in the U.S. This course emphasizes the role of proteins on the structure and stability of food and biological dispersions, emulsions and foams. He has also developed a new graduate level course on *Transport Phenomena in Food and Bioprocess Engineering*. This course is the first of its kind in the U.S. in that it applies the principles of momentum, heat, and mass transfer for rigorous analysis of various operations in food and bioprocess engineering. In addition, he created materials on functional properties of proteins and protein denaturation in a graduate course in Food Science, FS 610 – *Advanced Protein Chemistry*. In addition, Dr. Narsimhan has developed course materials on emulsions and foams and incorporated them in a graduate course in Food Science, FS 631 - *Polysaccharide Structure and Function.* He has also developed a new undergraduate course, ABE 310, *Thermodynamics of Food and Biological System*s for Food Process Engineering students which is a first of its kind in the U.S. This course combines thermodynamics of phase equilibria with physical chemistry of food and biological systems. Dr. Narsimhan is currently teaching a graduate level course, ABE 591a, *Transport Phenomena in Food and Bioprocess Engineering*,

❖ **ABET accreditation**

Dr. Narsimhan was in charge of ABET and was responsible for the development of curriculum materials for the *Food Process Engineering Program* for the ABET document that was submitted to the review team in 2001 and 2007. Food Process Engineering Program was accredited for six years. Dr. Narsimhan developed the *Program Objectives* and *Performance Criteria* for *Food Process Engineering Program*. He was instrumental in coordinating the *Course Learning Objectives* for all the courses in the curriculum. He also was responsible for the development of student and alumni surveys and analysis of the results for the evaluation of the effectiveness of the program in meeting the program objectives. Developed recommendations to the faculty to address Food Process Engineering program's academic gaps and deficiencies.

❖ **Curriculum Development**:

Dr. Narsimhan has been the departmental representative in the school of engineering curriculum committee for nine years. This committee oversees course and curricula changes in different undergraduate programs in the school of engineering.

4. Counseling and Recruiting

Dr. Narsimhan has been actively involved in counseling students in the food process engineering program. He is a part of the faculty advising team in the department, advising 25 students in Food Process Engineering.

Dr. Narsimhan has been giving *Freshmen Lectures* in the School of Engineering for the last three years. These lectures are given to freshmen in order to expose them to different engineering disciplines so as to enable them to make an informed decision about their major. He has also been

organizing recruiting informational sessions for interested freshmen in the department. In addition, Dr. Narsimhan has also been involved in *Women in Engineering*, a program designed to recruit high school women into engineering.

5. Participation in Summer Institutes and Other Programs

a. Teaching Workshop, Purdue CIS, Fall, 1986.

b. North Central Regional Teaching Symposium, June 24-26, 1991 at Madison, Wisconsin**.**

EXCELLENCE IN SERVICE

1. Advising, Counseling and Recruiting Students

a. Dr. Narsimhan was responsible for the Food Engineering Section of the "Workshop for High School Students" in summers of 1987 and 1988. This workshop provided an exposure to the academic program at Purdue as well as hands on experience in the laboratories in order to motivate high school students to choose a career in Agricultural Engineering.

b. Dr. Narsimhan was Faculty Advisor to American Society of Agricultural Engineering Student Branch (1987-1989).

c. Dr. Narsimhan participated in "Project Future" and "4-H Roundup" organized for high school students in summer 1990.

d. Dr. Narsimhan counseled freshmen engineering students once a week in Spring 1996.

e. Participated in *Society of Women in Engineering* student recruitment.

2. University/Departmental Administrative Service

a. Member, University Educational Policy and Faculty Affairs Committee (1990 - 1992)
b. Member, School of Engineering Committee on Faculty Relations (1989-1992), Secretary (1990-1991).
c. Member, School of Engineering Committee on Education Policy (1996 - present).
d. Member, Departmental Research Committee (1986 - 1994).
e. Member, Departmental Ad Hoc Committee for the Curriculum Development. (1988)
f. Member, Departmental Curriculum Committee (1994 - 1996).
g. Member, Departmental Academic Program Committee (1996 - present)

3. Professional Society

a. Organizer, American Chemical Society 62nd Colloid and Surface Science Symposium, 1988.

b. Member, Meeting Organizing Committee of Food & Biochemical Engineering Division, American Institute of Chemical Engineers (1995 - present).

c. Organizer, 4th Conference of Food Engineering, CoFE '95. Co-sponsored by American Institute of Chemical Engineers, American Society of Agricultural Engineers, Institute of Food Technologists, and American Association of Cereal Chemistry.

d. Organizer, Bienniel North American Mixing Conference, sponsored by American Institute of Chemical Engineers.

e. Organized 20 other technical sessions (see Section 5b) at the American Institute of Chemical Engineers Meetings.

4. Outreach

a. Gave an invited talk on “Emulsions” to predominantly industrial participants at the short-course on “Physical Chemistry of Foods”, May 30, 1991, Dallas, TX.

b. Gave an invited talk on “Foam-Based Separation of Proteins” to predominantly industrial participants at the short-course on “Bioseparation Processes in Foods”, June 24, 1994, Atlanta, GA.

c. Provided expert opinions on troubleshooting of processes for Kraft General Foods, Staley, Kentucky Fried Chicken and Frito-Lay.