Final Report on NAG3-2477

"Flows of Wet Foams and Concentrated Emulsions"

1 Objectives of Project

The aim of this project was is to advance a microstructural understanding of foam and emulsion flows. The dynamics of individual surfactant-covered drops and well as the collective behavior of dilute and concentrated was explored using numerical simulations. The long-range goal of this work is the formulation of reliable microphysically-based statistical models of emulsion flows.

2 Publications

The following invited papers and publications were wholly or partially supported by this grant.

Invited papers

1. Symposium on Foams and Minimal Surfaces, Isaac Newton Institute for Mathematical Sciences (Cambridge UK), "Bubble-scale modeling of foam drainage: the role of surfactants," August 2002
2. Gordon Conference, Gravitational Effects in Physico-chemical Systems, "Interacting time scales in flowing emulsions," July 2001
3. Annual AIChE meeting, Mixing colloquium, "Mechanisms of drop breakup in mixing flows," November 2001
4. International Congress of Theoretical & Applied Mechanics, "Numerical simulation of dense emulsion flows," August 2000
5. Euro-Conference on Foams, Emulsions, & Applications (Delft), "Linear viscoelasticity of a concentrated emulsion," June 2000

6. International Symposium on Food Rheology (Zürich), "Linear viscoelastic behavior of dense emulsions," March 2000

Publications

1. Nemer, M., Bławzdziewicz, J. & Loewenberg, M. 2001 Linear viscoelasticity of concentrated emulsions. In *Mechanics for a new millennium*, 75-84, H. Aref and J.W. Phillips (eds.), Kluwer.

2. Cristini, V., Bławzdziewicz, J. & Loewenberg, M. 2001 An adaptive mesh algorithm for evolving surfaces: simulations of drop breakup and coalescence. *J. Comp. Phys.* **168** 445-463.

3. Manga, M. & M. Loewenberg, 2002 Viscosity of magmas containing highly deformable bubbles. *J. Volcanology & Geothermal Res.* **105** 19-24.

4. Vlahovska, P., Blawzdziewicz, J. & Loewenberg, M., 2002, Nonlinear rheology of a dilute emulsion of surfactant-covered spherical drops in time-dependent flows. *J. Fluid Mech.* **463**, 1–24.

5. Blawzdziewicz, J, Cristini, V. & Loewenberg, M. 2002, Critical behavior of drops in linear flows: I. phenomenological theory for drop dynamics near critical stationary states. *Phys. Fluids* **14** 2709–2718.

6. Bławzdziewicz, J., Cristini, V. & Loewenberg, M., 2003, Multiple stationary drop shapes in strain-dominated linear Stokes flows. *Phys. Fluids Letters* **15**, L37-40.

7. Patel, P.D., Shaqfeh, E.S.G., Butler, J.E., Cristini, V.,Bławzdziewicz J. & Loewenberg, M. 2003 Drop breakup in the flow through fixed fiber beds: An experimental and computational investigation. *Phys. Fluids* **15**, 1146-1157.

8. Cristini, V., Bławzdziewicz, J., Loewenberg, M. & Collins, L.R. 2003 Breakup in stochastic Stokes flows: sub-Kolmogorov drops in isotropic turbulence. *J. Fluid Mech.* **492**, 231–250.

9. Cristini, V., Guido, S., Alfani, A., Bławzdziewicz, J. & Loewenberg, M. 2003 Drop breakup and fragement size distribution in shear flow. *J. Rheol.* **47**, 1283–1298.

10. Cunha, F.R. & Loewenberg M. 2003 A study of emulsion expansion by a boundary integral method. *Mech. Res. Commun.* **30**, 639–649.

11. Nemer, M., Chen, X., Papadopoulos, D. H., Bławzdziewicz, J.& Loewenberg, M., 2003, Hindered and accelerated coalescence of drops in Stokes flow. *Phys. Rev. Letters* **92**, 114501.

12. Ismail A.E. & Loewenberg, M. 2004 Long-time evolution of a drop size distribution by coalescence in a linear flow. *Phys. Rev. E.* **69** 46307.

3 Personnel

This grant supported the dissertation of Martin B. Nemer, Ph.D. 2002. Martin has a permanent position at Sandia Laboratories in Carlsbad, New Mexico.

The grant provided partial support for the dissertation of Ivan Galea, Ph.D. 2004 (currently employed by Boston Consulting Group, New York City), and a postdoc, Dr. Xiaohui Chen, who joined CitiBank in 2002.