Rheology and Stability of Fluids with Monodisperse Microbubble Suspension

Y. Shen, M. L. Longo and R. L. Powell, Department of Chemical Engineering and Materials Science, University of California, Davis, CA 95616.

Microbubbles are micron-scale hollow spheres (normally 1–100 um) with a gaseous core coated with a thin shell. Pure saturated phospholipid coated microbubbles are widely used as an ultrasound contrast agent in biomedical applications. Bubbles also play a significant role in manufacturing of many food products such as cakes, ice creams and soft drinks.

A food grade emulsifier is used to as alternative for saturated phospholipid to generate microbubbles. The relationship of between bubble size, stability and emulsifier concentration of this multiphase and multicomponent system are studied. The experiments show that a microbubble suspension obtains good short-term stability. Under a set of conditions specified by the amount of gas in the continuous phase as an individual microbubble dissolves its surface undergoes periodic crumpling. A dissolution model is used to determine the shell resistance and surface tension of the emulsifier monolayer at air/water interface. Fluorescence microscopy is used to study the microstructure of these microbubbles to further understand the dissolution behavior.

Suspensions of monodisperse coated microbubbles are generated using a flow focusing technique. The size of the microbubbles can be controlled by adjusting the ratio of air flow rate and liquid flow rate in the flow focusing chamber. Microscopy imaging of the size distribution and air entrainment measurements of the microbubble suspensions are used to obtain a relationship between emulsifier concentration and bubble size. Since the microbubbles are very stable for a short time period, a rotational rheometer is used to measure the relationship between the bubble size and the rheological properties. These results indicate that microbubble suspensions have viscoelastic behavior similar to that of a gel. The relationship among the bubble size and air fraction and the viscosity of the microbubble suspensions is discussed.

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