324b High-Speed Imaging of Particle-Bubble Interaction

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Interfacial and transport phenomena associated with particles interacting with gas bubble surfaces are important phenomenon for many processes, including wastewater flotation and gas-slurry reactions. The probability of particle attachment to a bubble surface is governed by several interactive phenomena: a particle must be intercepted by the bubble, the particle must adhere to the bubble surface, and a stable three-phase contact must be formed. Particle attachment and adhesion depend upon the surface properties of the bubble and particle and upon the fluid mechanics of the system. The important interactions are difficult to observe directly due to the very small length and time scales involved.

This presentation will focus on novel experimental methods developed to study interactions found in the three-phase (gas/liquid/solid) particle to bubble adhesion. High-speed, high-magnification imaging techniques are described and demonstrated that allow direct observations of the interactions between particles and bubbles in many different solution chemistries. Experiments are conducted in two different facilities. The stationary bubble facility provides a means of observing particles interactions with sessile or pendant bubbles in quiescent or stirred flow fields. The bubble suspending flow facility suspends a rising bubble in a counter-flow of particle laden solution, allowing observation of the particle and bubble interactions in a flow field. The imaging system provides high speed (up to 1000 frames per second) and high magnification visualization of particle-bubble interaction. Image processing and analysis methods are discussed that provide quantification of the efficiencies of the flotation (particle collection on the bubble surfaces) and estimates of the probabilities associated with the isolated mechanisms of collision, attachment, adhesion, and stability. Results are presented for glass spheres (50 to 450 micrometers), glass shards, polymeric materials, and ink particles interacting with bubbles ranging in size up to approximately 1 mm. The effects of surfactant, particle size, and particle surface properties on particle to bubble attachment are discussed. Application of these methods for understanding and design of flotation separations for polymers and ink particles will also be discussed.