The 8th European Congress on Computational Methods in Applied Sciences and Engineering
ECCOMAS Congress 2022
5 – 9 June 2022, Oslo, Norway

Contact behavior of particle laden bubbles

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Key Words: *Atomic Force Microscopy, Particle laden bubbles, Colloidal Probe*

Particle separation by flotation is of great importance in many industrial processes such as mineral flotation or the cleaning of metal melts from inclusion particles. The central step of such flotation processes is the so called heterocoagulate formation, which describes the attachment of particles to gas bubbles that are utilized to recover fine particles from multiphase systems. Reoccurring questions are the maximum particle load capacity of the gas bubbles, the conditions under which particles detach from heterocoagulates, and the probability of both particle attachment and detachment.

After the attachment of a single particle to a bubble, the particle will rest in its equilibrium position which is determined by the three-phase contact angle and the curvatures of both particle and bubble [1]. In heterocoagulates with high particle load the equilibrium position can be affected by the presence of neighboring particles and is further perturbed by the collisions of particles with the heterocoagulate and external forces that can lead to particle detachment.

Colloidal Probe Atomic Force Microscopy experiments on sessile bubbles and heterocoagulates with varying degrees of particle load are performed to gain a fundamental understanding of the mechanisms that determine the heterocoagulate formation and stability. Spherical alumina particles with diameters between 5 µm and 25 µm are used as colloidal probes in both unfunctionalized and silanized form. The particle laden bubbles with diameters between 80 µm and 100 µm are generated by a solvent exchange procedure in electrolyte solution, using an ethanol suspension prepared with silanized alumina particles in the size range 2 µm to 5 µm. Full force distance curves are measured at varying approach velocities and are analyzed with respect to the adhesion force, dynamic contact angles, and the equilibrium position of the colloidal probe in the interface.

Based on the surface coverage of the bubble with particles, different scenarios of attachment and detachment are considered. At low coverage the interaction is considered to be of particle – bubble type. At high surface coverages the interaction may show a solid-solid like behavior. The experimental results are compared to existing models for the different interaction types and their applicability to heterocoagulates, as well as possible extensions are discussed.

REFERENCES

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