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Nucleation and Growth of Multicomponent Gas Bubbles as a First Stage of Foam Formation at Fast Degassing & Effects of Adsorption and Line Tension on Contact Angle of Liquid Ridges and Sessile Droplets

Date： Friday, 13 APR. 2018, 14：00-15：30
Venue： Faculty of Engineering Bldg. 2, 3F, 31A

The kinetic theory of gas bubbles formation at degassing a gas-supersaturated liquid solution under conditions when gas supersaturation in the liquid-gas mixture is created by instant decompression had been developed for last 30 years. The traditional mean-field approach implies that nucleation and subsequent stationary growth of bubbles is followed by synchronous and uniform decrease in the dissolved gas supersaturation. However, this approach is unable to describe the considerable swelling of a highly metastable liquid and subsequent foam formation. In the case of large gas solubilities and supersaturations, diffusion of gas molecules to bubbles becomes nonstationary, and the diffusion shells with the depleted concentration of the dissolved gas form around the growing bubbles. For such a situation, the excluded volume approach in the case of one dissolved gas has recently been designed. In this report, we are focusing on a new detailed kinetic analysis of degassing and swelling of a decompressed liquid solution with several dissolved gases on the nucleation stage, i.e., the stage of intensive new bubble formation and growth. A main novel feature of the developed theory is its ability to predict the kinetic behavior of the whole ensemble of bubbles with different sizes under changes in the initial gas composition in the liquid solution or its fast decompression. With neglecting the role of the Laplace pressure in the larger bubbles, we are able to introduce the concept of total gas supersaturation in the multicomponent solution and to develop a kinetic theory of swelling liquid solutions with arbitrary number and any values of supersaturations and solubilities of the dissolved gases. We have shown that the effects of nonstationary diffusion may be very significant in the growth of multicomponent bubbles and, in particular, are responsible for swelling of a decompressed liquid solution by several times leading to foam formation. Distribution of bubbles in sizes as a function of concentrations of solute gases at any moment of the nucleation stage as well as duration of the nucleation stage and the swelling ratio at the end of nucleation stage have been found.

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