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LEVEL-SET BASED NUMERICAL SIMULATION OF BUBBLE GROWTH IN A DROPLET

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Numerical simulations were performed for bubble growth in a droplet, which receives increasing attention in medical diagnostic and therapeutic applications [1, 2]. The present approach was based on the sharp-interface level-set (LS) method [3] developed to include the effects of bubble compressibility and liquid-vapor phase change by incorporating the ghost fluid method, which is a numerical method to efficiently implement the matching conditions of velocity, stress and temperature at the interface. The LS method was extended to include two distance functions for tracking the bubble and droplet interfaces.

Computations were performed for the impact of a liquid-gas compound droplet on a horizontal wall. The numerical predictions obtained at the steady state for different bubble sizes showed good agreement with the analytical solutions, The LS method was also tested for phase change of vapor-liquid-liquid layers and droplet vaporization in an enclosed cylinder with a constant wall temperature.

The present numerical method was applied to bubble growth of a volatile droplet immersed in a liquid water. The computations demonstrated the whole process of bubble growth including complete droplet vaporization and subsequent bubble expansion and shrink. The numerical prediction of the temporal variation of bubble radius compared well with the experimental data available in the literature.

The numerical results for the bubble growth near a solid wall showed that the oscillation amplitudes of the bubble pressure and radius as well as the droplet lifetime are little dependent on the existence of the wall, but the oscillation period greatly increases with the wall. The bubble growth rate and the oscillation amplitude of bubble motion are observed to increase with the ambient temperature.

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