Numerical Study of Ultrasound-Driven Bubble Collapse and Solid Deformation

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ABSTRACT

Bubble collapse is an important subject in variety of marine, environment and medical applications, such as marine propellers, hydraulic machines, water treatment, surface cleaning, drug delivery and cell perforation [1]. It produces strong pressure waves that negatively or positively impact nearby solid or biological structures. A fundamental understanding and prediction of the bubble collapse and associated solid deformation is essentially important for its practical applications. Despite a number of studies, a general predictive model for bubble collapse and solid deformation has not yet developed due to the difficulties in tracking the multiple interfaces occurring in microscale lengths and times.

In this work, ultrasound-driven bubble collapse near a deformable solid boundary is numerically simulated by using a level-set (LS) method to track the bubble-water interface and to include bubble compressibility effect [2-4]. The LS formulation is extended to include solid deformation and fluid-solid interaction by incorporating a full Eulerian formulation of a left Cauchy-Green strain tensor for visco-hyperelastic solid materials. Computations are performed for ultrasound-driven collapse of microbubbles immersed liquid water. The numerical results demonstrate the bubble growth and wall deformation in the whole bubble oscillation process. The effects of acoustic pulsing amplitude and frequency as well as solid properties on the bubble growth and wall deformation are quantified.

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