

Dynamic Behavior of Two-dimensional Cavitation Bubble Located at a Corner with a Narrow Gap

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Extended Abstract

Cavitation bubbles are known to cause negative phenomena such as mechanical vibration and component damage, and many bubble dynamics approaches have been used to control them. In particular, bubbles that have grown spherically near the boundary surface collapse non-spherically to form liquid microjets at the end of the collapse phase. This jet formation is believed to contribute significantly to erosion at solid surfaces. In recent years, with the development of microfluidic devices, research on the behavior of cavitation bubbles in extremely confined spaces has been actively pursued. For example, Gebensleben et al. generated laser-induced bubbles in a narrow space between two flat plates and applied lateral flow to the bubbles to study the effect of the wall surface on the collapse time and motion translational dynamics of bubbles [1]. The results showed that the collapse position of the bubbles moved away from the wall surface due to the effect of the flow, suggesting the suppression of cavitation erosion. Liu et al. generated laser bubbles near the corner between two rigid walls and discussed the collapse process of non-spherical bubbles and their migration characteristics by changing the angle between the walls [2].

However, most of the research to date has focused on three-dimensional bubbles. Knowledge on two-dimensional (cylindrical) bubbles, which are indispensable for applications in microfluidic devices as well as for technological development in medical engineering and bioengineering, is scarce. Wang et al. generated bubbles in a two-dimensional space created by two flat plates and discussed the motion behavior of bubbles depending on the distance from the boundary with the three-dimensional space to the bubble center [3]. The clarification of the characteristics of liquid microjets generated in 2D bubbles is extremely important from the viewpoint of further miniaturization of devices and bubble generation in microscopic regions in the future.

In this study, a rigid wall with a certain angle and gap was placed in a narrow space between two flat plates, and bubbles were generated in the vicinity of the wall by underwater discharge. The behavior of the generated bubbles was observed by a high-speed camera. As a main result, it was confirmed that vortex cavitation bubbles are generated near the tip of the slit during the bubble growth and collapse process when the wall angle $\alpha = 15^\circ$, the slit width $b = 3$ mm, and the distance l_w from the origin to the bubble center is relatively small. This secondary vortex cavitation bubble affects the main bubble, which may induce microjets in the axial direction on the side of the expanding channel. This suggests that microjet control is possible depending on the geometrical conditions around the bubbles.

References

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