

Laser induced cavitation bubble interaction with bubbles attached to the surface

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Small gas bubbles generated in liquids are prone to attach to the solid surfaces. They have strong (usually negative) effect in various application where laser surface interaction in liquids is important (shading of the laser focus area), electroplating processes (bubbles prevent the plating solution to reach the surface uniformly), electrolysis (increased resistance and decreased efficiency of the process) etc.

An interesting effect of contactless cleaning process can be triggered by laser generating cavitation bubbles near surface covered with small bubbles. Till now the research on laser surface cleaning [1,2] and induced flows [3,4] during the cavitation bubble collapse was performed in the absence of surface attached bubbles and showed cleaned surface area with radius up to the 1.5 maximum cavitation bubble radius.

In this work we observe the interaction of the laser induced cavitation bubble with the surface attached bubbles and induced flow at different standoff distances using high speed imaging (Figure 1). Hydrogen bubbles are generated on a metal plate using electrolysis. Further, the process is also observed on a larger scale to show the bubble removal in the area with radius comparable to 5 times the maximum size of the cavitation bubble. Additionally, the surface attached bubbles can even help increase the cleaning area of the solid particles present on the surface.

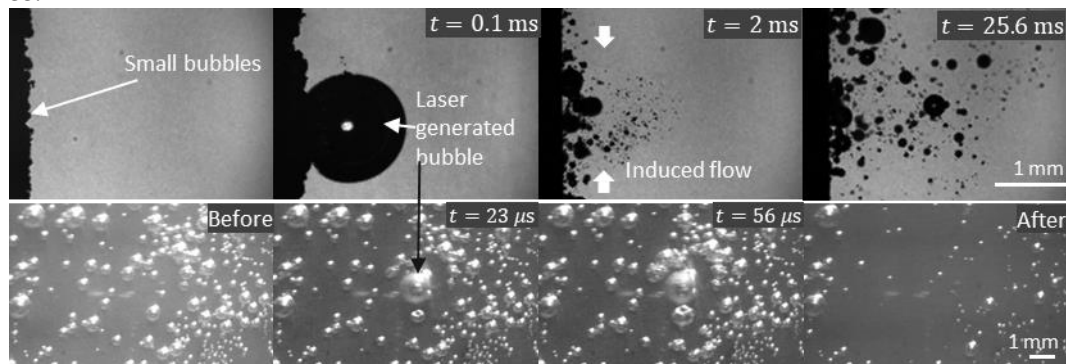


Figure 1: Top row, a high-speed shadowgraph images of the laser induced cavitation bubble interaction with the small bubble on the solid surface. A flow with much longer duration than the cavitation bubble lifetime is observed. Bottom row shows a front view of the cavitation bubble interaction with the attached bubbles. At the time of 56 μ s an expansion of the surrounding bubbles can be seen. Their destabilization together with the induced flow leading to the cleaning of the surface (Last image).

References:

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