Fast hydrodynamic events influenced by surfactant molecule dynamics

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Surfactant molecules are chemical compounds that stabilize interfaces between two fluids. Their presence at an interface also imparts elastic and viscous properties, giving rise to interfacial rheology through the reorganization of molecules at the surface and between the surface and the bulk. When a capillary wave propagates at such an interface, the surface area increases, and interfacial elasticity tends to resist this increase, thereby modifying the propagation and dissipation of the wave. This dissipation has been studied and utilized for low-amplitude and frequency (<1kHz) planar waves to characterize interfacial rheology in this frequency range. However, capillary waves and shock waves developed during rapid phenomena (bubble bursting, soap film bursting, etc.) are generally faster and of high amplitude.

From an experimental standpoint, it is impossible to directly observe the surfactant molecules. We only access consequences of their dynamics. As illustrated in Fig. 1a, when a millimeter-sized bubble bursts at the surface of a water bath, capillary waves propagate and focus at the bottom of the cavity, reversing and generating a fine, rapid jet of liquid. Adding surfactant molecules (Fig. 1b) almost eliminates the jet.

Combining high-speed cameras to track the shape of interfaces evolving over time, acoustic sensors to monitor the radiated pressure field, and theoretical modeling, we aim to elucidate physical mechanisms at play in the dynamics of both the flow and surfactant molecules.
We explored different configurations allowing fast interfacial reconfigurations: bursting of a bubble floating in a liquid bath, impact of a drop on a liquid bath, bursting of a soap bubbles, and bursting of a planar soap films. but without breaking too quickly.

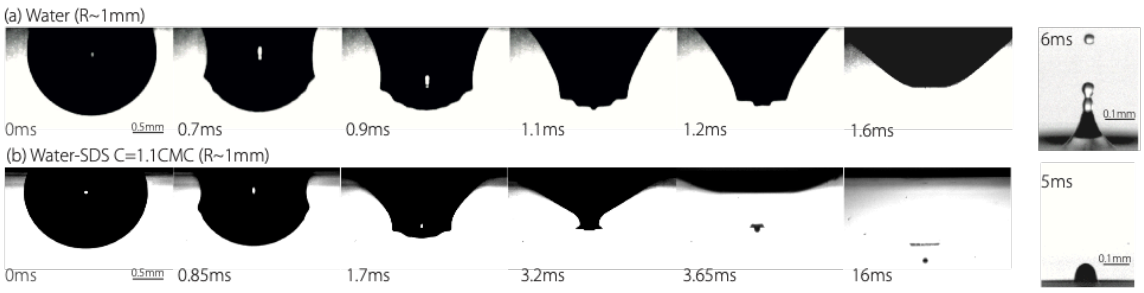

Figure 1. Sequence of images showing the collapse of two capillary bubbles at the surface of a water bath (a) and a bath of surfactant solution. Side view in water. The last frames depict the jet formed at the surface.

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Sala videoconferenze.
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