Antibubble collapse: Beyond the Taylor-Culick retraction

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Context

An **antibubble** is the opposite of a soap bubble and, thus, consists of an **air shell separating two liquids**. The popping of the antibubble involves the collapse of the air film and has been studied in recent years. However, the effect of surfactant concentration has never been investigated. When the **surface is not saturated**, *i.e.*, below the concentration is below the CMC, the retraction is interrupted by a **rupture** of the remaining air film. This poster presents preliminary experimental findings on the collapse of these antibubbles.

Liquid film retraction: the soap film

When a thin **liquid film** retracts, the **velocity** of this retraction is **constant** and only depends on the physics properties of the liquid [1].

$$v_{\mathrm{TC}} = \sqrt{\frac{2\gamma_{af}}{\rho_f h_0}}$$

Eq. 1 – Taylor-Culick velocity [1].

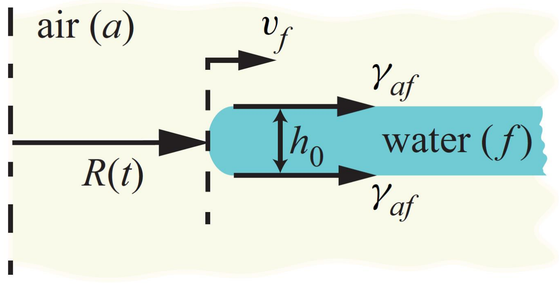
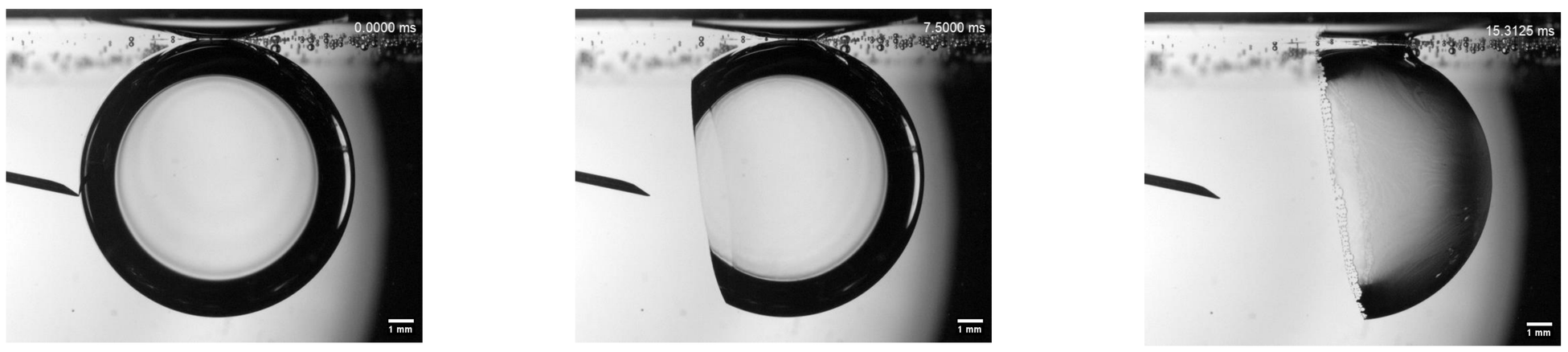


Fig. 1 – Retraction of a liquid film [1].

Observations

When we puncture an **antibubble** under typical conditions, *i.e.*, in a solution concentrated at **more than ten times the CMC**, the **air film retracts** like a normal liquid film. However, when the concentration is **smaller than the CMC**, the retraction is interrupted by a **rupture of the film**. This rupture begins when the retraction rim approaches the prime meridian.

This poster



Perspectives

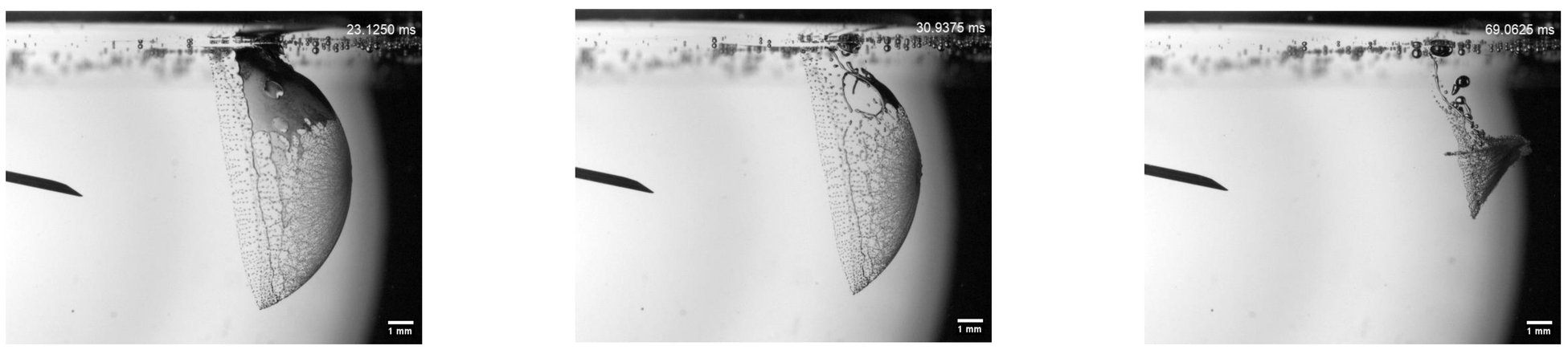


Fig. 2 – Collapse of an antibubble.

Air film retraction: the antibubble

When an **antibubble** is punctured, the **velocity** of the retraction rim **decreases over time**.

$$v = v_0 \sqrt[4]{\cot\frac{\theta}{2}}$$

Eq. 2 – Rim velocity [2].

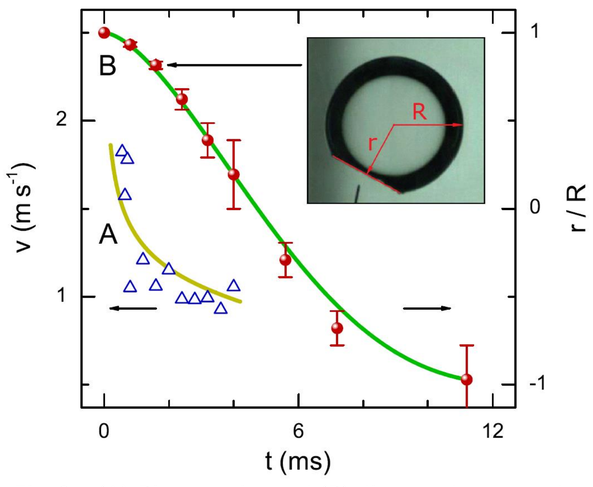


Fig. 3 – (A) Rim velocity and (B) distance between the hole center and the antibubble center over the antibubble radius [2].

Results

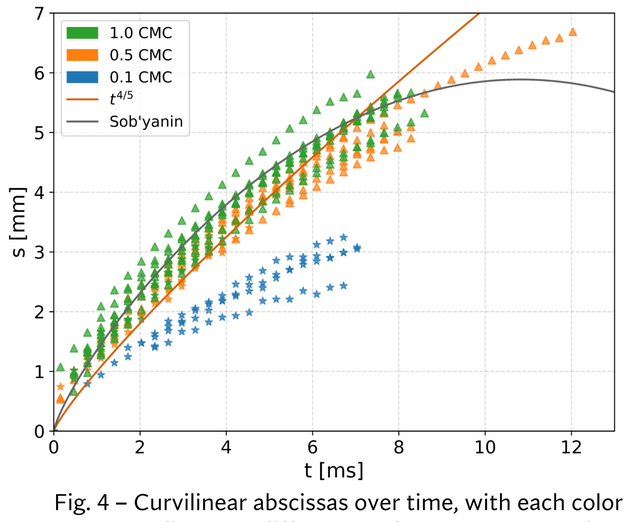


Fig. 4 – Curvilinear abscissas over time, with each color corresponding to a different surfactant concentration. The green line represents the retraction model, while the orange line represents only the exponent.

- Velocity decreases with surface tension
- Eq. 2 is not valid for concentration smaller than the CMC

References

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