

Flows in bursting soap film

Alexandre Guillemot¹, Juliette Pierre¹, Adrien Bussonnière²

¹ Institut d'Alembert, Sorbonne Université - UMR 7190, 75005 Paris, France

² Matière et Systèmes Complexes, Université Paris Cité, UMR 7057, 75013, Paris, France

alexandre.guillemot@dalembert.upmc.fr

A soap film is a thin layer of liquid with surfactant at its interface. Surfactants lower its surface tension and stabilize it. When a liquid film without surfactant molecules is punctured, a hole appears and grows at a well-defined speed called Taylor-Culick velocity, resulting from the balance between surface tension forces and inertia [1]. With surfactant the film retraction is more complex. Indeed, during the film bursting, a flow can sometimes be observed ahead of the hole edge, called the rim, while the area containing the flow is named the aureole [2].

This flow arises from the reduction in surface tension within the aureole, i.e. Marangoni flow, and is leading to a local thickening of the film. It does not come without an impact on the film's opening speed, as it decreases at the same time. The variation in surface tension is caused by the rapid bursting of the film (the film area decreases and vanishes in few ms), which compresses the surfactants at the interface, making it a completely out-of-equilibrium phenomenon [3]. The relation between surface tension and the degree of film compression is referred to as elasticity.

A dedicated setup has been built to track the aureole dynamics and various concentration of insoluble surfactant has been used to vary the elasticity. Deviations from the self-similar Frankel model are observed. After a transient regime, two different behaviour are observed. For low insoluble concentration, the aureoles are of constant size, while for higher concentration, aureoles increases in size but are smaller than expected in Frankel theory. We rationalize these two regimes by invoking the surfactant desorption.

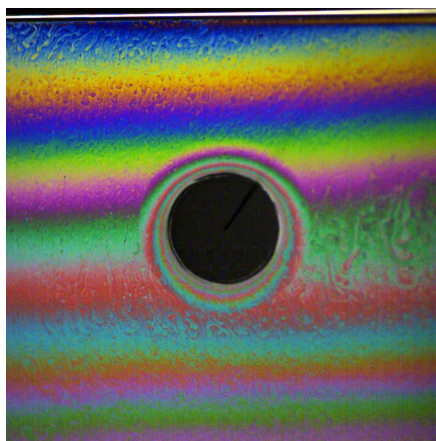


Figure 1. Aureole of a bursting soap film

Références

1. F. E. C. CULICK, *J. Appl. Phys.*, **31**, 1128 (1960).
2. W. R. MCENTEE, K. J. MYSELS, *J. Phys. Chem.*, **73**, 3018 (1969).
3. S. FRANKEL, K. J. MYSELS, *J. Phys. Chem.*, **73**, 3028 (1969).