
Coalescence of slender structures removed from a liquid bath

Hadrien Bense¹, Emmanuel Siéfert², Hoa-Ai Béatrice Hua³, and Fabian Brau^{*†3}

¹Le Mans Université – Laboratoire d’Acoustique de l’Université du Mans (LAUM), UMR 6613, Institut d’Acoustique – Graduate School (IA-GS), CNRS, Le Mans Université, France. – France

²Université Grenoble Alpes – Laboratoire Interdisciplinaire de Physique – France

³Université libre de Bruxelles (ULB) – Belgium

Abstract

We study the coalescence between two slender structures withdrawn quasi-statically or at finite velocity from a liquid bath. When partially immersed, the structures interact with each other through the capillary force induced by their menisci whose shape changes with the retraction speed. As the structures are removed from the bath, their dry length increases, and they become easier to bend until the capillary force is strong enough to trigger contact. Surprisingly, the structures snap to contact from a finite distance at a critical dry length. The transition to coalescence is thus subcritical and exhibits a large hysteresis loop between two stable states.

An analytical coalescence criterion is derived when the structures are withdrawn quasi-statically from the bath with a good agreement with experimental data for rods and lamellae (1).

In the case of two rods removed at finite velocity, the size of the menisci around them grows with the retraction speed and the capillary interaction increases. The rods coalesce then at a shorter dry length. We characterize the menisci growth as a function of the capillary number and show that the interaction between the structures is given by the static interaction with an effective surface tension increasing with the capillary number (2).

(1) E. Siéfert, H.-A. B. Hua & F. Brau, *Capillary coalescence of two partially immersed slender structures*, Extreme Mech. Lett. **55**, 101823 (2022).

(2) H. Bense, E. Siéfert & F. Brau, *Measurement of capillary forces using two fibers dynamically withdrawn from a liquid: Evidence for an enhanced Cheerios effect*, Phys. Rev. Lett. **131**, 184003 (2023)

*Speaker

†Corresponding author: Fabian.Brau@ulb.be