Facetted liquid foam under free and force drainage

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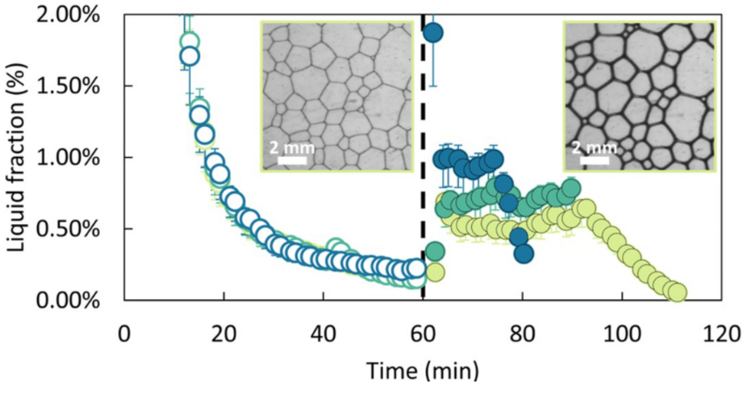
Surfactant-stabilized foams undergoing free and forced drainage were investigated by coupling optical imaging, conductivity measurements, and small-angle neutron scattering.[1] During free drainage, the Sauter mean bubble radius increases as $t^{1/2}$, while the liquid fraction rapidly decreases to below 0.5 vol%, after a transient regime characteristic of a coarsening foam.
During the forced-drainage sequence, at low flow rates of the injected solution, the liquid fraction increases again and reaches a steady value that depends on the imposed flow rate. At the same time, both the Sauter mean radius and the number of bubbles stabilize, indicating a strong reduction in the coarsening rate [2] and the maintenance of a stationary, swollen faceted foam structure. Small-angle neutron scattering, which enables the determination of the bubble film thickness as well as the specific surface areas of the films and Plateau borders, shows that these structural parameters also remain constant during forced drainage. These observations demonstrate that the structural characteristics of the foam under forced drainage (and not for foams under free drainage) are well described by equilibrium foam models reported in the literature, suggesting that hydrodynamic effects due to drainage are negligible at the low flow rates investigated.
Finally, this study provides, for the first time, a robust experimental comparison between aqueous polydisperse foam structures – under forced drainage - and theoretical models based on Kelvin cells.[3] These results open new avenues for exploring how hydrodynamics at higher forced-drainage flow rates affects foam structure, together with the role of surfactant chemistry and interfacial rheology in determining foam architecture.

Keywords:
Polydisperse foam, drainage, imaging, scattering, thin film, specific surface



Foam liquid fraction evolution versus time during the free drainage sequence on the left and during the forced drainage sequence at three different flowrates (followed by a free drainage) on the right

References:

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