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Viscoelastic coarsening of a quasi-2D foam

Many soft matter materials evolve through surface tension driven phase separation. During this process the growth of domains can occur via material transfer through the continuous phase. A particular example is foams, which coarsen as gas diffuses between bubbles due to differences in Laplace pressure. We study the temporal evolution of foams where the continuous phase is a viscoelastic fluid and specifically a concentrated emulsion. The foams are in a quasi-2D geometry, namely a single layer of bubbles squeezed between two plates, that allows following the structure and dynamics of the foam during its evolution. We are in particular interested in the regime where the foam behaviour is no longer dominated by capillary effects, but by the rheological properties of the fluid between the bubbles.
We show that if the elastic modulus of the continuous phase is sufficiently high, bubble rearrangements are arrested. This does not stop foam ageing, and coarsening continues. However, bubble size evolution is strongly slowed down and foam structure is hugely impacted. The main mechanisms responsible for the peculiar evolution are the absence of continuous phase redistribution and a non-trivial link between foam structure and mechanical properties. These combine to give spatially heterogeneous coarsening. Beyond their importance in the design of foamy materials, the results give a macroscopic vision of phase separation in a viscoelastic medium.

[1] Guidolin et al., 2023, Viscoelastic coarsening of quasi-2D foam, Nature Communications.

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