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Determining Stress During Finger Propagation in 2D Foams

Adrian D. Staicu, Bas van Gelder, Sascha Hilgenfeldt

Applied Physics, University of Twente, Netherlands

We investigate the formation of fingering patterns in a radial Hele-Shaw cell filled with quasi-two-dimensional polydisperse foam of very small liquid content. Air is used as the low-viscosity driving fluid. Using high speed imaging (up to 2000fps), we directly observe the topological rearrangements on the size scale of single bubbles at the air-foam interface. We find that the growth process of the finger can be discretized as successive elementary T1-type edge exchanges between neighboring bubbles at the interface of the advancing finger. Apart from the rate of T1 events, other statistical quantities can be determined with good spatial resolution using a coordinate system moving with the finger. Measures of local bubble anisotropy (such as the texture tensor) and connectivity are used to determine the deviatoric stress tensor in the material. The data are compared to continuum results in the viscous liquid and elastic solid limits, shedding light on the continuum behavior of foam as a viscoelastic material.

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