Bubble Migration and Size Segregation in Sheared Two-dimensional Foam

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We report experiments on simple shear flow of two-dimensional bidisperse and polydisperse foams in a Couette device [1]. The bubbles segregate according to their sizes, with larger ones in the middle of the gap and smaller ones closer to the walls, when the shear rate and the bubble size ratio are each above a threshold. The spatial distribution of the larger bubbles becomes flatter across the gap as its area fraction increases. To explain these observations, we first study the migration of a single large bubble in a sea of small and equal-sized bubbles [2]. To our surprise, the lateral migration is predicted well by an adapted Chan-Leal formula with an effective capillary number. In bidisperse foams, we adapt a model for monodisperse emulsions that predicts the spatial distribution of droplets as an outcome of the competition between migration away from the walls and shear-induced diffusion. The dense packing of bubbles in our foam intensifies bubble-bubble interaction, which manifests itself both in lateral migration due to wall repulsion and in collision-induced diffusion. After accounting for this difference via an effective capillary number based on the deformation of the bubbles, the model predicts the observed bubble distributions accurately.

References:

[1] H. Mohammadigoushki, and J. J. Feng, Langmuir 29, 1370-1378 (2013).
[2] H. Mohammadigoushki, and J. J. Feng, Phys. Rev. Lett. 109, 084502 (2012).