Use of micro-CT and pore network modelling as an innovative way to characterise liquid foam dynamics

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ABSTRACT

Foam stability is an important issue in the commercial industry and is directly linked to its performance. To control stability, it is necessary to understand how to suppress drainage, diffusive coarsening, and coalescence in foams. Although, coalescence and drainage are relatively well-understood, it is challenging to study diffusive coarsening in aqueous foams where drainage is a dominant mechanism. Here it is shown that that micro-computed tomography (μ-CT) and pore network modelling (PNM) can provide a valuable tool to characterise foam dynamics. For the purpose of this study, a foam sample consisting of SDS (3 times the critical micellar concentration), octanol, and 20% glycerol was prepared which would sustain during the total scan time of 4 hours. Unlike existing technologies, it allows us to measure the film thicknesses and Plateau border radii across the foam height as well as with respect to time, which is useful to predict the degree of coarsening and drainage, respectively. The co-ordination number of the liquid nodes further provides valuable information about the dynamic equilibration of the system. Furthermore, evaluation of the bubble size distributions acquired from the time-lapsed 3D μ-CT images help us to distinguish between coalescence and coarsening process. Our results follow the general drainage equation [1] and demonstrate that the permeabilities calculated from the PNM simulations can be utilized to model foam drainage. We anticipate our work to be a starting point for more sophisticated analysis involving the aging mechanisms of all types of foams (especially liquid foams) which are prevalent in froth flotation, enhanced oil recovery, foam fractionation, and fire-fighting processes.

[1] G. Verbist, D. Weaire, A. M. Kraynik (1996). "The foam drainage equation." Journal of Physics: Condensed Matter 8 3715.