

Experimental validation of the Navier-Stokes-Cahn-Hilliard equation and prediction of phase separation time

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One of the challenges for the modelling of the phase separation of emulsions are the ostwald ripening and the coalescence stages. To this respect, the mathematical framework developed by Cahn and Hilliard (1958) has several advantages with respect to other approaches such as population balance or kinetic equations: I) it is a mechanistic framework, which means that the parameters required to describe the phase separation (surface tension, interphase thickness, mobility) have a mechanistic meaning ii) it can be coupled with the Navier-Stokes equation, which would allow its use for the development of digital twins iii) on its most basic standard 2D formulation, its resolution yields a very intuitive graphical representation of the phase separation phenomenon.

As of today, there has been an extensive amount of theoretical work on the basis of this framework, for very different fields (e.g. polymer science, metallurgy, cancer research). Nevertheless, and at least for food-related applications, it does not seem to have been validated experimentally. Reasons behind this are the equation structure, which requires non-standard numerical schemes in order to perform acceptably without the need of significant computing power; as well as the need of an extra data extraction procedure that allows to compare the numerical to the experimental data.

The goal of the ongoing work is to provide experimental validation of the Cahn-Hilliard and the Cahn-Hilliard-Navier-Stokes frameworks for different systems. This will enlarge the currently non-existing parameters database, so that these frameworks become the standard to predict the stability of emulsions.