Phase-Field Simulations of Foam Ageing Based on Spontaneous Coalescence

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ABSTRACT

Controlling the microstructure formation process in aqueous foams is key to tailoring foam evolution and thus the resulting structures with defined geometries and properties. This requires understanding how different processes underlying foam evolution influence pore structure formation. We aim for a computer-aided design of foams with tailor-made microstructures. In this work, the dynamics of dry foam evolution determined by curvature minimisation and coalescence events is studied numerically. To map different processes during foam evolution, a model to describe gas bubbles undergoing spontaneous isolated coalescence as well as structural rearrangements is developed. A numerical simulation method based on a phase-field model [1] is used to perform large scale parallel simulations of 3D gas bubble ensembles. Phase-field simulations focusing on configurations of few individual bubbles allow for investigation of the coalescence behaviour of the bubble ensemble as well as of the relaxation into a pore structure in equilibrium, considering topological changes. The modelling approach yields the temporal dynamical evolution of foams with different bubble size distributions based on successive coalescence processes, as exemplarily shown in figure 1. Studies of several thousand bubbles are conducted and analysed to investigate the effect of initial dispersities on microstructure evolution.

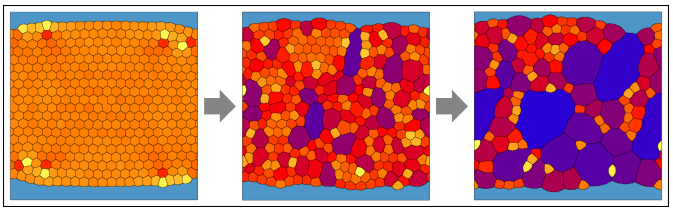

Figure 1: Simulation result of a 2D study of temporal evolution of an initially monodisperse ageing foam structure with dynamic coalescence of bubbles. Colours indicate gas pressure inside bubbles.

[1] J. Hötzer, A. Reiter, H. Hierl, P. Steinmetz, M. Selzer and B. Nestler. The parallel multi-physics phase-field framework Pace3D. J. Comput. Sci. 26, 1-12, 2018.