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Phase-field Modeling and Simulation of Surfactant-Laden Multiphase Flows using a Central Moment Lattice Boltzmann Method[1]
FARZANEH HAJABDOLLAHI, KANNAN PREMNATH, SAMUEL WELCH, University of Colorado Denver — Surfactants modulate interfacial flows in numerous multiphase dispersed systems. We will present a robust computational technique based on unified cascaded lattice Boltzmann methods (LBMs) for two-phase flows at high density ratios, and for the capturing of the interfacial motions and surfactant dynamics. The cascaded LBM for two-phase flows, which computes the pressure and velocity fields, is based on a discretized modified continuous Boltzmann equation, where the effect of collisions is modeled by relaxation of different central moments to their equilibria and includes source terms for surface tension effects. The interfacial dynamics is represented by a conservative Allen-Cahn equation which is solved by another cascaded LBM. The transport of the surfactant concentration field, based on a free-energy functional and accounts for the energetic preference of surfactants to get adsorbed on interfaces, is evolved via yet another cascaded LBM. The effect of surfactants, i.e., the lowering of the local surface tension and the generation of Marangoni stresses, are introduced via a nonlinear interface equation of state based on the Langmuir isotherm. We will demonstrate the potential of our proposed formulation for various surfactant-laden two-phase flow cases.

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