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A finite-element phase-field method for simulating interfacial dynamics in complex fluids PENGTAO YUE, CHUNFENG ZHOU, JAMES J. FENG, CARL OLLIVIER-GOOCH, University of British Columbia, HOWARD H. HU, University of Pennsylvania — We present a novel and efficient finite-element method for treating interfacial problems involving rheologically complex fluids. Two key ingredients of the method are a phase-field representation of the interface and an adaptive meshing scheme that allows fine interfacial resolution at manageable computational cost. In the phase-field framework, the interface is seen as a thin layer across which material properties change rapidly but continuously. Thus, a set of governing equations are derived that hold for both fluids across the interface. This circumvents the cumbersome task of interface tracking. The surface tension emerges from the mixing energy at the interface, and the energy-based formalism easily incorporates complex rheology. The challenge of the method lies in resolving the interfacial layer on a fixed Eulerian grid. This is handled by adaptive meshing on a unstructured grid using the phase- field as the criterion for local refinement and coarsening. We will present several simulations on drop deformation, retraction, coalescence and breakup for Newtonian and viscoelastic liquids and nematic liquid crystals. While some of these serve as validations of our new method, the results also reveal novel physics governing the interplay between interfacial dynamics and bulk rheology.

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