Abstract Submitted
for the DFD09 Meeting of
The American Physical Society

A numerical method for Stokes flow with capillary effects JOHN FETTIG, JONATHAN FREUND, LUKE OLSON, University of Illinois — A simulation tool is presented for capillary driven reacting and polymerizing low-Reynolds-number flows. The free surface is represented by a level-set function, but with extra terms added so that it remains sharp despite finite numerical diffusion. The governing equations are discretized with hierarchical finite elements. A splitting facilitates implicit time advancement of the nonlinear advection-diffusion transport equation. At small Capillary numbers, the pressure jump at the free surface due to surface tension makes the saddle-point discrete system for the velocity expensive to solve. A decomposition into two parts, facilitated by the hierarchical elements, significantly accelerates the overall solution. The first part governs the static system, which includes the sharp interface. This portion requires no incompressibility constraint and is therefore relatively easily solved using p refinement for high accuracy. The second part is dynamic but smooth, so it can be solved in relatively few iterations despite the incompressibility constraint. This decomposition reduces the computational expense, by up to 95% in the demonstration simulations, which are relevant to self-healing autonomic materials.

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Date submitted: 07 Aug 2009 Electronic form version 1.4