Abstract Submitted
for the DFD12 Meeting of
The American Physical Society

Breakup of liquid filaments on a partially wetting solid substrate
GIOVANNI GHIGLIOTTI, Department of Mathematics, University of British Columbia, Vancouver, B.C., Canada V6T 1Z2, CHUNFENG ZHOU, Corning Incorporated, One Science Center Drive, Corning, NY 14831, JAMES J. FENG, Department of Chemical and Biological Engineering, University of British Columbia, Vancouver, B.C., Canada V6T 1Z3 — We report direct numerical simulations of liquid filaments breaking up into droplets on partially wetting substrates. It is motivated by recent experiments, linear stability analyses, and lubrication-based calculations. The fluid flow is governed by the Stokes equations and the contact line motion is handled by a phase-field model, which also serves to capture the interfacial motion. The coupled Stokes and Cahn-Hilliard equations are solved using a finite-element algorithm in three dimensions. This avoids additional approximations of the fluid flow or contact line motion, and allows us to consider arbitrary contact angles $0 \leq \theta \leq \pi$ on the substrate. We simulate both the breakup of infinite liquid filaments via growing capillary waves and that of finite liquid filaments with drops pinching off from the ends. The results show the differences in the two processes and in the final drop size, spacing and polydispersity, as well as the dependence of these two phenomena on the value of the contact angle with the substrate. The development of capillary waves agrees well with prior linear analysis and the end-pinching results offer new insights into this poorly understood phenomenon.

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Date submitted: 01 Aug 2012 Electronic form version 1.4