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Dynamic Wetting Failure and Hydrodynamic Assist in Curtain Coating CHEN-YU LIU, ERIC VANDRE, University of Minnesota, MARCIO CARVALHO, PUC-Rio, SATISH KUMAR, University of Minnesota — Dynamic wetting failure in curtain coating of Newtonian liquids is studied in this work. A hydrodynamic model accounting for air flow near the dynamic contact line (DCL) is developed to describe two-dimensional (2D) steady wetting and to predict the onset of wetting failure. A hybrid approach is used where air is described by a one-dimensional model and liquid by a 2D model, and the resulting hybrid formulation is solved with the Galerkin finite element method. The results reveal that the delay of wetting failure in curtain coating—often termed hydrodynamic assist—mainly arises from the hydrodynamic pressure generated by the inertia of the impinging curtain. This pressure leads to a strong capillary-stress gradient that pumps air away from the DCL and thus increases the critical substrate speed for wetting failure. Although the parameter values used in the model are different from those in experiments due to computational limitations, the model is able to capture the experimentally observed non-monotonic behavior of the critical substrate speed as the feed flow rate increases [T. D. Blake et al., Phys. Fluids, 11(8), 1995 (1999)].

Satish Kumar
University of Minnesota

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