DYNAMIC WETTING FAILURE IN COATING FLOWS: THE INFLUENCE OF THE DISPLACED FLUID

E. Vandre(*), M. S. Carvalho(**), and S. Kumar(*)

(*) Department of Chemical Engineering and Materials Science
University of Minnesota, Minneapolis, Minnesota 55455-0331

(**) Department of Mechanical Engineering
Pontificia Universidade Católica do Rio de Janeiro, Rio de Janeiro, RJ, Brazil 22453-900

Presented at the 16th International Coating Science and Technology Symposium,
September 9-12, 2012, Midtown Atlanta, GA[1]

Dynamic wetting involves the displacement of fluid on a solid surface by an advancing liquid, and is essential to the successful operation of coating processes. In this work, we consider a model problem in order to examine the influence of the displaced fluid on the failure of dynamic wetting. Full two-dimensional (2D) calculations over a broad range of parameters are performed using the finite element method (FEM), and the results are compared to prior experiments and asymptotic analysis. This comparison motivates the development of a novel and efficient hybrid computational method that combines 2D FEM for the liquid and lubrication theory for the displaced fluid. We will discuss the limits of applicability of the hybrid approach, and its ability to describe realistic coating flows. Overall, our results highlight the significant influence of the displaced fluid on the conditions at which dynamic wetting failure occurs, along with the underlying physical mechanisms.

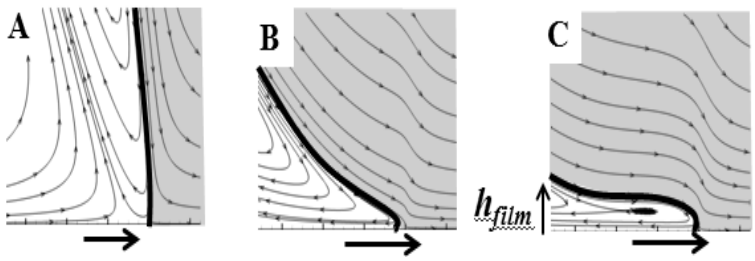

Figure. Flow fields calculated near the contact line for liquid (right phase) displacing air (left phase). Substrate speed increases from left to right, where figure (a) shows a nearly static system and figure (c) illustrates the air film that develops at the critical speed of wetting failure.

[1] Unpublished. ISCST shall not be responsible for statements or opinions contained in papers or printed in its publications.