DELAYING WETTING FAILURE IN COATING FLOWS VIA MENISCUS CONFINEMENT

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

(*) Department of Chemical Engineering and Materials Science
The University of Minnesota, Minneapolis, Minnesota 55455-0459

(**)Department of Mechanical Engineering
Pontificia Universidade Católica do Rio de Janeiro, Brazil 22451-900

Presented at the 15th International Coating Science and Technology Symposium,
September 13-15, 2010, St. Paul, MN[1]

Wetting failure in die coating methods typically occurs at higher speeds compared to coating methods where there is no meniscus confinement, but the reasons for this remain unclear. Wetting failure brought about by air entrainment remains one of the biggest obstacles to higher production capacity in many coating processes. Confinement of the meniscus associated with the wetting line is observed to delay air entrainment in many coating methods, but a fundamental understanding of the mechanisms underlying this observation is lacking.

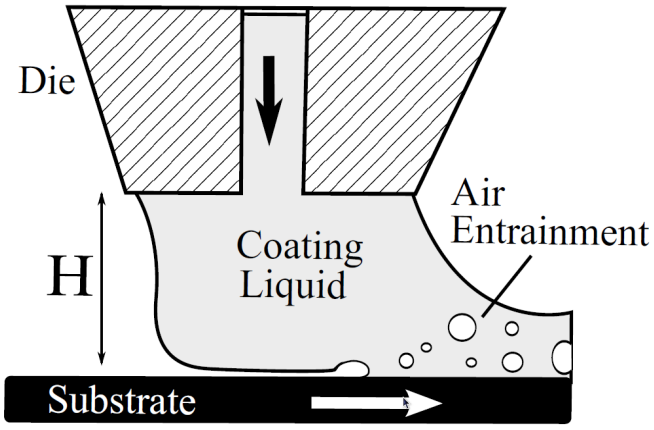

Figure: Schematic of wetting failure in a die coating system with meniscus confinement, H.

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We explore the effects of confinement on wetting failure through experiments performed on a laboratory-scale plunge coating system. Our experimental apparatus consists of a cylindrical steel roll that plunges into a bath of glycerol. Confinement is imposed by bringing a coating die near the wetting line, and liquid is injected through the die to compensate for liquid being dragged way by the roll. Flow visualization is used to record the critical roll speed at which wetting failure occurs, and the data show a clear increase in the critical speed with increasing confinement. A model based on the lubrication approximation does a remarkable job in accurately predicting the increase in the critical speed relative to the unconfined value.