Model for Precision Application Slot-Die Coating and Investigating the Mechanics of the Low-Flow Limit

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Slot-die coating is a precision pre-metered, film-deposition process compatible with a wide range of materials, including colloidal inks, low-molecular weight polymers and thermosets. Of topical interest to precision electronics applications is the deposition of high-cost nano-material dispersions (inks) over moderately sized (> 10 cm^2) areas with sub-micron wet film thickness. In these applications the speed of deposition is less important than non-uniformities resulting from start-up and shut down transients. In this work, a two-dimensional model has been developed to understand the limits of the process and to predict the thinnest possible film achievable. Coined as the *low-flow limit*, this parametric operating boundary presents the minimum uniform, defect-free film achievable at a given set of liquid properties and die/substrate geometry. We investigate the low-flow limit with a model that allows menisci to locate anywhere on the die lands, faces, and substrates with prescribed contact angles, thereby minimizing the assumptions on the bead configuration. The model is validated via comparison of its low-flow limit prediction to published experimental data [1]. Analysis of the model and its results yield insights into the mechanics of coating bead breakdown at the low-flow limit.

[1] Chang Y-R, Chang H-M, Lin C-F, Liu T-J, Wu P-Y. Three minimum wet thickness regions of slot die coating. *J Colloid Interface Sci*. 2007; **308**:222–230.

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