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Capillary Flow with Evaporation in Open Rectangular Microchannels PANAYIOTIS KOLLIOPOULOS, KRYSTOPHER JOCHEM, ROBERT LADE, LORRAINE FRANCIS, SATISH KUMAR, Department of Chemical Engineering and Materials Science, University of Minnesota — Numerous applications rely upon capillary flow in microchannels for successful operation including lab-on-a chip devices, porous media flows, and printed electronics manufacturing. We develop a Lucas-Washburn-type model that incorporates the effects of concentration-dependent viscosity and evaporation on capillary flow in open channels having rectangular cross section. In the absence of evaporation, prior studies have demonstrated better agreement between model predictions and experimental observations in low-viscosity liquids when using a no-slip rather than a no-stress boundary condition at the upper liquid-air interface. However, flow visualization experiments conducted in this work suggest the absence of a rigidified liquid-air interface. The use of the no-stress condition results in overestimation of the time evolution of the liquid front due to underestimation of viscous forces by the model. Model predictions are also compared to prior experiments in the presence of evaporation. Scaling relationships obtained from the model for the dependence of the final liquid-front position and total flow time on the channel dimensions and rate of uniform evaporation are found to be in good agreement with experimental observations (Kolliopoulos et al., Langmuir 35 (2019) 8131).

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