Abstract Submitted
for the DFD16 Meeting of
The American Physical Society

Capillary-driven, spatially-directed liquid transport on and through thin porous substrates SOUVICK CHATTERJEE, PALLAB SINHA MAHAPATRA, ALI IBRAHIM, Univ of Illinois - Chicago, RANJAN GANGULY, Jadavpur University- India, CONSTANTINE MEGARIDIS, Univ of Illinois - Chicago, LISHA YU, RICHARD DODGE, Kimberly-Clark Corporation — Thin porous substrates exhibit good wicking properties for liquid distribution. The low cost of such common substrates often makes them useful for point of care biomedical diagnostics. Isotropic and anisotropic liquid transport through porous media has been studied extensively in literature. Moreover, previous research has demonstrated spatially-directed liquid transport on textured surfaces featuring surface-tension confined track. Combining both these features, here we demonstrate and analyze capillary-driven, directional liquid transport both on the surface of, and through, a wettability-patterned, horizontal porous substrate. The vertical (through) penetration is governed by Darcy's law. The horizontal (on surface) transport is driven by the Laplace pressure gradient caused by the geometry of the meniscus on the wettability-confined track. The transport rate on the substrate is found to far exceed the liquid permeation rate through it. Consequently, the penetration resistance can be estimated using a quasi-static approach. Using a semi-analytical model, we analyze the effect of the liquid curvature on the penetration rate of a sessile drop placed on the substrate. The model accounts for the back pressure caused by the liquid on the opposing side. The transport model is validated against the experiments, and the geometry, wettability and substrate porosity parameters causing fastest transport are identified.

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Date submitted: 05 Aug 2016 Electronic form version 1.4