Abstract Submitted
for the DFD12 Meeting of
The American Physical Society

Spontaneous penetration of a non-wetting drop into an exposed pore[1] PENGTAO YUE, YURIKO RENARDY, Virginia Tech — We consider the penetration process of a liquid drop approaching an exposed pore along the axis of symmetry, which is intended to model the penetration of non-wetting drops into a porous medium. Inertia and gravity are neglected at the current stage. Different from the penetration into a capillary tube in literature, the drop may spread on the outer surface of the porous medium. Based the on the mechanical equilibrium states, we find the critical drop radius, below which the drop penetration is spontaneous. We further identify five penetration regimes based on the drop radius and the static contact angle, all of which are exemplified by phase-field simulations. The free energy as a function of penetration depth reveals only two stable equilibrium states — the drop either enters the pore completely (maximum penetration) or stays at the pore inlet (zero penetration). For a non-penetrating drop radius, the free energy has a local maximum which constitutes an energy barrier that prevents spontaneous penetration. Finally, we modify the Lucas-Washburn equation to describe the dynamic process of penetration, which turns out to greatly overestimate the penetration rate due to the neglect of dissipation from moving contact lines and flows outside the pore.

[1]This work is supported by NSF-DMS 0907788.

Pengtao Yue
Virginia Tech

Date submitted: 29 Jul 2012 Electronic form version 1.4