Current developments of open-channel microfluidics: dynamics of the capillary flow in bifurcations, networks and two-phase capillary flows.

Berthier J[1], Lee Jing[1], Berry S.B[1], Lee Ulri[1], Dostie A.M.[1], Berthier E[1], Theberge A.B[1, 2]

[1]Department of Chemistry, University of Washington, Seattle, United States
[2]Department of Urology, University of Washington School of Medicine, Seattle, United States

Keywords: open-channel microflow, friction length, generalized Cassie angle, capillary tree, capillary pumping, biphasic flow

I. Abstract

Open microfluidics has recently seen many new developments [1-3], triggered by numerous new applications in biotechnology, biology, material sciences, space sciences (space plumbing), thermics and electronics [4-7].

It is recalled that the advantages of open microfluidics are costless fabrication, easy surface access for functionalization, absence of bubbles, and facilitated access to the flow.

In this study, we present some recent developments for the dynamics of open-channel capillary flows, such as the division of the flow at a bifurcation—symmetrical or asymmetrical—, the flow repartition in a simple loop-network, and in a capillary tree. In particular, the flow repartition at a bifurcation is analyzed and a theoretical model is proposed. It is also demonstrated how capillary trees can act as capillary pumps.

In a second part, we present the recent developments of two-phase open capillary flows. Using numerical and experimental approaches, characteristic modes (plug morphologies) are pointed out, depending on the shear rate of the flow. It is shown that capillary wagons can be transported by an open capillary flow.

II. Image:



Left: view of the division of the fluid at a bifurcation; right: view of a two-phase open capillary flow of pentanol (blue) and water (yellow) in a winding open-channel.

III. Reference:

1 Berthier J., Brakke K.A., Berthier E., Open Microfluidics, Wiley, 2016.
2. Jing Lee, Berthier J., Brakke K.A., Dostie A.M., Theberge A.B., Berthier E., Droplet Behavior in Open Biphasic Microfluidics, Langmuir, 34, 5358, -5366, 2018.
3. Li C., Boban M., Tuteja A., Open-channel, water-in-oil emulsification in paper-based microfluidic devices, Lab on a Chip, 17(8), 1436-1441, 2017.
4. Casavant B.P, Berthier E., Theberge A.B, Berthier J., Montanez-Sauri S.I., Bischel L.L., Brakke K.A., Hedman C.J., Bushman W., P. Keller N.P., and Beebe D.J., Suspended microfluidics, PNAS 110 (25), 10111–10116, 2013.
5. Humayun M., ChowC-W. and Young E.W. K., Microfluidic lung airway-on-a-chip with arrayable suspended gels for studying epithelial and smooth muscle cell interactions, Lab Chip 18, 1298-1309, 2018.
6. Weislogel M.M, Baker J.A., Jenson R.M., Quasi-steady capillarity-driven flows in slender containers with interior edges, J. fluid Mechanics, 685, 271-305, 2011.
7. Kimura Y., Henares T.G., Funano S., Endo T. and Hisamoto H., Open-type capillary-assembled microchip for rapid, single-step, simultaneous multi-component analysis of serum sample, RSC Advances 2, 9525–9530, 2012.

IV. Biography:

Ashleigh Theberge is an Assistant Professor at the University of Washington, and the head of the laboratory, Erwin Berthier is Affiliate Assistant Professor at the University of UW and co-head of the laboratory, Jean Berthier is a visiting Professor at UW, Jing Lee, Ulri Lee, Samuel Berry and Ashley Dostie are PhD students at UW.

V. Presenting author details



Jean Berthier
Research gate: https://www.researchgate.net/profile/Jean_Berthier
Session name: Microfluidics
Category: Oral presentation

Copyright © 2016-2018 Meetings International Pte Ltd, All Rights Reserved.