

## **Liquid flow through paper**

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### **Abstract**

Paper is one of the most widely used porous media for absorbing liquid, and accurate control of water imbibition in paper is crucial in developing paper-based microfluidic devices. Washburn equation is usually used to describe the dynamics of the liquid flow through the cellulose matrix of paper. However, it is well known that this equation has limitations in predicting water flow in paper. We report that swelling and intra-fiber pores that have not been considered in developing Washburn equation are mainly responsible for the limited accuracy when predicting imbibition length of water. We demonstrate that cellulose fibers have significant internal voids that absorb water. In addition, we quantify water induced swelling that leads to the expansion of inter-fiber space. We develop a hydrodynamic model of water imbibition with the consideration of intra-fiber voids and cellulose fiber swelling that well explain experimental observations. Our study provides a new insight into not only porous media flow with intra-void structure and swelling effects, but also a theoretical background to design  $\mu$ PADs.

**Keywords:** *capillary flows, porous media*

### **References**

- [ 1 ] S Chang, J Seo, S Hong, DG Lee, W Kim, Dynamics of liquid imbibition through paper with intra-fibre pores, Journal of Fluid Mechanics 845, 36-50

### **Biography**

Prof. Wonjung Kim is an Associate Professor with the Department of Mechanical Engineering, Sogang University and currently a visiting professor at Technical University of Denmark. He received the B.S. and M.S. degrees in mechanical engineering from Seoul National University, and the Ph.D. degree from MIT. Since joining the Faculty of Sogang University in 2013, he has been conducting experimental and theoretical research on microscale fluid dynamics for engineering and biological applications.