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Design of Capillary Flows with Spatially Graded Porous Films YOUNG SOO JOUNG, BRUNO MICHEL FIGLIUZZI, CULLEN BUIE, Massachusetts Institute of Technology — We have developed a new capillary tube model, consisting of multi-layered capillary tubes oriented in the direction of flow, to predict capillary speeds on spatially graded porous films. Capillary flows through thin porous media have been widely utilized for small size liquid transport systems. However, for most media it is challenging to realize arbitrary shapes and spatially functionalized micro-structures with variable flow properties. Therefore, conventional media can only be used for capillary flows obeying Washburn's equation and the modifications thereof. Given this background, we recently developed a method called breakdown anodization (BDA) to produce highly wetting porous films. The resulting surfaces show nearly zero contact angles and fast water spreading speed. Furthermore, capillary pressure and spreading diffusivity can be expressed as functions of capillary height when customized electric fields are used in BDA. From the capillary tube model, we derived a general capillary flow equation of motion in terms of capillary pressure and spreading diffusivity. The theoretical model shows good agreement with experimental capillary flows. The study will provide novel design methodologies for paper-based microfluidic devices.

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