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Fingering Instabilities during Capillary Imbibition into Paper N. YOUNG, B.G. HIGGINS, W.D. RISTENPART, Dept. Chem. Engr. & Mat. Sci., Univ. California at Davis — When a porous medium, such as a piece of paper, is placed into contact with a liquid reservoir, capillary action drives the liquid through the porous medium. The penetration distance $L(t)$ of the liquid/air interface is typically described by the Lucas-Washburn equation, with any deviations normally occurring on a length scale set by the average pore size. Here we report that solutions with a sufficient amount of hydrophobic solute undergo a fingering instability during capillary imbibition into paper. The finger amplitudes are two to three orders of magnitude larger than the average pore size, suggesting that the typical capillary fingering mechanism is not operative. Instead, we demonstrate that the finger growth rate is directly proportional to the solute concentration, and is strongly mediated by the ambient relative humidity. We interpret the fingering in terms of an instability driven by solutal effects on the local imbibition velocity, and we discuss the implications for various applications including thin layer chromatography and paper-based microfluidics.

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