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Controlling capillary fingering using pore size gradients in disordered media NANCY LU, CHRISTOPHER BROWNE, DANIEL AMCHIN, Department of Chemical and Biological Engineering, Princeton University, JANINE NUNES, Department of Mechanical and Aerospace Engineering, Princeton University, SUJIT DATTA, Department of Chemical and Biological Engineering, Princeton University — Capillary fingering is a displacement process that can occur when a non-wetting fluid displaces a wetting fluid from a homogeneous disordered porous medium. Here, we investigate how this process is influenced by a pore size gradient. Using microfluidic experiments and computational pore-network models, we show that the non-wetting fluid displacement behavior depends sensitively on the direction and the magnitude of the gradient. The fluid displacement depends on the competition between a pore size gradient and pore-scale disorder; indeed, a sufficiently large gradient can completely suppress capillary fingering. By analyzing capillary forces at the pore scale, we identify a non-dimensional parameter that describes the physics underlying these diverse flow behaviors. Our results thus expand the understanding of flow in complex porous media and suggest a new way to control flow behavior via the introduction of pore size gradients.

Nancy Lu
Department of Chemical and Biological Engineering, Princeton University

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