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The effect of a blurred interface on the viscous fingering instability THOMAS E. VIDEBAEK, Department of Physics, University of Chicago, THIBAULT GUILLET, Department of Mechanics, École Polytechnique, IRMGARD BISCHOFBERGER, Department of Mechanical Engineering, Massachusetts Institute of Technology, SIDNEY R. NAGEL, Department of Physics, University of Chicago — The viscous fingering instability in a quasi-two dimensional Hele-Shaw cell provides a simple tool for studying a complex structure formation. Concentrating on the instability between pairs of miscible fluids where the interfacial tension is nearly zero, we smooth out the discontinuity in the gap-averaged viscosity at the boundary between the fluids; in this system we discover two new features. (i) We find a delay in the instability onset when we change the curvature of the finger tip by applying an oscillatory translational shear of the top plate. (ii) We observe a sharp transition in the structure of the fingers when we decrease the injection rate of the inner fluid so that diffusion smooths the interface. At this transition, there is a jump in both the wavelength and the onset radius of fingering as well as a change in the three-dimensional structure as the fingers go from half filling to fully filling the cell. These experiments indicate that, by controlling the viscosity contrast at the interface, one can alter and perhaps even completely suppress the instability.

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