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A transition in the viscous fingering instability in miscible fluids THOMAS VIDEBAEK, SIDNEY R. NAGEL, University of Chicago — The viscous fingering instability in a quasi-two dimensional Hele-Shaw cell is an example of complex structure formation from benign initial conditions. When the invading fluid has the lesser viscosity, the interface between the two fluids is unstable to finger formation. Here, we study the instability between pairs of miscible fluids in a circular cell with fluid injected at its center. As the injection rate is decreased, diffusion will smooth out the discontinuity in the gap-averaged viscosity at the interface between the fluids. At high injection rates (i.e., high Péclet number, Pe), fingering is associated with three-dimensional structure within the gap between the confining plates. On lowering Pe, we find a sharp transition in the finger morphology at a critical value, $\mathrm{Pe_c} \sim (\eta_\mathrm{i}/\eta_\mathrm{o})^{1/2}$, with η_i (η_o) being the viscosity of the inner (outer) fluid; at this point, the width of the fingers jumps, the length of the fingers shrinks towards zero and the three-dimensional structure goes from half filling to fully filling the gap. Thus, by controlling the viscosity contrast at the interface, one can alter and even completely suppress the instability.

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