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Anomalous structure formation in the zero surface tension limit of viscous fingering IRMGARD BISCHOFBERGER, RADHA RAMACHANDRAN, SIDNEY R. NAGEL, The University of Chicago, Department of Physics, THE UNIVERSITY OF CHICAGO TEAM — The displacement of a more viscous fluid, of viscosity η_{out}, by a less viscous one, of viscosity η_{in}, in a two-dimensional geometry or a porous medium is unstable and typically produces complex fingering patterns. These fingering patterns are predicted to become sharper as the surface tension between the two fluids is decreased. However, our experiments performed in a radial Hele-Shaw cell suggest the opposite conclusion: fingering is less likely to occur in the limit of low surface tension. When the two fluids are miscible, so that the surface tension is negligible, the instability can be entirely suppressed; when the viscosity ratio of the two fluids, η_{out}/η_{in}, is greater than, but close to, one, the interface between the fluids is circular. With increasing viscosity ratio, the pattern starts to develop small blunt structures (toes) and when the viscosity ratio is large the pattern consists of highly branched fingers. We measure the amount of external fluid that gets displaced by the less viscous one and find that the displacement across the gap is always incomplete; the fingers form three dimensional structures. We discuss the implications of this 3D nature of the instability on the overall pattern formation.

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