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Wetting, disorder, and pattern formation

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In their seminal work, Saffman and Taylor showed that the displacement of a more viscous fluid by a less viscous one in a Hele-Shaw cell, as an analogue porous medium, leads to an interfacial instability. This description, however, neglects the inherent disorder in porous media, as well as the non-hydrodynamic interactions between the fluids with the solid surfaces. Here, we revisit the Saffman-Taylor instability using a roughened Hele-Shaw cell and show that the interplay between disorder and wettability of the medium can fundamentally alter the pattern formation dynamics. Our observations show the critical role of the contact-line dynamics in the macroscopic pattern formation, and point to new directions for controlling flows with applications ranging from microfluidics to CO₂ sequestration.

References

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