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Wetting and roughness: pattern formation in a rough fracture AMIR PAHLAVAN, LUIS CUETO-FELGUEROSO, GARETH MCKINLEY, RUBEN JUANES, Massachusetts Institute of Technology — Wetting phenomena are inherently multiscale; owing to the complex nature of porous and fractured media, immiscible flows in this setting continue to challenge our microscopic and macroscopic descriptions. To gain some insight into the interplay between wettability and roughness of the medium, here we study experimentally the immiscible displacement of one fluid by another in a Hele-Shaw cell (two glass plates separated by a thin gap) with rough surfaces. We use a radial Hele-Shaw cell and saturate it with highly viscous silicone oil; we then inject a less viscous liquid at the center of the cell. Displacement of a more viscous liquid by a less viscous one leads to a hydrodynamic instability, known as viscous fingering. Wettability of the medium, however, has a profound influence on the displacement pattern and can lead to a complete suppression of the instability. Roughness, on the other hand, amplifies the wettability of the medium, and can also lead to contact-line pinning and intermittent avalanche-like behavior in the flow. We study the interplay between roughness and wettability of the medium by isolating each effect. We then propose a phase diagram that classifies the different displacement patterns, elucidating the underlying physics at play across scales.

Amir Pahlavan
Massachusetts Institute of Technology

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