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**Viscous fingering with partial miscible fluids** XIAOJING FU, LUIS CUETO-FELGUEROSO, RUBEN JUANES, Massachusetts Inst of Tech-MIT —  
When a less viscous fluid displaces a more viscous fluid, the contrast in viscosity destabilizes the interface between the two fluids, leading to the formation of fingers. Studies of viscous fingering have focused on fluids that are either fully miscible or perfectly immiscible. In practice, however, the miscibility of two fluids can change appreciably with temperature and pressure, and often falls into the case of partial miscibility, where two fluids have limited solubility in each other. Following our recent work for miscible (Jha et al., PRL 2011, 2013) and immiscible systems (Cueto-Felgueroso and Juanes, PRL 2012, JFM 2014), here we propose a phase-field model for fluid-fluid displacements in a Hele-Shaw cell, when the two fluids have limited (but nonzero) solubility in one another. Partial miscibility is characterized through the design of thermodynamic free energy of the two-fluid system. We elucidate the key dimensionless groups that control the behavior of the system. We present high-resolution numerical simulations of the model applied to the viscous fingering problem. On one hand, we demonstrate the effect of partial miscibility on the hydrodynamic instability. On the other, we elucidate the role of the degree of fingering on the rate of mutual fluid dissolution.

Xiaojing Fu  
Massachusetts Inst of Tech-MIT

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