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Controlling Interfacial Instabilities in Hele-Shaw Cells: Theory SHUWANG LI, JOHN LOWENGRUB, University of California at Irvine, JAKE FONTANA, PETER PALFFY-MUHORAY, Liquid Crystal Institute, KSU — The growth of crystals in an undercooled melt and interface evolution in Hele-Shaw cells are governed by similar underlying mathematics. Hele-Shaw experiments can therefore give valuable insights into crystal growth. In the context of crystal growth, Li, Lowengrub and co-workers have demonstrated (e.g. see J. Crystal Growth, Physica D) that by varying the temperature conditions in the far-field in a prescribed way without feedback, interface instabilities (e.g. Mullins-Sekerka) can be suppressed and crystals may be grown with desired symmetries. Interestingly, at long times nonlinear stabilization is observed and leads to the existence of universal crystal shapes that depend only on the far-field temperature conditions. Here, this work is adapted to interface evolution in Hele-Shaw cells where the control parameter is the injection pressure. Namely, we consider the displacement of oil by air and we demonstrate that by varying the injection pressure in a prescribed, time-dependent way (without feedback) that the Saffman-Taylor instability can be suppressed and controlled such that bubbles of desired symmetries can form. This is in agreement with recent experimental predictions (presented separately in this session). We further predict the existence of universal bubble shapes that depend only on the injection pressure; the experimental confirmation of such universal shapes is the subject of ongoing studies.

Peter Palffy-Muhoray
Liquid Crystal Institute

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