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Designing functional materials with interfacial instabilities in thin films PIERRE-THOMAS BRUN, JOEL MARTHELOT, ELIZABETH STRONG, PEDRO REIS, MIT — We harness interfacial instabilities in thin liquid films to fabricate lens-shaped solid structures. A liquid elastomeric polymer is spin-coated on a flat substrate to create a uniform film, which is then turned upside-down, leading to the formation of a pattern of drops that emerges through the Rayleigh-Taylor instability. As the polymer cures, this array of liquid drops solidifies, thereby permanently structuring the geometry of the originally fluid system. The drops arrange in a lattice pattern with a wavelength that is well captured by stability analysis so that tuning the properties of the polymer enables us to tailor the morphology of the drops. Upon curing, the drops can then be peeled off from the substrate. Carefully designing a layout of surface defects, etched on the substrate onto which the thin film is initially deposited, is used as seed perturbations that trigger the instability in a controlled manner. This perturbation field significantly augments the monodispersity of the final solid structures, thereby making the fabrication process both robust and scalable. We demonstrate that by using an optically clear polymer (e.g. PDMS) during fabrication, the solid drops that are produced act as working lenses that can readily turn any smartphone into a microscope.

Pierre-Thomas Brun
MIT

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