Abstract Submitted
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Liquid-Bridge Breaking Limits ASHLEY MACNER, PAUL STEEN, Cornell University — Wet adhesion by liquid bridges in large arrays shows promise for use in lightweight, controllable on-demand devices. Applications include grab/release of wafer substrates, transport of micron-sized tiles for use in 3D printing and micro-dosing of personalized pharmaceutical drugs. By wetting and spreading, a drop can form a bridge and thereby "grab" a nearby solid substrate. By volume decrease or extension, the bridge can break. The breaking limit corresponds to bridge instability which can be predicted, knowing the static mechanical response of the bridge. Mechanical behaviors include force-volume (FV), pressure-volume (pV) and force-length (FL) responses. Instability crucially depends on the mode of failure – failure under constant-force or constant length are typical cases. We study single bridge equilibria for their breaking limits. FV diagrams for the pin-pin equal and pin-pin unequal radii boundary conditions for different bridge heights are measured in the laboratory. The FL response in the case of pin-pin equal radii is also measured. Results are compared to predictions of static theory. Static results are then used to compare to dynamical sequences where volume is driven quasistatically by syringe or an electro-osmotic pump. As the breaking limit is approached, the shape deformation accelerates leading to non-equilibrium shapes not captured by the static analysis.

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