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Stability of Liquid Rivulets on Liquid Substrate COLIN CERRETANI, SHO TAKATORI, CLAYTON RADKE, University of California, Berkeley — The human tear-film lipid layer is a thin (100nm) oily film on water. Such films are unstable and dewet into lenses surrounded by a monolayer (Harkins, 1941). Dewetting has four stages: initial rupture, hole growth, hole coalescence, and retraction into lenses. The human lipid layer is shown to behave similarly. Brochard-Wyart has addressed the first two stages (1993); here we focus on the third. As adjacent holes grow into each other, the oil between them takes the shape of a long, thin rivulet with a lens cross-section. Eventually this rivulet undergoes an instability and the holes coalesce. We perform a linear stability analysis on a thin symmetric lens rivulet on a horizontal liquid substrate at low Bond number (Davis, 1980; Schiaffino, 1997), accounting for the first time for the liquid-substrate hydrodynamics. Analytical expressions are derived for the wavelength and breakup times associated with the maximum growth rate of the instability for multiple substrate flow conditions. We show that for negligible thin-film forces, a liquid rivulet on an immiscible liquid substrate is unstable at a critical wavelength disturbance. The instability growth rate varies by orders of magnitude depending on the lens contact angle.

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