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Thin film flow along a periodically-stretched elastic beam CHRIS BOAMAH MENSAH, GREG CHINI, Univ of New Hampshire, OLIVER JENSEN, University of Manchester — Motivated by an application to pulmonary alveolar micro-mechanics, a system of partial differential equations is derived that governs the motion of a thin liquid film lining both sides of an inertia-less elastic substrate. The evolution of the film mass distribution is described by invoking the usual lubrication approximation while the displacement of the substrate is determined by employing a kinematically nonlinear Euler–Bernoulli beam formulation. In the parameter regime of interest, the axial strain can be readily shown to be a linear function of arc-length specified completely by the motion of ends of the substrate. In contrast, the normal force balance on the beam yields an equation for the substrate curvature that is fully coupled to the time-dependent lubrication equation. Linear analyses of both a stationary and periodically-stretched flat substrate confirm the potential for buckling instabilities and reveal an upper bound on the dimensionless axial stiffness for which the coupled thin-film/inertial-less-beam model is well-posed. Numerical simulations of the coupled system are used to explore the nonlinear development of the buckling instabilities.

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