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A Thin-Film Model for Droplet Spreading on Soft Solid Substrates VASILEIOS CHARITATOS, SATISH KUMAR, University of Minnesota — The spreading of droplets on soft solid substrates is relevant to applications such as tumor biophysics and controlled droplet condensation and evaporation. In this paper, we apply lubrication theory to advance fundamental understanding of the important limiting case of spreading of a planar droplet on a linear viscoelastic solid. The contact-line region is described by a disjoining-pressure/precursor film approach, and nonlinear evolution equations describing how the liquid-air and liquid-solid interfaces evolve in space and time are derived and solved numerically. Parametric studies are conducted to investigate the effects of solid thickness, viscosity, shear modulus, and wettability on droplet spreading. Softer substrates are found to speed up spreading for perfectly wetting droplets but slow down spreading for partially wetting droplets. For perfectly wetting droplets, faster spreading is a result of more liquid being pumped toward the contact line due to a larger liquid film thickness there arising from the repulsive component of the disjoining pressure. In contrast, slower spreading of partially wetting droplets is a result of less liquid being pumped toward the contact line due to a smaller liquid film thickness there arising from the attractive component of the disjoining pressure. The model predictions for partially wetting droplets are qualitatively consistent with experimental observations, and allow us to disentangle the effects of substrate deformability and wettability on droplet spreading. Due to its systematic formulation, our model can readily be extended to more complex situations involving multiple droplets, substrate inclination, and droplet phase changes.

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