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Dynamic wetting and dewetting of viscous liquid droplets/films on viscoelastic substrates

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Liquid droplets on soft, solid, elastic substrates tend to deform the substrate on which they sit due to the interaction of interfacial and elastic forces. This deformation is the more pronounced the softer the substrate. Our project aims at understanding the mechanisms that determine the resulting morphology of equilibrium droplets.
To study these phenomena, we explore the dewetting of nanoscopic liquid polystyrene (PS) layers from polydimethylsiloxane (PDMS) elastomer substrates with elasticities varying from G = 1 kPa to 2 MPa. The experimental results reveal a strong influence of the PDMS elasticity on the dewetting dynamics. At the late stages of dewetting, we obtain PS droplets sitting on PDMS seemingly surrounded by a “ring”of liquid, non-crosslinked PDMS molecules at the three-phase contact line (TPCL). This ring appears to be more prominent when the PDMS substrate is softer with a larger proportion of non-crosslinked PDMS molecules compared to stiffer PDMS substrates with only a small proportion of non-cross-linked PDMS molecules.
To understand the experimental observations in detail, we are developing certain numerical techniques that allow us to reveal this liquid phase and the corresponding shape of equilibrium droplets for different substrates and adapt a physical model that can explains it.

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