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Investigating equilibrium droplets on elastic substrates

The dewetting and equilibration of liquids on soft solids is studied and compared quantitatively with numerical simulations from our tandem project using the experimentally derived input parameters. The size of the explored liquid structures is well below the capillary length and in the range of the elastocapillary length. For these studies, we use a system consisting of a 120 nm thick liquid layer of Polystyrene (PS) with a molecular weight of 18 kg/mol, which is dewetting from polydimetylsiloxane (PDMS) substrates with elasticities varying between 3 kPa and 1.2 MPa. Combining optical microscopy, atomic force microscopy and a lift-off technique, we explore the influence of elasticity on the dynamics of the dewetting process and the 3d shape of the formed transient dewetting rims and the equilibrium droplets shapes.

The dewetting rims reveal a characteristic shape with a dewetting velocity that depends non-monotonously on substrate elasticity. The global shape of equilibrium drops is lenticular and can be described well with numerical models. At the three-phase contact line, however, there is a deviation from this simple geometric shape. The three phase contact line is pulled further upwards and inwards than predicted with an unexpected region of liquid PDMS extracted from the bulk. Besides the changes in drop shape, the demixed liquid also leads to cloaking of the PS droplet and a reduced interfacial tension. This demixing and the deviation from the lenticular shape is more pronounced for softer substrates and smaller droplets.

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