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Measuring dynamic forces between droplets and polymeric surfaces

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Droplets sitting on soft, polymeric surfaces form so-called wetting ridges around their three-phase contact line. The vertical component of the droplet's surface tension exerts traction on the surface, leading to elastic deformation of the polymer network and accumulation of unbounded polymer chains. When droplets move over the surface, the wetting ridge moves accordingly, yielding visco- and poroelastic surface responses. The coupling between surface response, free chain reorganization, and the sliding droplet is key to understanding liquid repellency. However, investigations are hampered by the large-scale separation of unbound polymer chains (nanometer), surface (micrometer), and droplet (millimeter). Here, we utilize confocal laser scanning microscopy and interferometry to directly visualize the wetting ridge during droplet motion. Those methods let us distinguish between phases and enable optical resolutions below a micron. A novel optical force sensor let us measure the evolving friction forces between droplets and surface which occur in the order of micro Newton. We show that friction forces scale with velocity and contact lubrication. The presented techniques give new methods to directly determine the coating rheology of soft surfaces.

Hauptautoren: HAUER, Lukas (Max Planck Institut for Polymer Research); Prof. VOLLMER, Doris (Max Planck Institut for Polymer Research)

Vortragende(r): HAUER, Lukas (Max Planck Institut for Polymer Research)

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