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Wetting And Adhesion Of Soft And Swollen Polymeric Interfaces

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Soft surfaces are found in a host of applications, from coatings and adhesives to 3D printing to and soft devices. However, understanding the behavior of soft interfaces is an ongoing challenge. For many applications, crosslinked polymeric networks are implemented for their useful properties. When these crosslinked materials are sufficiently soft, or the relevant size scale becomes sufficiently small, they display liquid-like characteristics – properties traditionally reserved for liquids emerge as an important part of the response, like capillarity. Moreover, many soft polymeric surfaces are inherently swollen or infused with a liquid, which can also lead to true liquid behavior. By using fluorophores, confocal microscopy, and custom experimental testing setups, we investigate how static and dynamic water drops or particles interact with soft or swollen polymer coatings. We show that combinations of both solid and liquid characteristics control how drops and/or particles interact with soft deformable surfaces. In particular, we demonstrate conclusively how the swelling liquid separates near a three-phase contact line, which is a function of the type of swelling liquid, the swelling ratio, the crosslinking, and the dynamics. Based on confocal microscopy images, we propose a theory for liquid separation and network deformation near the contact line. In dynamic cases, the liquid separation behavior is altered, which appears to be a function of the swelling ratio and the drop velocity. We expect that these swollen surfaces can also adhere and collect solid particulates, like dust and aerosols if desired. For example, on soft surfaces with a layer of oily liquid, microparticles make contact differently as a function of their size relative to the oil layer. The knowledge from these studies should offer guidelines for the design of coatings, and potentially filters, that repel and/or collect external contaminants for a broad range of applications.

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