The effects of interfacial shear elasticity on droplet spreading dynamics

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The interaction between liquid droplets and solids is ubiquitous in many commercial and industrial applications. Often the application governs the nature of the liquid-solid interaction with the droplet adhesion and the ability to coat a substrate controlled by physical, chemical and environmental conditions. Researchers have studied droplet spreading dynamics and developed fundamental understanding for a range of liquid and surface properties including wettability, viscosity, surface tension, etc. However, to the authors' knowledge the effect of interfacial shear elasticity on droplet spreading dynamics has not previously been considered.

Saponin, a bio-surfactant, was used to significantly increase the interfacial shear elasticity of a droplet air-water interface. Using a DHR-II TA Instruments rheometer, Figure 1a shows the time-dependent growth of interfacial shear elasticity, with concentrations above the CMC (0.008 wt.%) forming, strongly elastic interfacial films within a few minutes. Studying the bulk rheology of these solutions it was identified that the condition 0.01 wt.% saponin provided rapid interfacial aging but did not significantly increase the viscosity of the bulk fluid, the relative viscosity $\left(\frac{\mu_{sap}}{\mu_{wat/eth}}\right)$ at 10 s^{-1} equals 1.1 and equals 0.97 at a 100 s^{-1}, thus the difference in bulk rheology between a water/ethanol (7.5% ethanol) droplet and a water droplet with strong interfacial elasticity is minimal.

The droplet spreading dynamics were captured at 10,000 fps as a droplet was gradually brought into contact with a silicon wafer. Early observations indicate increased dampening of the air-water interface in the presence of saponin and modification to the spreading rate. For the first time, the critical role of interfacial shear rheology on droplet dynamics is being explored.

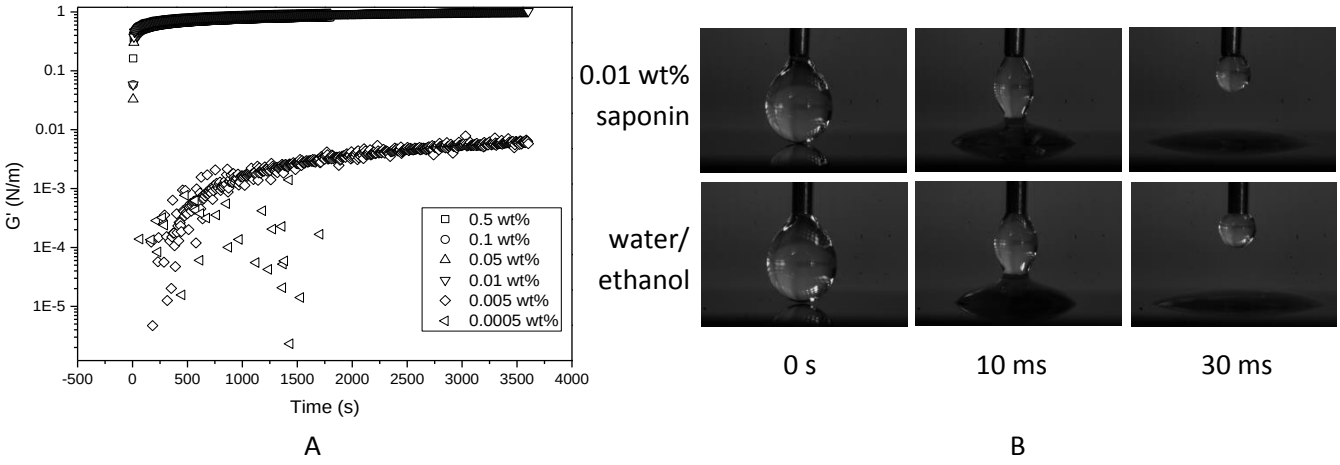

Figure 1: a) The interfacial elasticity was plotted as a function of time in order to show the time dependence of the film b) Shows a water/ethanol and 0.01 wt% saponin droplet spreading on a silicon wafer.