SPREADING AND CONTRACTING THREE-COMPONENT DROPLETS

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When a binary droplet is placed on a surface, inhomogeneous evaporation (1) can cause surface tension gradients that lead to enhanced spreading (2) or droplet formation, even on a fully wetting surface (3). Introduction of additional components can lead to much richer dynamics as seen in Ouzo and Whiskey droplets. (4,5).

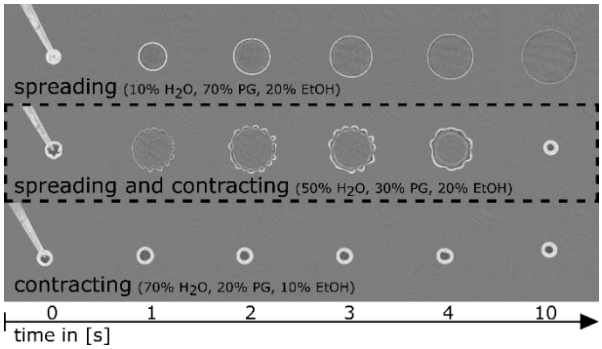

Figure 1: Timeseries of the three different dynamics observed in ternary droplets. We focus on the spreading and contracting dynamic only seen in ternary droplets.

Here we explore the Marangoni convection of a fully miscible, three-component system of water, ethanol, and propylene glycol on a completely wetting substrate. Evaporation of ethanol (most volatile and lowest surface tension) results in a higher surface tension around the perimeter of the droplet and causes rapid spreading. After ethanol has mostly evaporated, water evaporation (next most volatile component and highest surface tension) from the perimeter reverses the surface tension gradient. This induces a reversal in the direction of Marangoni stress and causes the droplet to contract.

We investigate the ternary parameter space of compositions at different relative humidities to understand how the interplay of Marangoni flow, capillary flow, and evaporation give rise to different droplet dynamics. Such a ternary self-spreading and contracting droplet may have applications in cleaning high energy surfaces.

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