BUCKLING INDUCED SURFACE MORPHOLOGY TRANSITION OF DRYING POLYMER BASED DROPLET

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Drying of complex liquids to form structural solids, as a conventional and cost-effective technique, has been widely used in the fabrication of many industrial products, such as membranes, bio-scaffolds, cell substrates and drug carriers. The challenge arising from this drying process is how to control the morphologies of the formed solids. The current strategy is to design and establish the desired surface chemical/physical equilibrium during the evaporation of the solvent, by adjusting the droplet ingredients and environmental conditions. Understanding of the process is based on the thermo-dynamic equilibrium of the surface/interface when forming the elastic shell and the mechanics of the subsequent shell deformation.

In this project, we are investigating the formation of the morphology and the transition/evolution in a Polyvinylpyrrolidone (PVP) based droplet. Our experiments consider various inputs such as chemical composition of the droplet, the solvent, the molecular weight of polymer, evaporation temperature and surface wettability. The morphology has been investigated using fluorescence microscopy and Laser Scanning Confocal Microscopy (LSCM). Figure 1 shows the controllable morphologies on a single droplet. There is a scaling relation between the time to the onsite of buckling and initial geometries of the droplet. For drops with the same contact angle and concentration, $t_B \sim (1 - RH)^{-2}(V_0)^{2/3}$, where R is the radius, H is the height and V_0 is the initial volume of the droplet. In this study, the controllable morphology formation/transition are discussed in terms of a phase diagram as a function of the system variables. This provides an understanding of how to controllably form structures when drying a polymer droplet. These results have potential applications in the fabrication of bio-scaffolds.

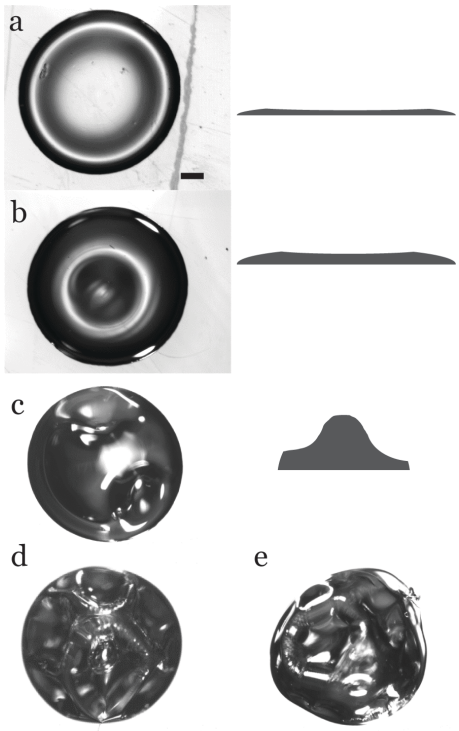

Figure 1. The controllable morphologies includes, a) pancake, b) deep pancake, c) double buckling, d) quadruple bucking , e) crumpling.

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