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Solid Angle Approach to Quantify the Shape of Daughter Cavity in Drying Nano Colloidal Sessile Droplets

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Abstract : Drying of a sessile droplet imbibed with colloidal solution is a complex process in many aspects. Till now, most of the work revolves around; conditions for buckling onset, post-buckling effects, nature of change of droplet shape etc. In this work, we are determining the shape of daughter cavity (DC) formed during post-buckling onset, a less explored stage, and its relationship with experimental parameters. We have introduced solid angle as a special parameter that can quantify the shape of DC at any instant. It facilitates us to compare the shape while experimenting across different substrate types, droplet sizes and particle concentration. Furthermore, the angular location of 'weak spot' on the periphery of droplet, which marks the initiation of cavity growth, varies in different conditions. To solve this problem, we have evaluated the deflection angle of weak spots w.r.t. the vertical axis going through the middle of droplet. Subsequently, the solid angle subtended by DC is analyzed about that inclined axis. Finally, results of analysis allude that increasing colloidal concentration has inverse effect on the growth rate of cavity's shape. Moreover, the cap radius of DC is observed lower for high PLR which makes the capillary pressure higher and thus tougher to expedite cavity formation relatively. This analysis can be helpful in further studies to relate the shape, deflection angle, growth rate of daughter cavity to the type of droplet crust formed in the end. Examining DC stage shall add another layer to nano-colloidal research which aims to influence many industrial applications like patterning, coatings, drug delivery, food processing etc.

Keywords : buckling of sessile droplets, daughter cavity, droplet evaporation, nanoporous shell formation, solid angle
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