Colloid Droplet Transport and Micro/nanoparticle Self-assembly

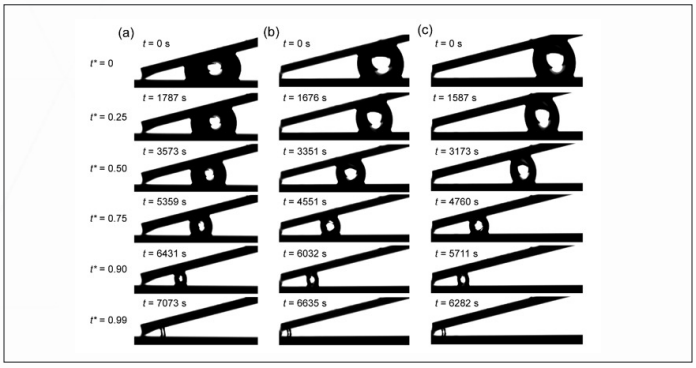
VTIP 21-100: “Topography-guided Colloidal Transport and Assembly in an Evaporating Liquid Droplet”

THE CHALLENGE

Physical transport and thermal evaporation of liquid microdroplets are two essential phenomena in biochemical analyses and colloidal materials assembly. However, techniques utilizing these two phenomena were developed separately and applied independently. It remains unclear how simultaneously leveraging both phenomena might influence downstream applications.

OUR SOLUTION

The Cheng lab has developed technologies enabling the transport of a colloidal droplet and the self-assembly of micro/nanoparticles contained in the evaporating droplet in a combined manner. By leveraging structures asymmetric geometries, e.g., V-shaped grooves or non-parallel plates, the morphology of a confined droplet can be controlled while evaporating, allowing for the unidirectional transport of the droplet. Furthermore, this technology minimizes potentially-undesirable colloid deposition properties of evaporating liquids such as the coffee-ring effect, resulting in the enrichment of initially dilute analytes for downstream detection applications.



Snapshots over time of an evaporating droplet confined between two non-parallel hydrophobic surfaces with dihedral angle (α = 14°) and different initial droplet locations (l0 = (a) 3000 μm, (b) 4500 μm, and (c) 5350 μm).

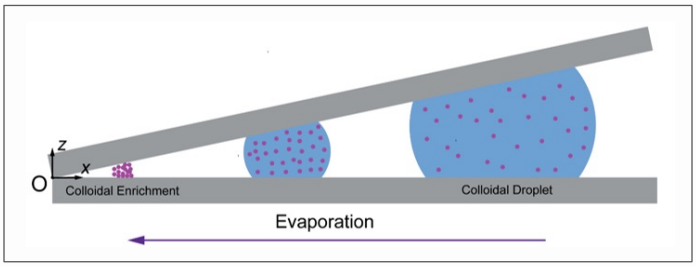
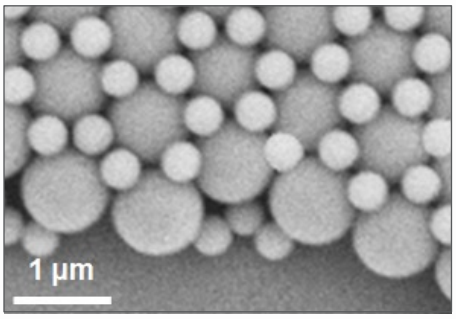


Illustration of a colloidal droplet moving towards the cusp of a V-shaped groove while evaporating, resulting in solute enrichment at the cusp upon full evaporation.



The self-assembly of binary colloidal particles into crystal structures.

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