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Interfacial Dynamics and Heat Transfer of Microdroplets on Biphilic Micro/Nanostructured Surfaces

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Utilizing biphilic micro/nanostructured surfaces has attracted significant attention owing to their special features in controlling interfacial dynamics and evaporation of sessile droplets. Though significant progress has been made in studying contact line dynamics and evaporation of a sessile droplet on homogeneous surfaces, many unanswered questions remain for chemically patterned biphilic surfaces. Furthermore, the heat transfer and evaporation of a multicomponent droplet on a chemically patterned surface is more complex due to local Marangoni force variations. In fact, the pinning and depinning of a sessile droplet on chemically patterned surfaces are determined by the interplay of the interfacial free energies of the droplet and the wettability pattern of the surfaces. The interplay can give rise to morphological transitions upon changing the volume/concentration of the droplet or the wettability contrast and thus the contact angle on the substrate.

In this talk, the questions of the effects of micro/nanofabricated surfaces with chemical patterns on the interfacial dynamics, heat transfer and evaporation of single/multi-component sessile droplets are addressed. We first report the dynamics of droplets on hydrophobic-network surfaces and found out that the evaporation processes can be divided into different stages. We developed analytical models for accurately predicting the transition of evaporation stage (critical receding contact angle). The effective contact line length that affects the evaporation rate is analyzed taking the influence of chemically patterned surfaces into consideration. The contact line dynamics, fluid flow and species dynamics of an evaporating multicomponent droplet on chemically patterned surfaces are reported utilizing a novel AIEgen-based direct high speed visualization technique. Utilizing the experimental and analytical results, the mechanisms behind contact line pinning/depinning and the critical receding contact angles under different species concentrations on biphilic micro/nanostructured surfaces are discussed in details on the microscale.