3D view of evaporating multicomponent droplets

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The evaporation of liquid droplets is a common occurrence in nature and technology. The fundamental physics has been investigated widely over the past decades, motivated not only by scientific researches but also by various practical applications ranging from inkjet printing, coating, spray cooling, deposition of materials to food industry. However, further understanding is required about the evaporating behaviours of multicomponent droplets rather than pure liquid droplets. In the current work, we observe the evaporation process of multicomponent droplets in 3D view using confocal microscopy. Thanks to the different dyes labelling different components, the overall behaviours inside and outside the binary and the ternary mixtures of liquids have been investigated. For the evaporating binary droplets, segregation of two miscible components has been captured, which is identified as the influence factor of the evaporation rate. Flow patterns on the droplet surface due to the convection of the segregated components are also obtained, as well as the convection flow inside the droplet. For the evaporating ternary droplets, we pick a sessile Ouzo droplet (a mixture of water, ethanol, and anise oil) as the model system. Four life phases have been revealed along with the nucleation of oil droplets due to the varying solubility of oil in ethanol-water mixtures. The nucleation occurs first at the rim of the Ouzo droplet and then allover. An oil ring will eventually form at the rim of the Ouzo droplet. The variations of the contact angles at the phases contact line (the junction of air, oil ring, and ethanol-water mixture) are revealed, showing the complex dynamic evaporation process of ternary droplets. The movement and development of the oil droplets inside the Ouzo droplet can also be recorded in three dimensions, indicating the convection flow. The current work provides a further understanding of the fundamental phenomena in multicomponent droplet evaporation.