

# Physiochemical hydrodynamics of the phase-segregation in an evaporating binary microdroplet

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Phase segregation triggered by selective evaporation can emerge in multicomponent systems, leading to complex physiochemical hydrodynamics. Recently, Li *et al.* (*Phys. Rev. Lett.*, vol. 120, 2018, 224501) and Kim & Stone (*J. Fluid Mech.*, vol. 850, 2018, 769) reported a segregative behavior (i.e., demixing) in an evaporating binary droplet. In this work, by means of experiments and theoretical analysis, we investigate the flow dynamics *after the occurrence of the phase segregation*. As example, we take the 1,2-hexanediol-water binary droplet system. First, we experimentally reveal the overall physiochemical hydrodynamics of the evaporation process, including the segregative behavior and the resulting flow structure close to the substrate. By quantifying the evolution of the radial flow, we identify three successive life stages of the evaporation process. At Stage I, a radially outward flow is observed. It is driven by the Marangoni effect. At the transition to Stage II, the radial flow partially reverses, starting from the contact line. This flow breaks the axial symmetry and remarkably is driven by the segregation itself. Finally at Stage III, the flow decays as the evaporation gradually ceases. At this stage the segregation has grown to the entire droplet, and the flow is again controlled by the Marangoni effect. The resulting Marangoni flow homogenizes the distribution of the entrapped volatile water over the whole droplet.

**Key words:** Binary droplet evaporation, phase segregation, Marangoni flow, physiochemical hydrodynamics

## 1. Introduction

Evaporation of sessile droplets has been vastly studied in the past decades (Cazabat & Guéna 2010; Brutin 2015; Zang *et al.* 2019; Lohse & Zhang 2020; Wang *et al.* 2022). Beyond the scope of fundamental research, the interest also originates from its huge relevance to various technological and biological applications, e.g. inkjet printing (Park

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# Physiochemical Hydrodynamics An Introduction

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