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Lattice Boltzmann Simulations of Evaporating Droplets with Nanoparticles MINGFEI ZHAO, XIN YONG, Binghamton University — Elucidating the nanoparticle dynamics in drying droplets provides fundamental hydrodynamic insight into the evaporation-induced self-assembly, which is of great importance to materials printing and thin film processing. We develop a free-energy-based multiphase lattice Boltzmann model coupled with Lagrangian particle tracking to simulate evaporating particle-laden droplets on a solid substrate with specified wetting behavior. This work focuses on the interplay between the evaporation-driven advection and the self-organization of nanoparticles inside the droplet and at the droplet surface. For static droplets, the different parameters, fluid-particle interaction strength and particle number, governing the nanoparticle-droplet dynamics are systematically investigated, such as particle radial and circumferential distribution. We clarify the effect of nanoparticle presence on the droplet surface tension and wetting behavior. For evaporating droplets, we observe how droplet evaporation modulates the self-assembly of nanoparticles when the droplet has different static contact angles and hysteresis windows. We also confirm that the number of nanoparticles at the liquid-vapor interface influences the evaporation flux at the liquid-vapor interface.

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