INTERFACIAL PARTICLE ACCUMULATION IN THE DRYING-TEARDROP EFFECT

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Salts can be found in different forms in almost any evaporating droplet in nature, our homes and in laboratories. The transport processes in such - apparently simple- systems differ strongly from 'sweet' evaporating droplets[1] since the liquid flows in the inverse direction due to Marangoni stresses at the liquid-gas interface. The inverted flow pattern that takes place in such salty droplets is revealed using 3D particle tracking measurements to quantify the full three-dimensional flow in evaporating droplets of sodium chloride[2]. Contrary to what is typically reported, the flow inversion does not prevent the coffee-stain effect; on the contrary, particles accumulate, get trapped in the vicinity of the liquid-gas interface and are consequently advected towards the contact line along the interface. In this work, we make use of confocal imaging to quantify the accumulation process and the growth of the particle interfacial deposits for different salt concentrations along the droplet's interface. The experimental results are contrasted with numerical simulations that capture the solvent evaporation, the evaporation-induced liquid flow and the quasi-equilibrium liquid-gas interface.

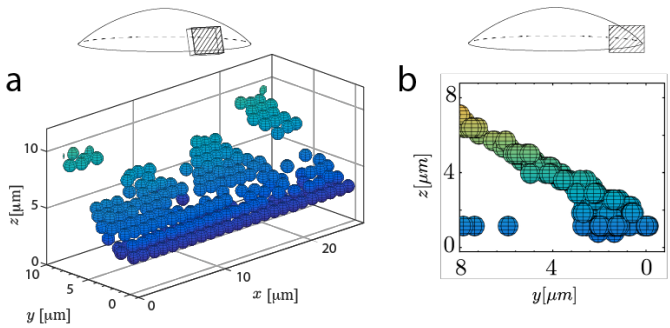

Figure 1. Confocal reconstructions of 1-µm-diameter polystyrene particles accumulating at the interface of a salt solution droplet (initial concentration NaCl 5mM) during its evaporation.

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REFERENCES:

1. R.D. Deegan, O. Bakajin, T.F. Dupont, G. Huber, S.R. Nagel, T.A. Witten. “Capillary flow as the cause of ring stains from dried liquid drops.”. Nature 389 (6653), 827
2. A. Marin, S. Karpitschka, D. Noguera-Marín, M.A. Cabrerizo-Vílchez, M.Rossi, C.J. Kähler, M.A. Rodríguez-Valverde. “Solutal Marangoni flow as the cause of ring stains from drying salty colloidal drops”. https://arxiv.org/abs/1809.07722