Controlling particle deposit morphologies in drying nano-particle laden sessile droplets using substrate oscillations

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Electronic Supplementary information

Derivation of the evaporation time scale τ_e -

To evaluate this timescale, a completely spherical droplet with radius R_0' is considered (far away from any substrate) with identical mass as that of the sessile droplet -

$$m = \frac{\rho_l \pi R_0^3}{3}\left(\cos^3\theta_c - 3\cos\theta_c + 2\right) = \frac{4}{3}\rho_l \pi R_0'^3 \tag{1}$$

The evaporation rate through vapor diffusion for this spherical droplet at t=0 can be approximated as [1] -

$$\left(\frac{dm}{dt}\right)_{t=0} = 4\pi D C_{sat} R_0' \left(1 - RH\right) \tag{2}$$

From eqn. 1 and eqn. 2, the measure of the evaporative time scale thus becomes

$$\tau_e \sim m\left[\left(\frac{dm}{dt}\right)_{t=0}\right]^{-1} = \frac{\rho_l \left[R_0^3\left(\cos^3\theta_c - 3\cos\theta_c + 2\right)\right]^{\frac{2}{3}}}{D C_{sat}\left(1 - RH\right)}$$

In the above, ρ_l is the density of water, D is the diffusivity of water vapor in air, C_{sat} is the saturation density of the same in air and RH is the ambient relative humidity. Any numerical constants have been discarded in the final expression of τ_e.

1. R. G. Picknett, and R. Bexon, J Colloid Interface Sci. 61, 336 (1977).