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

Apratim Sanyal\textsuperscript{1}, Saptarshi Basu\textsuperscript{1*}, Swetaprovo Chaudhuri\textsuperscript{2}

\textsuperscript{1}Department of Mechanical Engineering, Indian Institute of Science, Bangalore, India

\textsuperscript{2}Department of Aerospace Engineering, Indian Institute of Science, Bangalore, India

*Corresponding author email: sbasu@mecheng.iisc.ernet.in

Electronic Supplementary information

Derivation of the evaporation time scale $\tau_e$ -

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 -

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

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

$$\left(\frac{dm}{dt}\right)_{t=0} = 4\pi DC_{\text{sat}} R_0' \left(1 - RH\right)$$ \hspace{1cm} (2)

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

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

In the above, $\rho_l$ is the density of water, $D$ is the diffusivity of water vapor in air, $C_{\text{sat}}$ 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 $\tau_e$.