Universal behaviour of evaporating sessile water droplets in the presence of contact angle hysteresis

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ABSTRACT

The process of evaporation of a sessile liquid droplet is of interest in many industrial applications: molecular combing process, cooling systems and heat exchangers, coating, painting and printing including a 3D printing, printed electronics and MEMS devices.

This work presents a theory describing the evaporation of sessile water droplets in presence of contact angle hysteresis. It is established that in the presence of contact angle hysteresis the evaporation of a sessile droplet in non-saturated vapour atmosphere can go through three stages: (i) evaporation proceeds with a constant contact area and decreasing contact angle, θ, until the contact angle reaches the receding value, θ_r; (ii) evaporation with a constant contact angle, θ_r, and decreasing radius of the contact line, L; (iii) evaporation with decrease of both L and θ until droplet disappears.

The theory presented is based on the results of computer simulations [1] on evaporating droplets. It gives universal curves (Fig. 1) describing two first stages of the evaporation process.

Obtained universal curves agreed well with experimental data extracted from literature sources [2, 3].

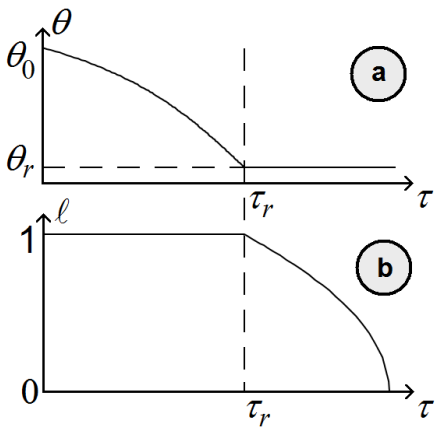

Fig. 1. Dependencies of: (a) contact angle, θ, and (b) dimensionless radius of the contact line, $\ell = L/L_0$, on the dimensionless time, τ. Here τ_r is the time when contact line starts to recede, and θ_r is the value of static receding contact angle.

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