Secondary atomization of drop impactions onto heated inclined surfaces

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The present work addresses an experimental study of the secondary atomization of liquid droplets impacting onto heated inclined surfaces of known roughness, at moderate absolute Weber numbers (245<We<600). The impact angle, α, defined as in Figure 1, is varied over a wide range, between 6º<α<90º. The effect of the impact angle in the morphology and secondary droplet size distribution is analyzed for droplets of different liquids (water and isooctane) at distinct temperatures, covering different boiling regimes.

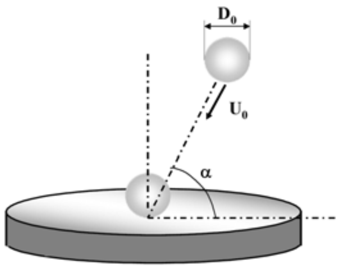

Fig. 1. Definition of the impact angle, α.

1. Measurement techniques

The morphological characterization of the impacting droplets is carried out using two CCD cameras: a Color PCO SensiCam 1280x1024pixels and a Kodak Motion Corder Analyzer, Series SR, Model PS-120 high-speed camera, with maximum frame rate up to 10kHz. Post-processing of the recorded images (Image Analysis Technique – IAT) is used to determine the size of the larger secondary droplets, having diameters within the range of 40μm up to a few millimeters. Size and velocity of smaller droplets are evaluated with a two-component phase Doppler system. The PDA measurements are then integrated in time up to the impact instant t_0, before comparison with the IAT probability distribution. Finally, a scaling of the IAT p.d.f. and of the integrated PDA p.d.f. is performed by equating the count values where the two size ranges overlap, obtaining an *extended p.d.f.* which is used to evaluate secondary droplet size distribution along time. The combination of these two techniques allows covering a wide range of droplet diameters, from 5.5μm up to few millimeters.

2. Results

Figure 2 depicts the temporal evolution of the mean secondary droplet (D_{10}), obtained from PDA measurements, for different impact angles, within the nucleate and the film boiling regimes. The figure shows that the measured secondary droplet diameter is faintly influenced by large impact angles (α>45º) but becomes considerably smaller for small impact angles (α<15º).

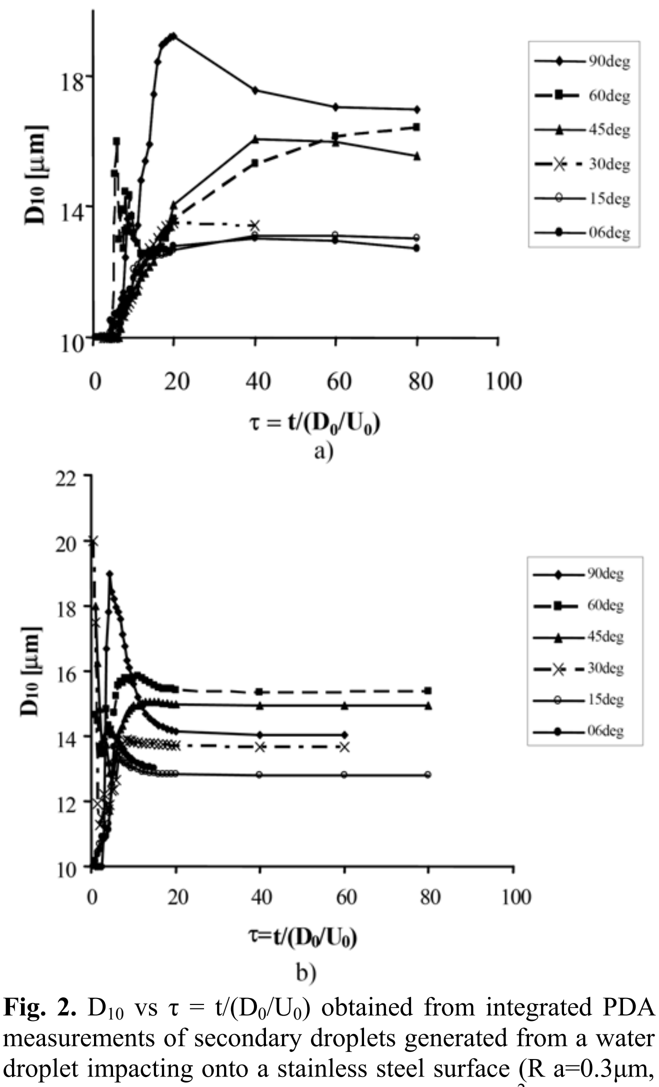

Fig. 2. D_{10} vs $\tau = t/(D_0/U_0)$ obtained from integrated PDA measurements of secondary droplets generated from a water droplet impacting onto a stainless steel surface (R a=0.3μm, R_z=2.01μm). Absolute Weber number, $We=\rho V_0^2 d_0/\sigma = 245$. a)Nucleate boiling regime (T w=161ºC), b) Film boiling regime (T w=260ºC).

Comparison between water and isooctane droplets, which have dissimilar surface tension values, reveal differences in the morphology, mainly due to the formation of a crown at the impact of isooctane droplets within the film boiling regime at large impact angles (α>45º), which consequently influences secondary droplet size distribution.