Supplementary Information for
How microstructures affect air film dynamics prior to drop impact

Roeland C. A. van der Veen,[*a] **Maurice H. W. Hendrix,**[a] **Tuan Tran,**[a] **Chao Sun,**[a] **Peichun Amy Tsai,**[b‡] **Detlef Lohse,**[a‡]

In this supplemental material we describe details on the high-speed color interferometry technique that is employed in the main paper, "How microstructures affect air film dynamics prior to drop impact".

Method A color-matching approach in combination with known reference surfaces is used to construct air layer profiles[1]. For this method it is beneficial to obtain a good match between the white balance and exposure of the experiments and reference color database. To this end, the white balance and image contrast are independently optimized to obtain the smallest average color difference. After finding an approximate profile, this is optimized by vertically translating every data point (with steps of 3 μm in the horizontal direction). For every point the optimal color difference is found, resulting in the final air layer profile, which is then smoothed with a moving average filter of width 4.5 μm.

Once the final air film profile is obtained, we can extract information such as the dimple volume and dimple height from this data. The dimple height is found by fitting the dimple profile with a second order polynomial to a width of 0.1 mm around the center.

Error analysis The inaccuracies in determining the air layer profiles arise from several sources. One is in the comparison with a reference color database which has an intrinsic error of approximately 40 nm[1]. This is a systematic error which is equal for all experiments and therefore not relevant in for example Fig.4(b) where height differences between different experiments are considered. Another source of inaccuracies is in the determination of the line with smallest color difference. This results from white balance and exposure difference between measurements and reference images, and is slightly higher for larger air thicknesses because there the contrast is smaller. For an air layer thickness below 1 μm this error is 50 nm and beyond 1 μm it is approximately 100 nm.

Determination of t = 0 The reference time $t = 0$ is determined by the time at which fringes are first fully visible in the image. This depends on the depth of field and/or coherence length of the imaging setup, but in the present experiments these variables are constant. In the case of a recording frame rate of 20000 frames per second (fps) and impact velocities of the order of 0.4 m/s, one typically first sees some faint fringes, after which in the next frames the fringes are fully visible.

To achieve sub-frame accuracy of the reference time $t = 0$, we use the following method. Consider frame 0 without a visible fringe pattern, frame 1 with fringes which are visible to a certain degree, and frame 2 with completely visible fringes. The measure for visibility of fringes we use is the standard deviation of the intensity fluctuation along a line across the dimple, averaged over all three color channels. If the fringes in frame 1 are almost completely visible, we set $t = 0$ to be at the beginning of frame 1. If they are very faint, $t = 0$ is set close to the beginning of frame 2. The start time from frame 1 is then $\Delta t = 1/\text{fps} \cdot (1 - (\sigma_2 - \sigma_1)/(\sigma_3 - \sigma_1))$. Standard deviations are used to get a measure of the intensity fluctuation of the fringes themselves, and exclude variations in overall exposure. The accuracy we can achieve in $\Delta t \cdot \text{fps}$ is about 0.5, meaning half a frame. This method can be expanded to higher frame rates or lower impact velocities by including more than three frames.

References

1 R. C. A. Van Der Veen, T. Tran, D. Lohse and C. Sun, *Physical Review E*, 2012, **85**, 026315.

[a] *Physics of Fluids Group, MESA+ Institute for Nanotechnology and J.M. Burgers Centre for Fluid Dynamics, University of Twente, P.O. Box 217, 7500AE Enschede, The Netherlands*
[b] *Soft Matter, Fluidics and Interfaces Group, MESA+ Institute for Nanotechnology and J.M. Burgers Centre for Fluid Dynamics, University of Twente, P.O. Box 217, 7500AE Enschede, The Netherlands*
‡ These authors contributed equally to this work. Corresponding e-mail addresses: p.a.tsai@utwente.nl, d.lohse@utwente.nl