AIR ENTRAPMENT DURING THE IMPACT OF VISCOUS DROPS ONTO THIN VISCOUS FILMS

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When a liquid drop approaches a solid or liquid surface, the impact is cushioned by a thin layer of air. A stagnation point below the center of the drop prevents the air within the layer from completely escaping. Instead the pressure within the layer becomes sufficient to form a dimple in the drop ultimately entrapping an air bubble. For low viscosity liquids (~1 cSt), contact between the drop and the surface occurs around a ring marking the perimeter of the dimple. In the case of higher viscosity drops impacting on solid surfaces, Langley *et al.* [1] found that the drop glides over an extended layer of air thinner than 160 nm, initially avoiding contact between the liquid and solid all together. Eventually localized contacts between the drop and solid appear at random locations within this gliding layer.

Herein, we investigate drops ranging in viscosity between 10 and 10^6 cSt impacting onto a thin film of the same liquid at 1 - 5 m/s. Using ultra-high-speed interferometry at frame rates up to 5 million frames per second, we measure the evolution of the thickness of the intervening air disc and the ultimate entrapment of an air bubble. As with impacts onto solid surfaces, the drop glides on a thin layer of air. Since liquid surfaces are molecularly smooth, there are substantially fewer localized contacts when compared with impacts onto solid surfaces. Figure 1 shows bottom view images from the impact of a 100,000 cSt drop onto a thin film. The centerline height of the dimple decreases as the drop glides on an air layer. Notice the absence of local contacts in (b). The centerline height of the air disc is weakly dependent on the viscosity and follows the scaling for impacts onto solid surfaces when scaled by half of the impact velocity.

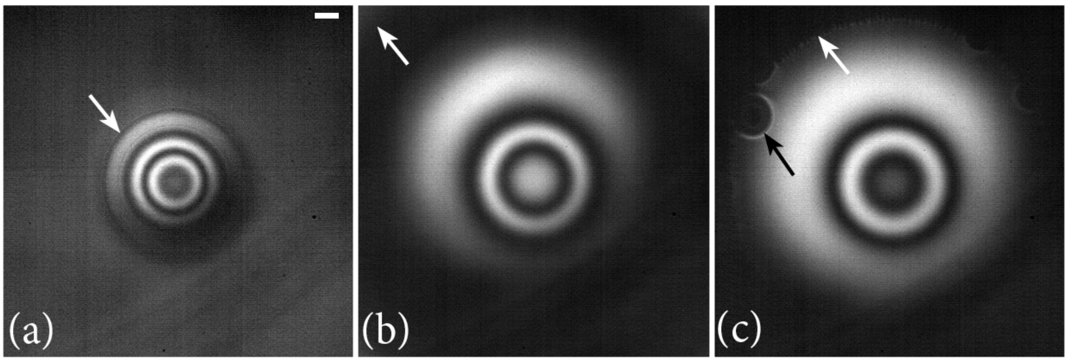

Figure 1. Bottom view interferograms from the impact of a 100,000 cSt silicone oil drop onto a thin film of the same liquid (R_b = 1.8 mm, V = 1.24 m/s). Panels are spaced by 240 microseconds. The white arrows mark the outer edge of the thin air layer. After the dimple is initially formed (a), the drop glides on a thin film of air less than 160 nm thick in (b). Eventually the air film ruptures and the central bubble contracts in (c). There are also some localized random contacts between the drop and film at later stages (black arrow)

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REFERENCES:

1. Langley K., Li E. Q. and Thoroddsen S. T. ‘Impact of ultra-viscous drops: air film gliding and extreme wetting’, *Journal of Fluid Mechanics*, **2017**, 813, 647-666.