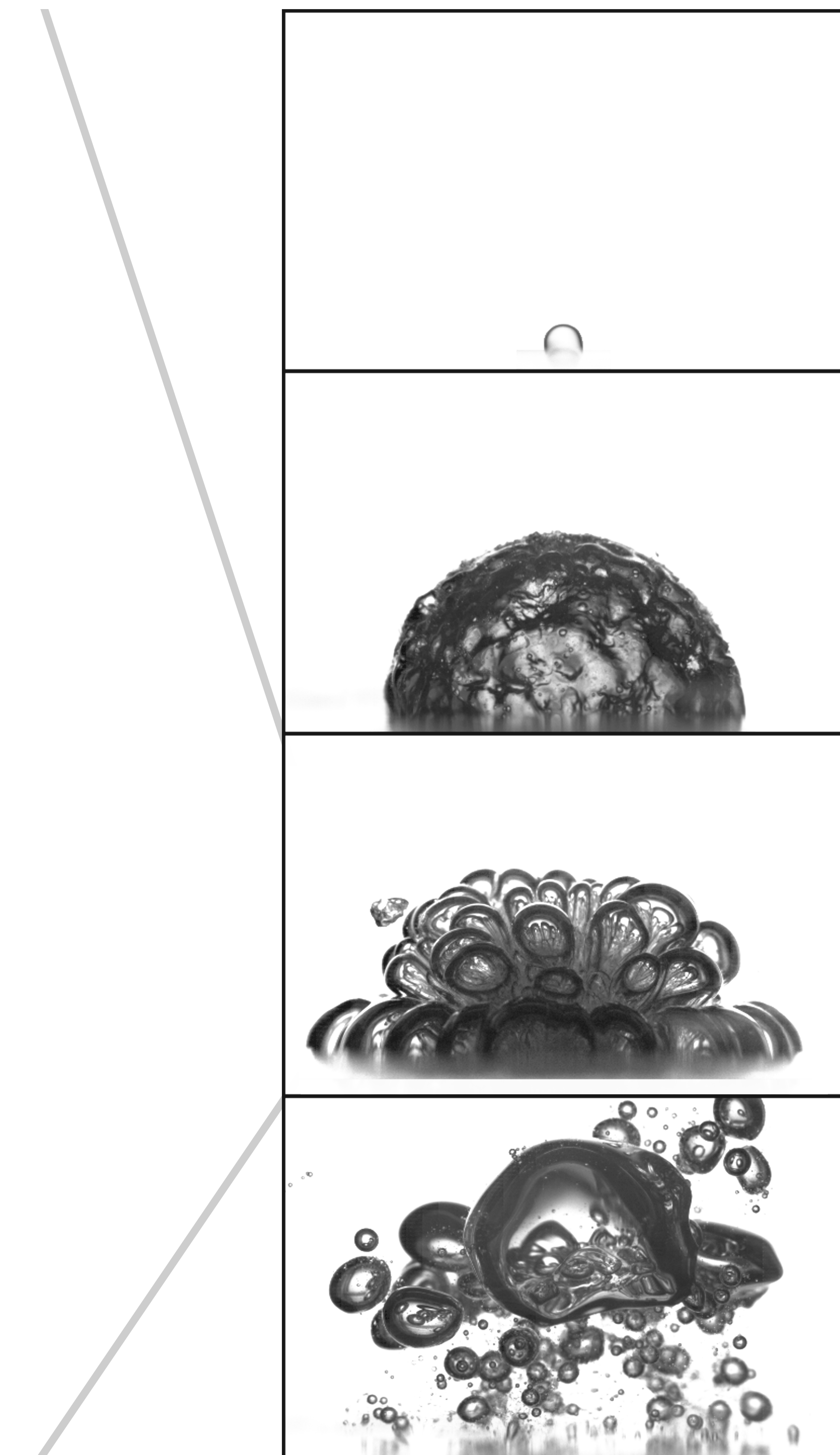
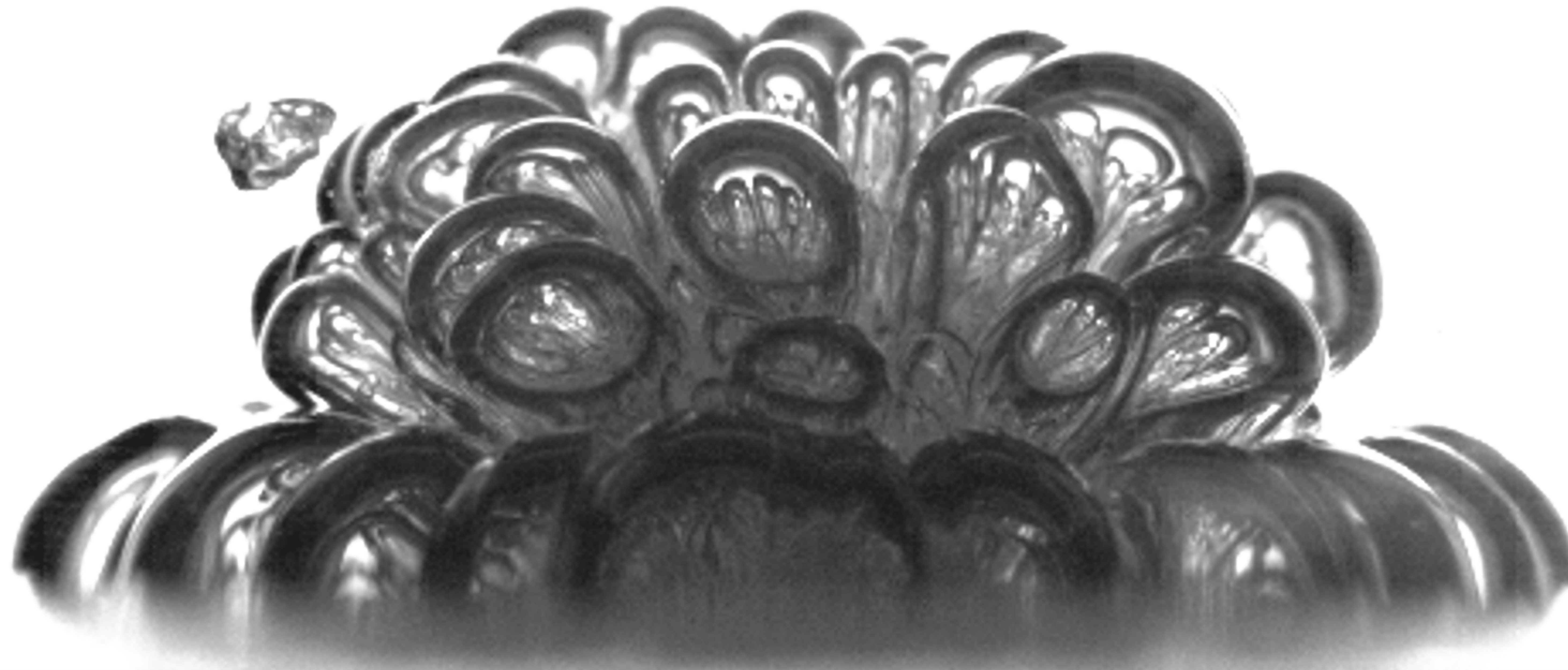
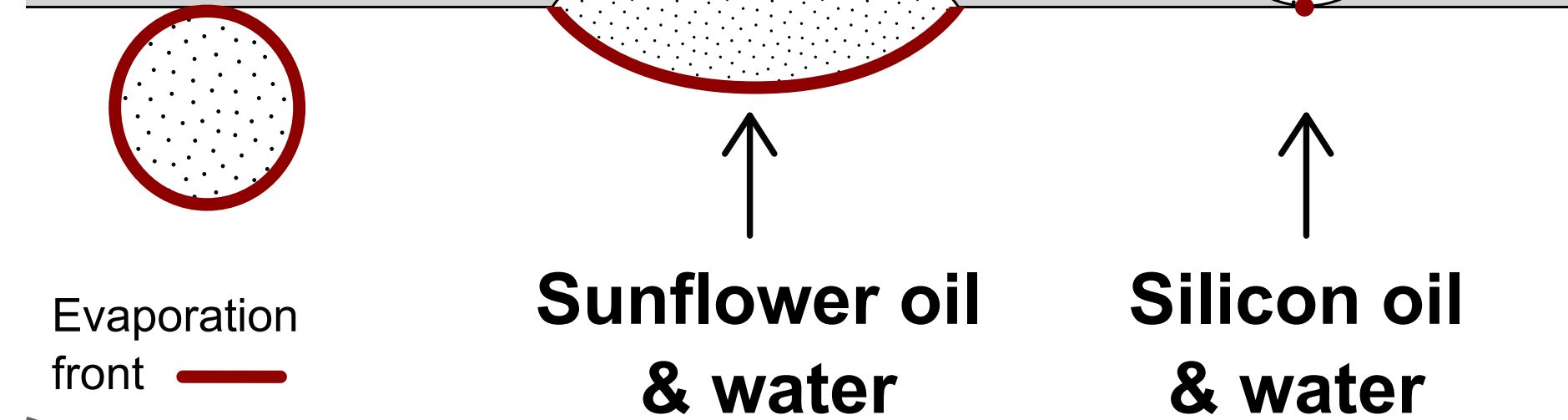
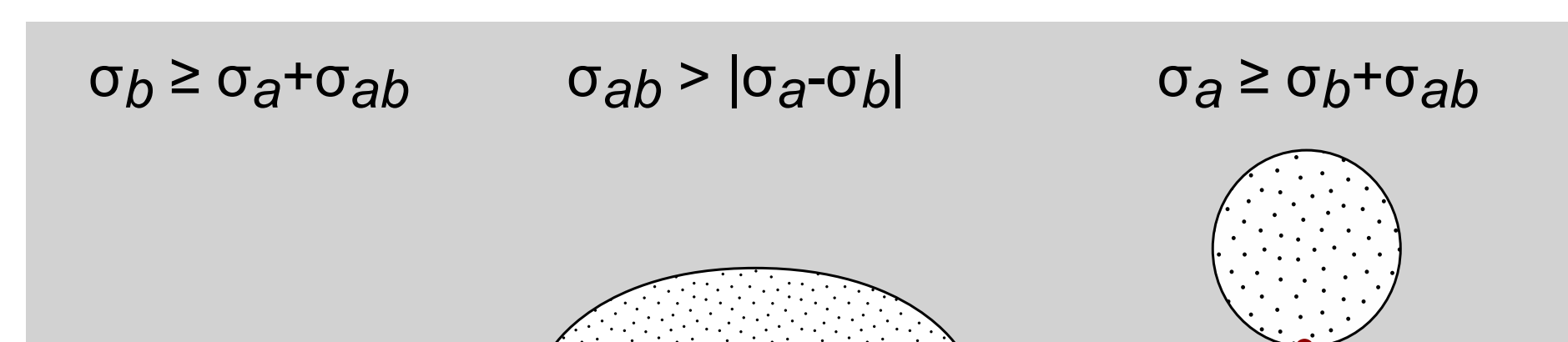


# Explosive boiling ?



**Boiling of a superheated water drop in sunflower oil.** The whole drop, resting at the bottom of a glass container, evaporates explosively. As a consequence, the bubble radius  $R$  overshoots and oscillates around its equilibrium value. When  $R$  is minimum the positive acceleration  $\ddot{R}$  towards the denser phase promotes a Rayleigh-Taylor destabilisation of the bubble interface, in the form of prominent lobes, which leads to the bubble fragmentation ( $T = 190^\circ\text{C}$  at ambient pressure, the drop radius is 0.8 mm and the images are taken at  $t = 0, 2, 4$  and 40 ms after nucleation occurred).



Shape of the nucleated bubble for different liquid surface tensions  $\sigma_a$  and  $\sigma_b$  and liquid-liquid interfacial energy  $\sigma_{ab}$  (see Moore 1959).

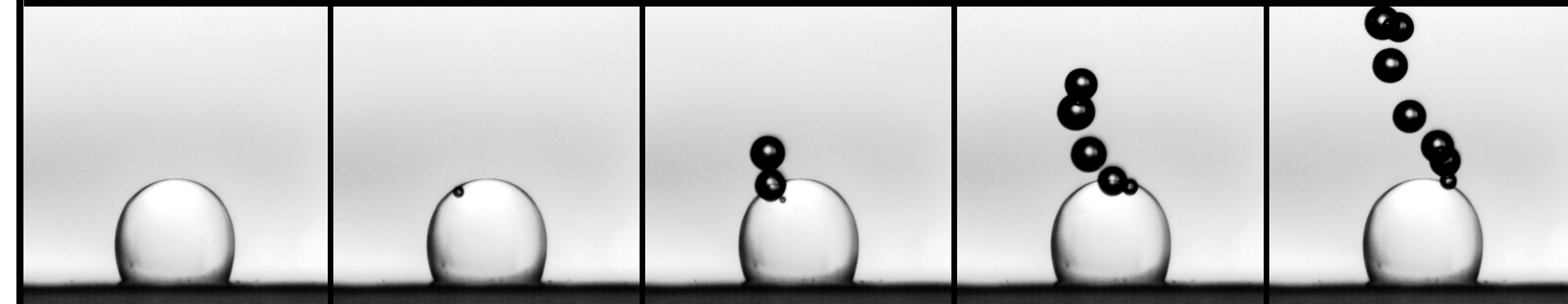
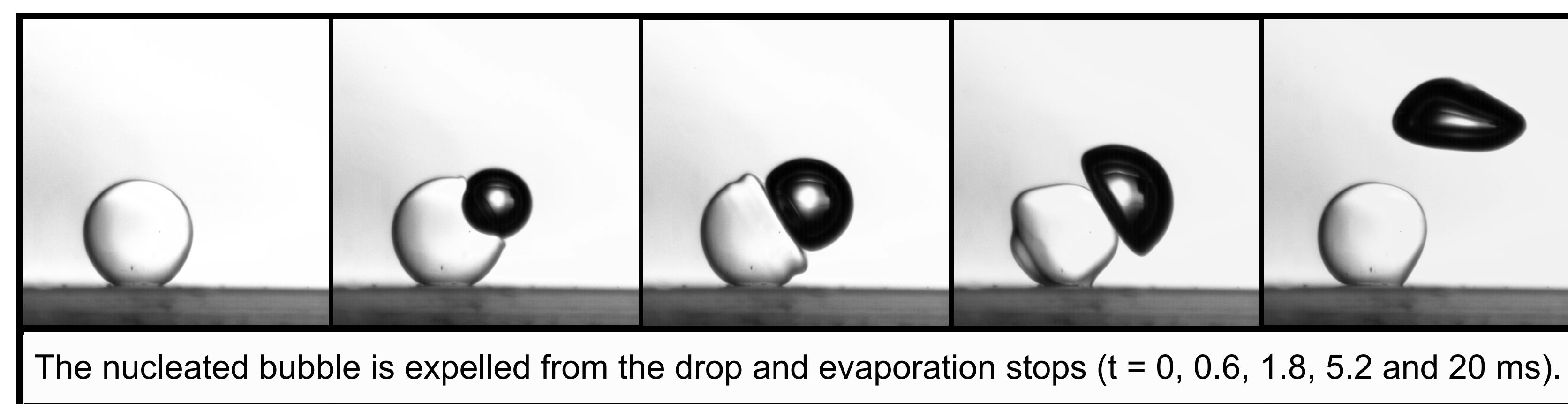
A liquid drop immersed into a host liquid can be strongly superheated before nucleation occurs. A millimetre-size water drop indeed survives several minutes at  $T = 170\text{-}190^\circ\text{C}$  at ambient pressure into sunflower or silicone oil.

When nucleation eventually occurs the water *may* boil explosively as shown above with sunflower oil as the host liquid. In this case the bubble growth is only limited by the diffusion of heat and the whole drop evaporates within milliseconds.

The boiling behaviour however changes dramatically when the host liquid wets the drop liquid as with the silicone oil/water system shown on the right-hand side. In this case, bubble nucleation also occurs at the drop interface, since it is energetically favourable, but the boiling process is rapidly stalled as the host liquid wets the drop, leaving only a small area where the drop is in contact with its vapour. The bubble is either totally expelled, or a small stem of vapour remains, resulting in a regular, self-sustained and minute-lasting boiling of the drop.

Ironically, both boiling behaviours lead, though by very distinct mechanisms, to the dispersion of the vapour phase into many small bubbles.

**Boiling of a superheated water drop in silicone oil.** ( $T = 170^\circ\text{C}$  at ambient pressure)



The nucleated bubble is expelled from the drop and evaporation stops ( $t = 0, 0.6, 1.8, 5.2$  and 20 ms). The nucleated bubble detaches and leaves a stem of vapour from which new bubbles grow and detach (the time-step between frames is 8 ms). On the right-hand side, a train of bubble rises from the self-sustained nucleation site illustrating the slow sequential boiling of the drop.