Micro Air Bubble Manipulation by Electrowetting on Dielectric (EWOD) by Zhao and Cho

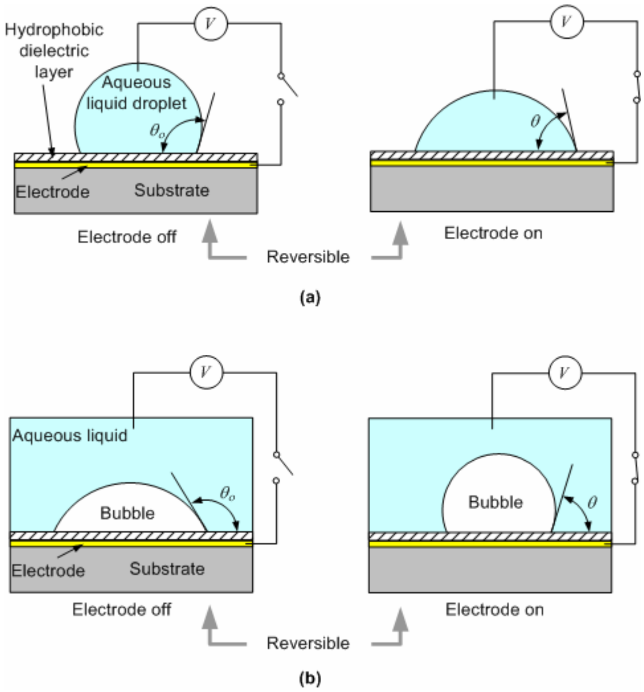

Fig. S1 Principle of electrowetting on dielectric (EWOD). When the voltage is applied, the contact angle θ is reduced. As a result, **(a)** the droplet spreads **(b)** while the capped bubble contracts. When the voltage is removed, both return to the initial shapes, respectively.

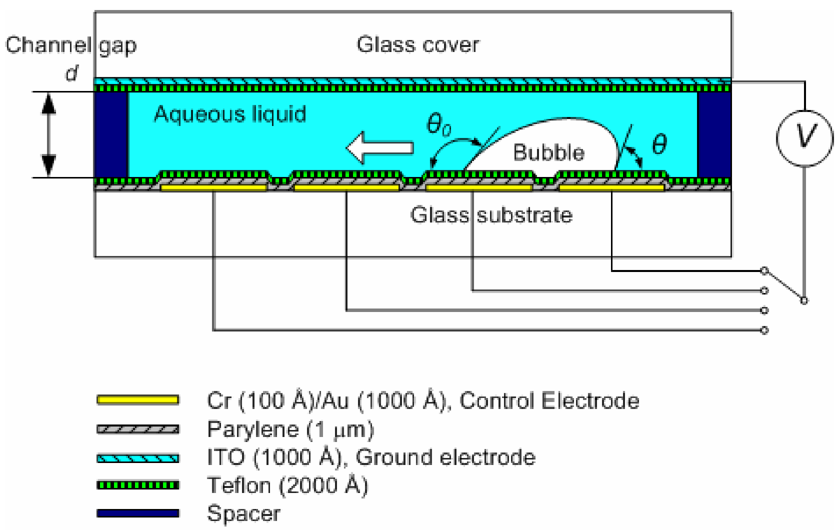

Fig. S2 Cross-sectional view of testing devices for bubble operations. Sequential activations of control electrodes on the bottom plate generate bubble motions in a variety of ways. Note that the bubble is contacting only the bottom plate (called Channel I). For successful bubble splitting, the bubble has to be in contact with the top as well as bottom plates (called Channel II, not shown) by reducing the channel gap *d*.

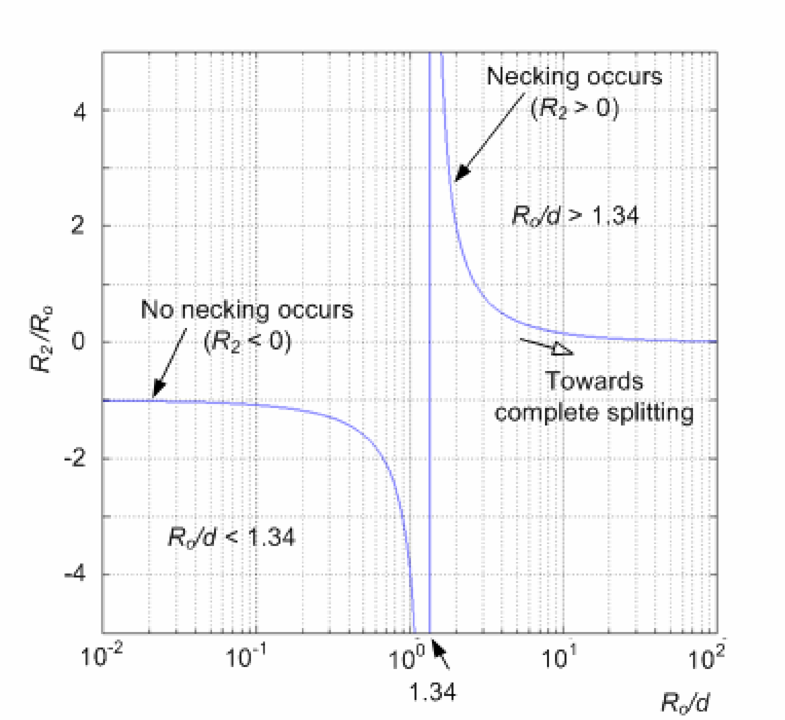

Fig. S3 Bubble splitting criterion based on Eq. (6). There is no necking when $R_o/d < 1.34$, while the bubble necking occurs when $R_o/d > 1.34$. As R_o/d becomes larger, it is more likely for the pinched menisci to meet together near the centre of the bubble, completing the splitting process. In this calculation, $\theta_{b1} = 117^o$ and $\theta_{b2} = 73^o$ are assumed based on the contact angle change shown in Fig. 1.

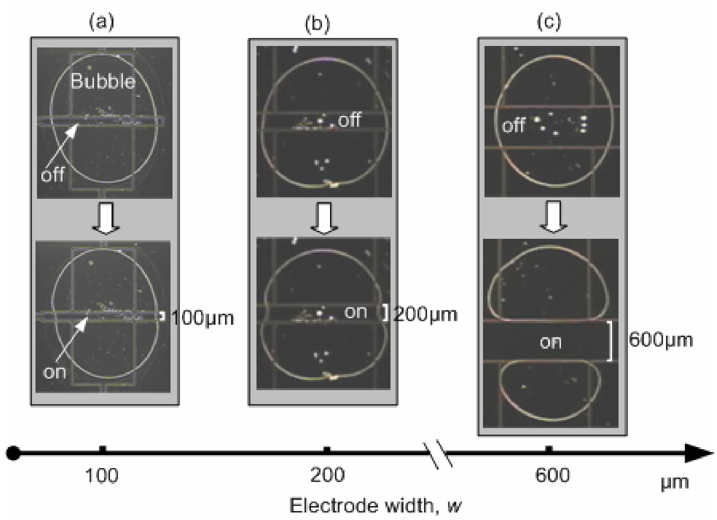

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Fig. S4 The effect of the splitting electrode width w. In each case, two images are taken before (shown top) and after (shown bottom) activating the splitting electrode. *w* are **(a)** 100, **(b)** 200 and **(c)** 600 μm, respectively. As *w* increases, it becomes easier to split the bubble. Note that in all the three cases the channel gap *d* and the applied voltage are fixed at 80 μm and 90 V_{DC}, respectively. The bubble size R_o is also fixed around 900 μm (0.2 μL in volume).

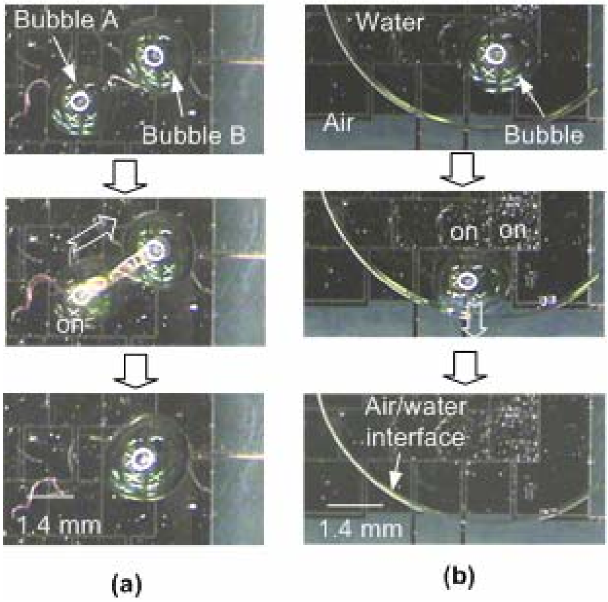

Fig. S5 Sequential photos of bubble **(a)** merging and **(b)** eliminating. Note that the bubble is in contact with the bottom plate only (Channel I).

Bubble Merging: Bubble merging is achieved by moving one bubble toward another in Channel I. Shown on the top of Fig. S5(a) is the initial position of bubbles A and B. Bubble A is partially sitting on an electrode with a little upper-offset while bubble B is positioned at the upper and right side of bubble A. By activating the electrode, bubble A is moving toward bubble B, as shown in the middle photo of Fig. S5(a). Bubble B is not moving since there is no driving electrode activated under bubble B. As soon as moving bubble A touches bubble B, the two bubbles are spontaneously merged ending up with a single larger bubble in a very short time (less than 0.03 second). The CCD camera used (30 frames/sec) is not fast enough to capture the detailed images of merging process. At last, the merged air bubble is produced near which air bubble B was placed, as shown in the bottom photo of Fig. S5(a).

Bubble Eliminating: Bubble elimination is achieved by moving a bubble to the air-to-water interface. The top photo in Fig. S5(b) shows the initial position of the air bubble. The air-to-water interface visually differentiates a bulk of water and the air filled in the gap between the top and bottom plates. The air bubble is sitting over three electrodes. Activating the two upper electrodes together makes the air bubble move toward the air-to-water interface, as shown in the middle photo of Fig. S5(b). As soon as the moving bubble contacts with the interface, it is spontaneously removed into the air (bottom photo in Fig. S5(b)).