















Fig. 8. Dynamic driving of two different droplets (Media 1).

Based on the above mentioned cell structure, we can increase the droplet size and make its dome close to the top substrate if the cell gap is thick enough. Usually a single liquid droplet is too small for practical applications. For a large size beam control or optical switch, it is possible to fabricate a liquid droplet array using cavity patterned method [18]. By controlling the shape of the droplet, the total aperture ratio of the droplet array can be increased significantly. By choosing proper liquids with a large refractive-index mismatch, the droplet will exhibit strong light scattering and divergence in the voltage-off state. However, in the voltage-on state the beam will transmit through in the regions where the dome touches the top substrate. Therefore, such a droplet can be used as optical beam control, especially for light-emitting diode (LED) beam modulation. For example in Fig. 3, we suppose the beam is from an LED, the beam can be expanded or collimated depending on the shape of the droplet. For a large-sized light switch, we can adopt a droplet array with the same electro-optical performance as that of droplet-2. To improve device stability and transition speed, it is desirable to coat polymers with quite different surface tensions on the two substrates. Although the density of L-1 ( $1.26 \text{ g/cm}^3$ ) is slightly smaller than that of L-2 ( $1.33 \text{ g/cm}^3$ ), the gravity effect will not be significant when the cell is placed in vertical position, because of the support from surface anchoring of substrates, surrounding L-2, and interfacial tension of the two liquids.

## 5. Conclusion

We investigated a liquid droplet whose dome is initially spherical but flattened by the top substrate as the voltage increases. If the dome of the droplet is close to the top substrate, the required voltage to deform the droplet is low ( $16 \text{ V}_{\text{rms}}$ ). The speed for the dome to touch the top substrate is fast ( $\sim 5 \text{ ms}$ ). Due to the reversible change between spherical and flat shapes, the droplet can be used for optical beam control. Potential application for a large-size optical switch using a droplet array is also discussed.