Electronic Supplementary Information (ESI) for Lab on a Chip
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Water-oil core-shell droplets for electrowetting-based digital microfluidic devices

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S. Supplementary Information

S.1. Electrowetting experiments

Figure S1 shows the contact angle *vs.* voltage electrowetting curves for water droplets in air and in silicone oil. For water droplets in air (Fig. S1a), the contact angle is seen to decrease from 118^o to about 80^o when the voltage is increased from 0 to 120 V while, in a silicone oil medium (Fig. S1b), the contact angle changes from 167^o to 60^o. In both fluids, a rather good agreement is found in between the electrowetting curves and the Young-Lippmann's theoretical equation (see eq. 2) up to about 80 V. At higher voltages, the contact angle is seen to deviate from the theoretical equation and to saturate at a constant value. The exact mechanism behind such saturation of the contact angle is still in debate even if this effect has always been observed for every dielectrics (see for example Mugele et al. 2005; ref #39). On the other hand, because of this saturation effect, increasing the operation voltage of our EWOD-based devices beyond 90 V would result only in a marginal increase of the electrowetting effect, thus explaining the presence of a plateau at high voltages in the velocity curves (Fig. 2).

It is also noteworthy that, by varying the voltage back and forth from 0 to 120 V, a rather complex hysteresis pattern is evidenced in air (Fig. S1a) while almost no hysteresis is seen in oil (Fig. S1b). Indeed, in air, the measured contact angles not only follow different paths for increasing and decreasing voltages but also remain at a smaller value of only 110^o at 0 V at the end of the first cycle. Also, from the second cycle, the contact angle is seen to remain constant until the potential reaches a value of about 40 V. Such hysteresis pattern can clearly be detrimental to the manipulation of droplets in EWOD-based devices. Thus, the presence of oil around the droplets (either as a continuous fluid or as a shell) provides not only the advantage of a smaller contact line friction (as discussed in section 2.3) but also permits to reduce the hysteresis pattern of the electrowetting curve.

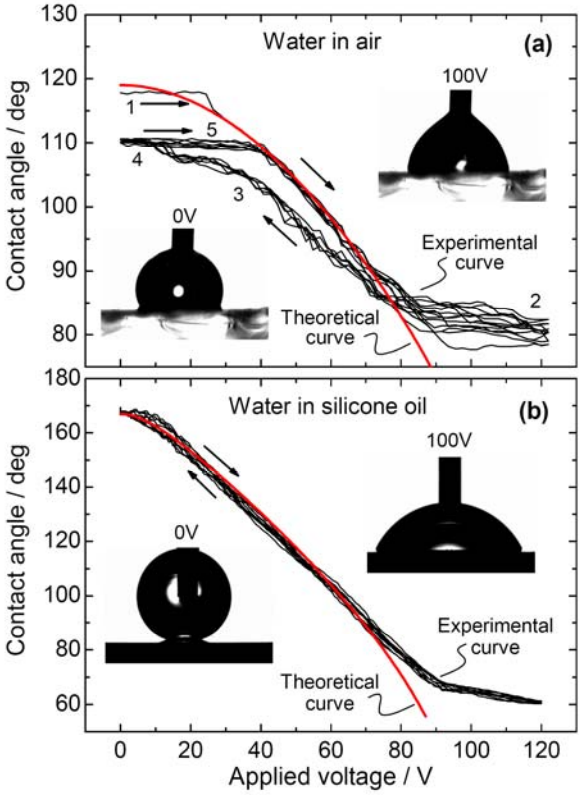

Fig. S1 Contact angle *vs.* voltage electrowetting curves for water droplets sitting on a Teflon AF surface for (a) air and (b) silicone oil as the surrounding fluid. The shape of the droplet at 0 and 100 V is also shown for both mediums. The theoretical curves (in red) are calculated from the Young-Lippmann's theoretical equation (eq. 2) by considering a dielectric constant k of 4 for the 2.5 µm thick insulating layer, $k = 2$ for the 30 nm thick Teflon layer, $\chi_{w-a} = 72.8$ mN/m and $\chi_{w-o} = 35$ mN/m. The numbers from 1 to 5 shown in (a) illustrate the sequence of events when the voltage is swept back and forth several times from 0 to 120 V. In both (a) and (b), the droplets were placed on the Teflon AF surface so that the electrowetting curves start at the advancing contact angle.

S.2. Video clips

Three video clips are also available as supplementary information.

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