Supplementary Material (ESI) for Lab on a Chip

Rapid and selective concentration of microparticles in optoelectrofluidic platform

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1. Equivalent circuit model of lab-on-a-display

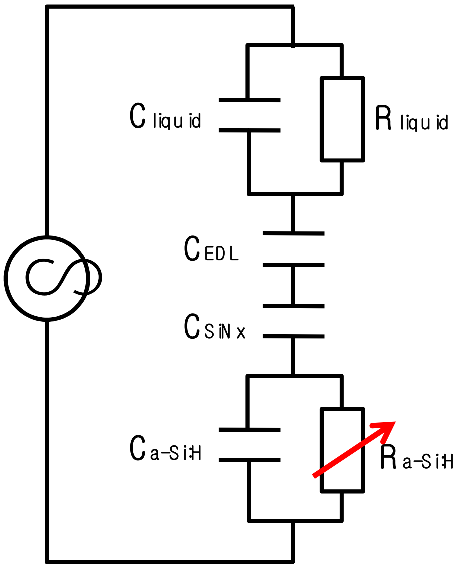

Fig. S1 Equivalent circuit model of the lab-on-a-display device

We could calculate the zeta potential with the equivalent circuit model of the lab-on-a-display device (Fig. S1). The photoconductive a-Si:H layer and the liquid layer was assumed to be a parallel circuit of a capacitor and a resistor. In the case of the a-Si:H layer, the resistance can be changed by the projected images. The electric double layer and the silicon nitride layer act as a capacitor. The impedances of each part of the circuit can be defined as below:

$$Z_{liquid} = \frac{R_{liquid}}{1 + j\omega R_{liquid} C_{liquid}}$$

$$Z_{EDL} = \frac{1}{j\omega C_{EDL}}$$

$$Z_{SiN_x} = \frac{1}{j\omega C_{SiN_x}}$$

$$Z_{a-Si:H} = \frac{R_{a-Si:H}}{1 + j\omega R_{a-Si:H} C_{a-Si:H}}$$

where R and C are the resistance and the capacitance, respectively. ω is the angular frequency of the applied AC signal. We can calculate the voltage drop (V_{ac}) across the electric double layer – the zeta potential (ζ) through those values as below:

$$\zeta = Vac \frac{Z_{EDL}}{Z_{a-Si:H} + Z_{SiN_x} + Z_{EDL} + Z_{liquid}}$$

To obtain the impedance – the capacitance – of the electric double layer, we should know the thickness of the electric double layer, $\lambda_{D,}$ which is called the Debye length, since the capacitance of the electric double layer is $C_{EDL} = \varepsilon_r \varepsilon_0 A / \lambda_D$, where ε_r is the relative permittivity of liquid, ε_0 is the permittivity of free space, and A is the unit area. The thickness is a function of the liquid conductivity, σ, as below:

$$\lambda_D = \sqrt{\frac{\mu \varepsilon k T}{2 \sigma z^2 e}}$$

where μ, ε, k, T, z and e are the ion bulk mobility, the liquid permittivity, the Boltzman's constant, the temperature, the electrolyte charge number, and the elementary charge, respectively. Consequently, by substituting the liquid conductivity which can be measured experimentally into the equations, we could calculate the zeta potential.

2. Particle concentration by optically-induced AC electro-osmosis (ACEO)

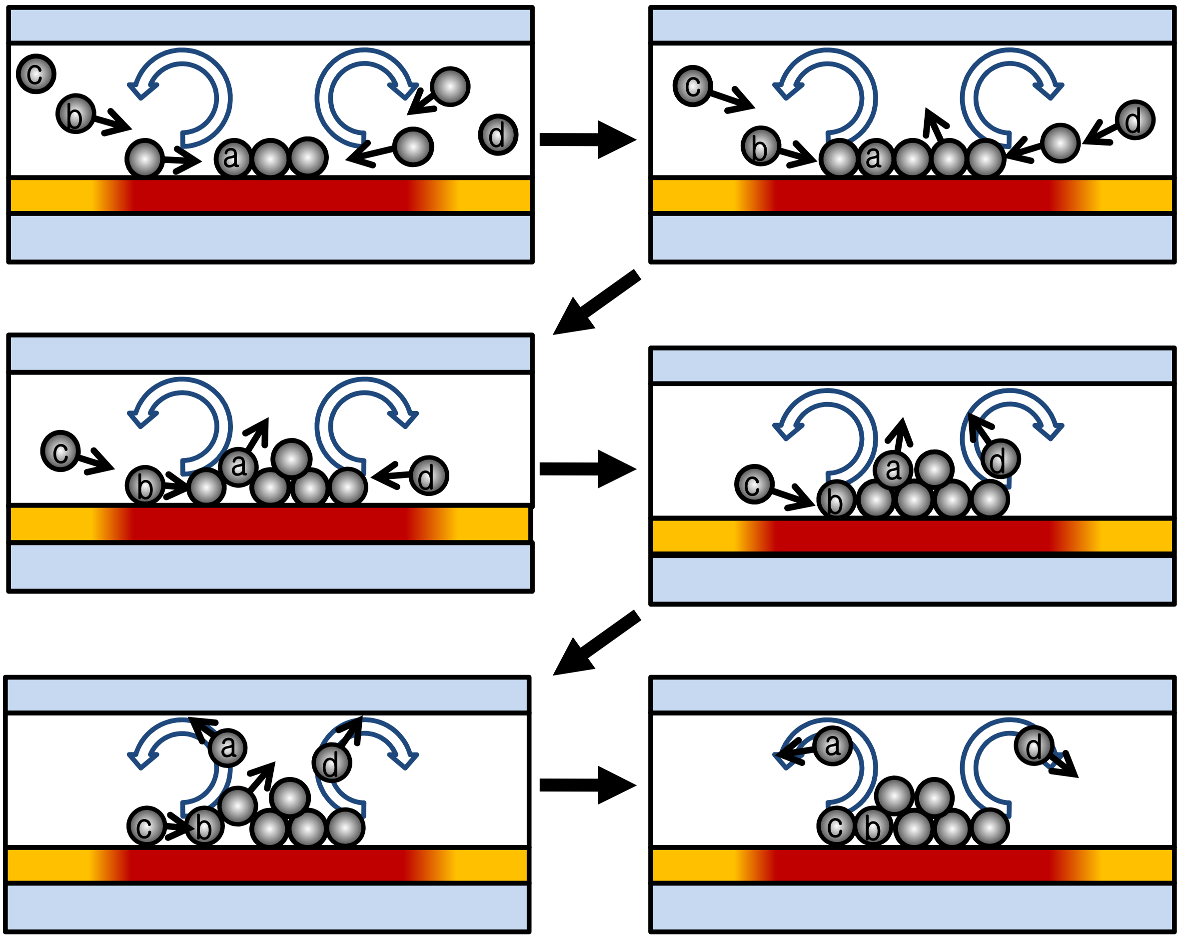

Fig. S2 The concentrated particles (particle **a**) form a monolayer on the substrate until they fill the most area of the image pattern. However, if there are a number of particles (particle **b, c** and **d**) being concentrated by the optically-induced AC electro-osmotic flow, they (particle **b** and **c**) force itself into the outside of the concentrated particle group and push the particles at the center (particle **a**) out upward, or just whirl at the edge of the image pattern along the flow (particle **d**). Consequently, they are saturated and form the additional area at the center of the image pattern, where some particles are moved upward resulting in the darker transmitted image.