Supporting Information

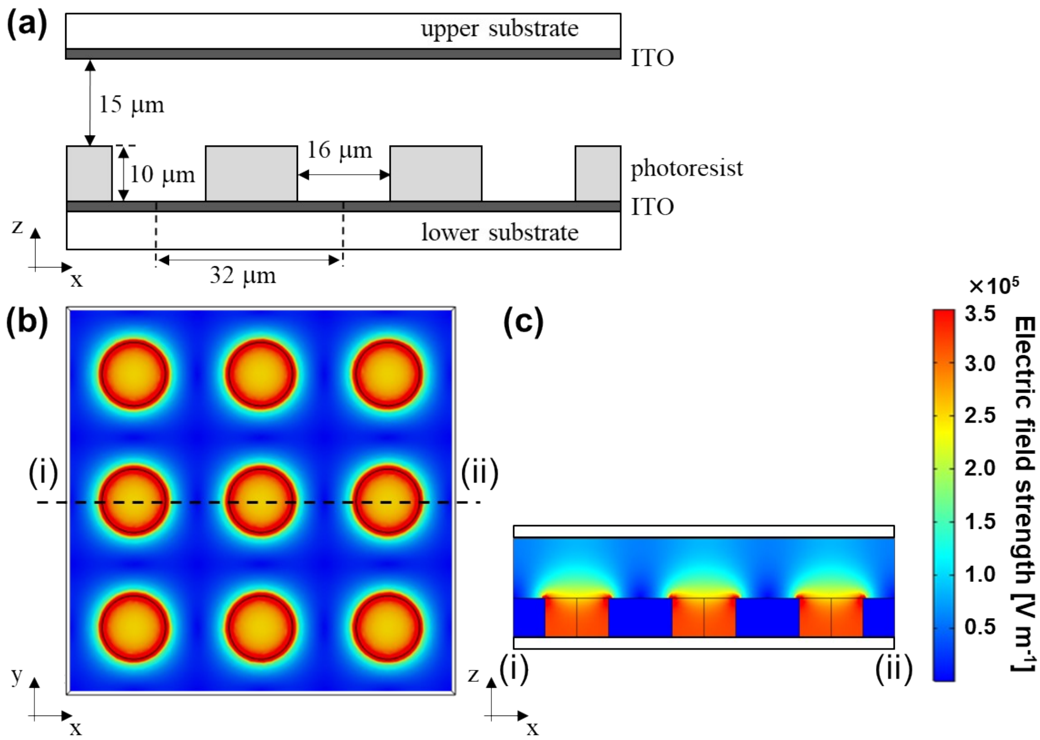

Figure S1. (a) Cross-sectional schematic of the micowell array electrode device. The distribution of the calculated electric field strength in the microwell array electrode device in (b) the x-y plane 10 μm above the bottom of microwells and (c) the x-z plane through the centers of microwells along the line (i)-(ii) in Fig. S1(b).

S2 Calculation of the real part of CM factors

The DEP force acting on dielectric spherical particles with radius R and permittivity ε_p, suspended in a medium with permittivity ε_M under an electric field gradient ∇E, can be described as follows[1]:

$$F_{DEP} = 2\pi\varepsilon_M R^3 Re[K(\omega)]\nabla|E|^2 \#(S1)$$

where K(ω) is the Clausius-Mossotti (CM) factor and given as follows:

$$K(\omega) = \frac{\varepsilon_p^* - \varepsilon_M^*}{\varepsilon_p^* + 2\varepsilon_M^*} \#(S2)$$

Here, ε_p^* and ε_M^* are the complex permittivity of the particle and the medium, respectively. These complex permittivities are written as:

$$\varepsilon^* = \varepsilon - j\frac{\sigma}{\omega} \#(S3)$$

in which σ is the conductivity, *j* is the imaginary unit, and ω is the angular frequency, which is related to the applied frequency, *f*, by *ω=2πf*.

The single-shell model that contains a homogeneous core (cytoplasm) and an outer shell (cell membrane) was used to express the complex permittivity of cells. When this model is applied to a cell with radius R, membrane thickness d, complex permittivity of the cytoplasm ε_c^*, and complex permittivity of the membrane ε_m^* (Fig. S2(a)), it results in a complex effective permittivity of the entire cell, ε_p^{eff*}, written as follows:

$$\varepsilon_p^{eff*} = \frac{\left(\varepsilon_c^* + 2\varepsilon_m^*\right)R^3 - 2\left(\varepsilon_m^* - \varepsilon_c^*\right)(R-d)^3}{\left(\varepsilon_c^* + 2\varepsilon_m^*\right)R^3 + \left(\varepsilon_m^* - \varepsilon_c^*\right)(R-d)^3}\varepsilon_m^* \#(S4)$$

In situations where $R \gg d$, as in mammalian cells, ε_m can be written as follows:

$$\varepsilon_m = C_m d \#(S5)$$

where C_m is the membrane capacitance. As shown here, C_m and R influence the CM factor and shift the DEP spectrum (Figs. S2(b) and (c)).

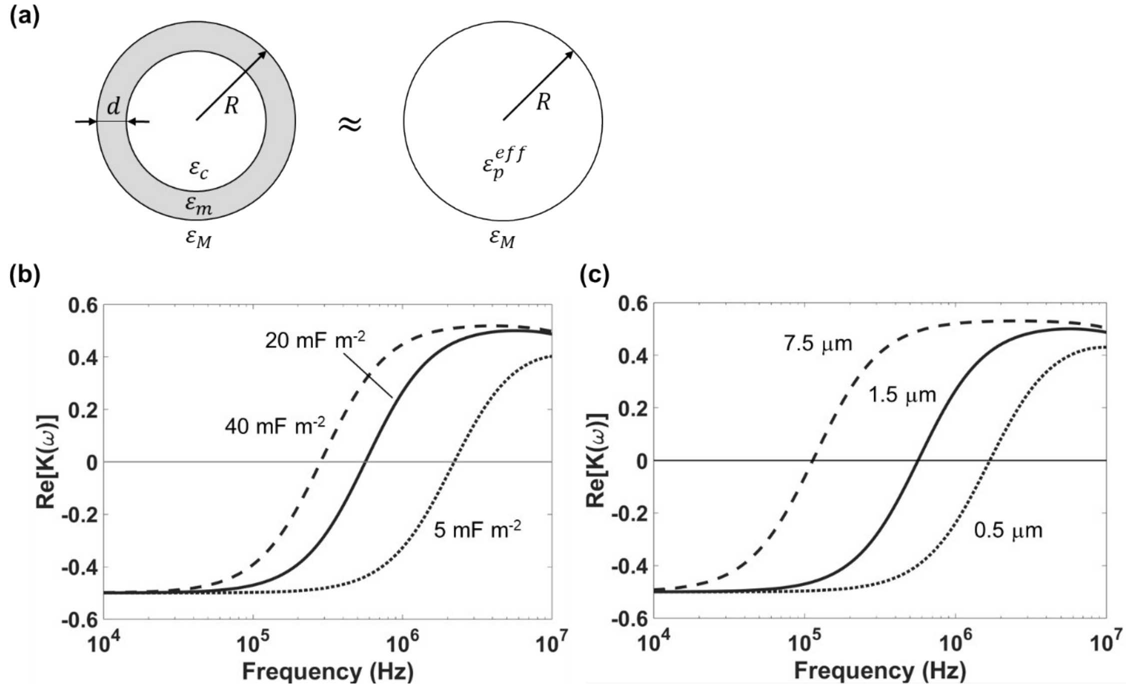

Figure S2. (a) Schematic illustration of single-shell model. (b, c) Calculated results for the real part of the Clausius-Mossotti factor of single-shell particle with membrane thickness d = 7 nm, cytoplasm permittivity $\varepsilon_c = 60\ \varepsilon_0$, cytoplasm conductivity $\sigma_c = 360$ mS m^{-1}, medium permittivity $\varepsilon_M = 78\ \varepsilon_0$, medium conductivity $\sigma_M = 80$ mS m^{-1}, (b) radius R = 1.5 μm, membrane capacitance C_m = 5, 20, 40 mF m^{-2}, (c) R = 0.5, 1.5, 7.5 mm, C_m = 20 mF m^{-2} at various frequencies.

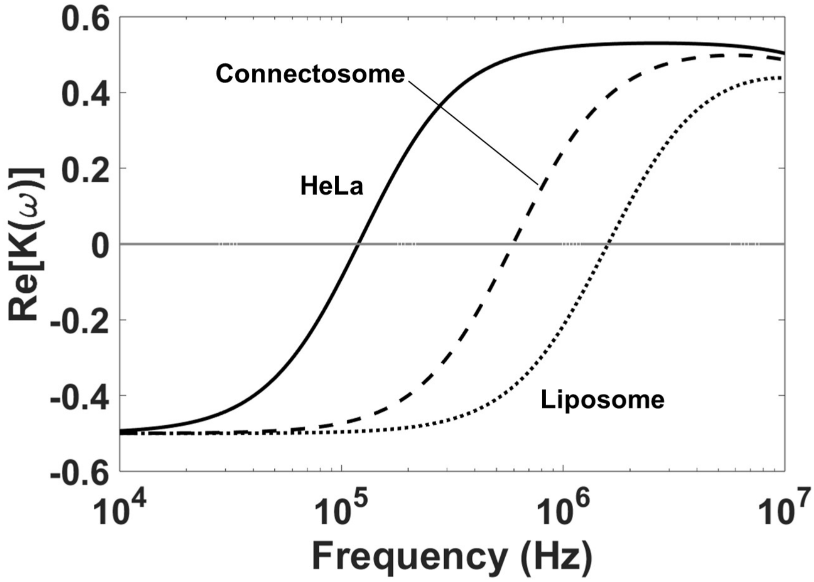

Figure S3. Calculated results for the real part of the Clausius-Mossotti factor of HeLa cells, Connectosomes, and Liposomes at various frequencies.

	medium permittivity ε_M (F m^{-1})	medium conductivity σ_M (mS m^{-1})	cytoplasm permittivity ε_c (F m^{-1})	cytoplasm conductivity σ_c (S m^{-1})	membrane capacitance C_m (mF m^{-2})	radius R (μm)
HeLa cells	78 ε_0	80	60 ε_0	0.36	19	7.5
Liposomes	78 ε_0	80	78 ε_0	0.36	7.5	1.5

Table S1. Clausius-Mossotti parameters for HeLa cells and liposomes.

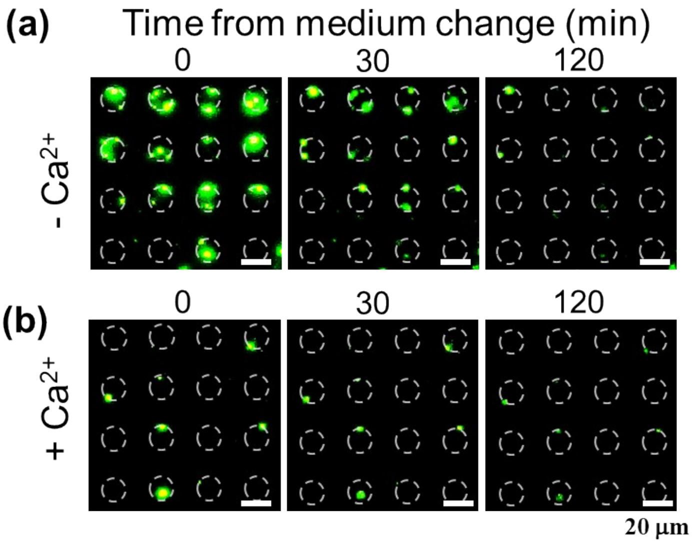

Figure S4. Fluorescence images of GPMVs trapped in microwells in (a) the absence and (b) the presence of Ca^{2+}.

1. “*Dielectrophoresis*”, **2017**, John Wiley & Sons, Ltd, 1.