Supporting Information for

Selective detection of live pathogens via surface-confined electric field perturbation on interdigitated silicon transducers

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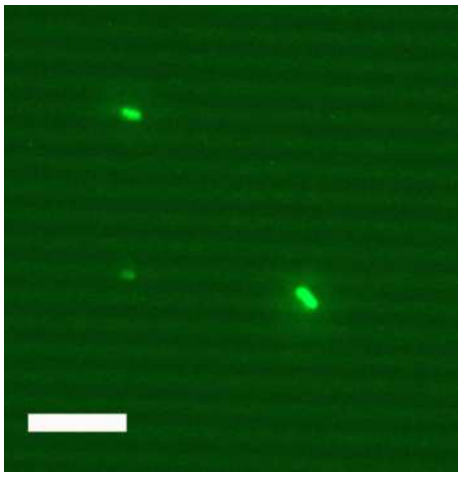
1. Determination of the number and the position of *E. Coli* cells on the detection platform.

After performing the immunoassay, the electrodes with surface-anchored *E. Coli* cells were immersed in a solution containing FITC-labeled anti-*E. Coli* overnight. Then the electrodes were washed with a PBS-Tween 20 solution (0.05%), rinsed with water, and dried with nitrogen. Figure S1 shows a representative image of the cells at the electrodes surface. By counting the number of cells in 20 small areas, the surface coverage was 10^5 cells/mm^2 for a total interdigitated area of 2 mm^2; 50% of the cells were located on the electrodes and 50% of the cells were located at the space between the electrodes.

Figure S1. A fluorescence image of *E. Coli* cells on the antibody-functionalized polysilicon electrodes. The surface-anchored cells were labeled by FITC-conjugated *anti-E. Coli*. Scale bar: 20 μm



2. Equivalent electric circuit

Figure S2 represents the equivalent circuit of the interdigitated silicon electrodes immersed in an electrolyte solution:

- R_c is the resistance of the contacts and the silicon traces
- R_{sol} is the resistance associated the solution between the electrodes and is related to its resistivity through the cell constant.
- C_{sol} is the capacitance of the solution between the electrodes and is related to the permittivity through the cell constant
- C_{int} is the capacitance of the electrochemical double layer in series with the native silicon oxide layer capacitance. This term appears at low frequencies and it is modeled as a constant phase element (CPE), to account for deviations from the ideal behavior of a capacitor.
- R_{si} is the resistance associated to the silicon substrate
- C_{subs} is the stray capacitance of the polysilicon electrodes to the silicon substrate through the silicon oxide insulating layer.

In the present case, differential measurements were carried out to determine the variation of the impedance due the presence of viable bacterial cells on the electrodes. Since R_{si} and C_{subs} are constant among all sensors, the equivalent circuit can be reduced to the simplified one as shown in Figure 2e; In other words, any contributions from these two parameters to the fitted impedance values is cancelled out upon subtraction.

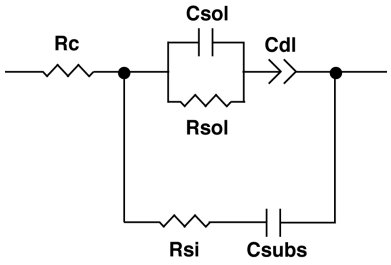


Figure S2. The equivalent circuit of the interdigitated polysilicon electrodes immersed in an electrolyte solution.

3. Viability test for bacterial cells

The following experiment was performed to validate the protocol for the preparation of viable cells samples with fixed concentrations. After *E. Coli* was cultured overnight, these cells were centrifuged for 5 minutes at 10,000 rpm and suspended in fresh PBS buffer. Then, two *E. Coli* solutions were prepared: the first one was in a fresh PBS buffer (1:100 dilution), the second one was in LB growth medium. A third control sample consisted in a dilution of the original live *E. Coli* sample to 1:100 in the LB growth medium. The concentration of cells was estimated from the value of the absorbance at 600 nm, (i.e., OD_{600}). Figure S3 shows the resulting growth curves with time obtained at room temperature. Bacteria that were suspended in the PBS buffer and diluted in the LB medium (red squares) grew at the same rate as the original cells (black dots). This outcome demonstrated that these *E. Coli* cells were still alive after the centrifugation and the suspension in the PBS and hence validated the use of these bacteria as the viable cells. In the PBS solution without the LB medium, the OD_{600} of bacteria did not significantly change with time (green triangles), which indicated that the concentration of bacteria sample was fixed. This protocol is important for the cell concentration-dependent experiments since it allows one to determine the concentration of the live cells without increasing their numbers during subsequent experiments. Therefore, the observation of the concentration change of live bacterial cells in Figure 2f is solely dependent on the number of cell bindings.

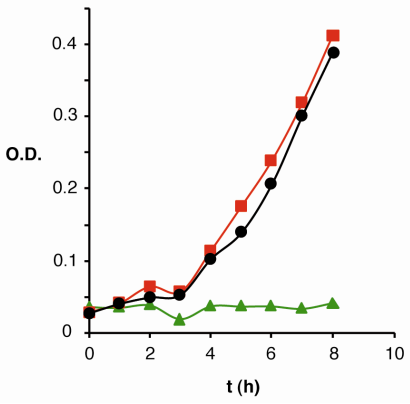


Figure S3. The absorbance at 600 nm as a function of time to probe the viability of cells in the time-dependent binding of *E. Coli* to the substrate. Bacteria that were suspended in the PBS buffer and diluted in the LB medium (red squares) grew at the same rate as the original cells (black dots). In the PBS solution without the LB medium, the OD_{600} of bacteria did not significantly change with time (green triangles), which indicated that the concentration of bacteria sample was fixed.

4. Time-dependent variation of the capacitance of the solution between the electrodes from t = 0 to t =100 minutes in a 10^5 cells/ml solution of *E. Coli*

When the value of ΔC_{sol} was plotted as a function of time, a significant difference was observed between live and dead bacteria cells as shown in Figure S4. In this figure, the 10^5 cells/ml solutions of live *E. Coli* cells (dots) and dead *E. Coli* cells (triangles) were treated in various incubation times. Blue dots represent the anti-*E. Coli* sensor, red dots are the control sensor, and black dots are the subtracted trace of the control sensor line from the anti-*E. Coli* sensor line. The values of $-\Delta C_{sol}$ of the live bacteria increased with time because more bindings of live cells to anti-*E. coli* sensors decreased the capacitance (Figure S4, dots). However, the values of $-\Delta C_{sol}$ for dead bacteria cells did not change with time even with the relatively high bacteria concentration and the prolonged exposure time (Figure S4, triangles). It should be noted that $-\Delta C_{sol}$ measured by the control sensor (red dots) was very small and constant even in the presence of live bacterial cells.

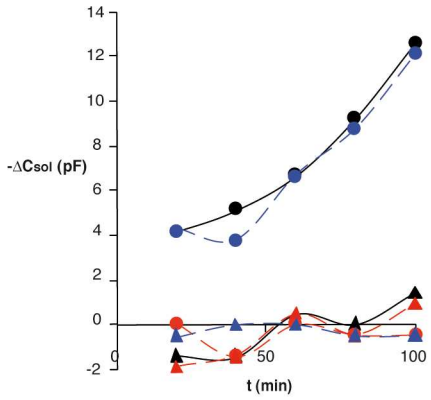


Figure S4. Variation of C_{sol} with the incubation time from t = 0 to t = 100 minutes in a 10^5 cells/ml solution of live *E. Coli* cells (dots) and dead *E. Coli* cells (triangles). Blue: anti-*E. Coli* sensor, red: control sensor, black: subtraction of control sensor from anti-*E Coli* sensor yields specific interaction.

5. SEM images of interdigitated electrodes.

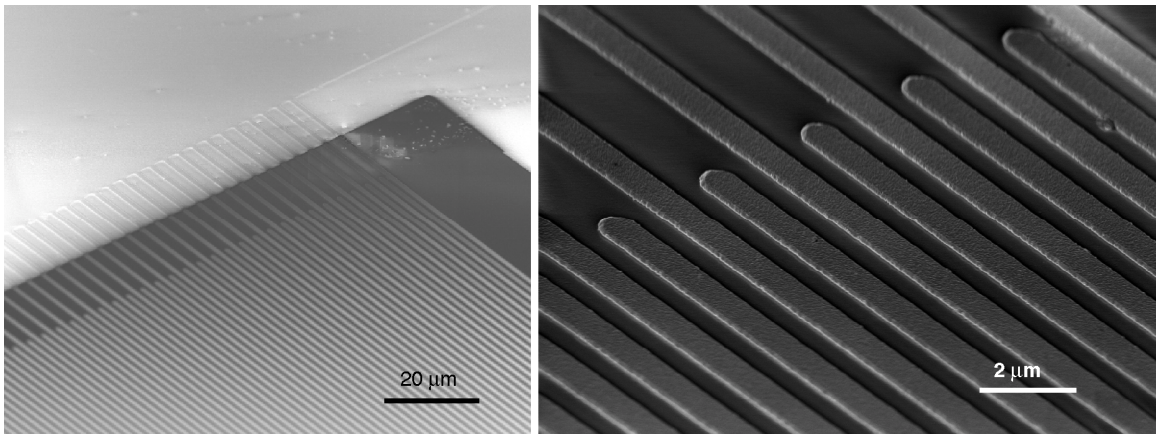


Figure S5. SEM images of interdigitated electrodes