On-chip impedance sensor array
measurement of small impedance in pL solution

- detection of single pathogenic microorganism (virus, bacterium, parasite) in micrometer resolution

**dielectric dispersion specific to pathogenic microorganism**

$f = 1 \text{ Hz} - 3 \text{ MHz}$

$Z = 1 \text{ M}\Omega - 10 \text{ G}\Omega$
verification using ion solution

- Impedance measurement of E.coli β-dispersion, which is proportional to the density.
- Impedance change can be observed by living E.coli, not by dead E.coli.

**Equivalent parallel-plate permittivity**

$$\varepsilon^* = \frac{|Y|}{f}$$

<table>
<thead>
<tr>
<th>plot</th>
<th>solution</th>
<th>average number of E.coli between electrodes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$7.6 \times 10^6$ CFU/mL</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>$7.6 \times 10^5$ CFU/mL</td>
<td>1.4</td>
</tr>
<tr>
<td></td>
<td>$7.6 \times 10^4$ CFU/mL</td>
<td>0.14</td>
</tr>
<tr>
<td></td>
<td>0 CFU/mL</td>
<td>0</td>
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</tbody>
</table>

$Y$: admittance, $f$: frequency
Detection process of E.coli

Detection of living E.coli

introduction to sensor

pathogenic microorganism

impedance measurement

schematic cross-sectional view

reagent

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<th>None</th>
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detection range

| 1-10^7 CFU/mL |

detection time

| 10 minutes |

Detection of specific E.coli

introduction to sensor

1-2 cycles

sample mixing with antibody-beads

magnet

beads captured by magnet

removal of solution

mixing with cleaning solution

antibody

impedance measurement

~ 10 minutes

~ one minute