Integrated On-Chip Biological and Chemical Sensing
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Schematic of Biosensor System

Optical Field Confinement in Ridge Waveguide for Bio-Sensing

Mode Calculation Example

Sensor Cross-sections

E.coli Refractive Index: Theoretical Calculation and Experimental Measurement

Measurement Sensitivity

<table>
<thead>
<tr>
<th>Sensing Principle</th>
<th>DL (pg/mm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface Plasmon Resonance</td>
<td>2-5</td>
</tr>
<tr>
<td>Resonant mirror</td>
<td>5</td>
</tr>
<tr>
<td>Grating coupler</td>
<td>1-10</td>
</tr>
<tr>
<td>Mach-Zehnder interferometer</td>
<td>0.1</td>
</tr>
<tr>
<td>Young interferometer</td>
<td>0.7</td>
</tr>
</tbody>
</table>

\[ \Delta \phi = \frac{2\pi}{\lambda} L \Delta n_{eff} = 0.8\pi \]
\[ I = \cos^2 \left( \frac{\Delta \phi}{2} \right) \approx 9.5\% \]

Microfabrication Process Flow Diagram of Optical Sensor Chip

Challenges of Fiber-to-Chip Alignment Through V-Groove

- Optimal distance between the fiber and the waveguide due to spot size mismatch
- Fiber spot size around 3μm compared to Si waveguide height of about 300nm
- Theoretical prediction vs. experimental results
- Fiber mechanical integrity during alignment and coupling
- Develop an assembly procedure to ensure alignment accuracy according to calculated parameters.

S-Bend Waveguide: V-Groove to MZI Sensor Head

Photomask for Bio-Sensor Chip Fabrication

Pictorial Component Layout

Calculation
\[ n = 1.37673x - 3 - 1.86907x = 4 \]

Measurement
\[ n = 1.3776 \]

Silicon dioxide deposition

Silicon dioxide etch

Strip PR

PR application and development

PR application

Development

Fabrication

Si

SO₂

Fiber

Sbend

Alignment marker

MZI (biosensing area)