DFB-QCL based optical breath sensor for sensitive and real-time ammonia detection


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Important Biomedical Species

<table>
<thead>
<tr>
<th>Species</th>
<th>Formula</th>
<th>Biological/Pathologic Indication</th>
<th>Current Mackenzie</th>
</tr>
</thead>
<tbody>
<tr>
<td>NH3</td>
<td>H2N3</td>
<td>Alkaline earth elements, lung metabolism</td>
<td>3.8</td>
</tr>
<tr>
<td>CO</td>
<td>CO2</td>
<td>Carbon monoxide metabolism</td>
<td>4.4</td>
</tr>
<tr>
<td>NO</td>
<td>NO2</td>
<td>Nitric oxide metabolism</td>
<td>4.8</td>
</tr>
<tr>
<td>NO2</td>
<td>NO3</td>
<td>Nitrogen oxides metabolism</td>
<td>6.3</td>
</tr>
</tbody>
</table>

QEPAS based NH3 Gas Sensor Architecture

QEPAS (Quartz Enhanced Photothermal Acoustic Spectroscopy) is a technique that allows for the measurement of trace gases in real-time. It combines the high spectral resolution of FTIR with the sensitivity of QCM ( quartz crystal microbalance) technology.

NH3 line selection for a 10.34 μm CW RT DFB-QCL

Wavenumber (cm⁻¹)

NH3 spectra obtained with a 10.34 μm DFB-QCL

Performance of HAMAMATSU 10.34 μm CW DFB-QCL

Dilution of a 5ppm NH3 Reference Concentration

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Real-time exhaled human NH3 Breath Measurements

Clinical Tests of NH3 sensor in Bethlehem, PA

Summary

Measuring of ammonia concentration in exhaled breath using laser spectroscopy techniques provides a fast, non-invasive, diagnostic tool for patients with asthma and chronic obstructive pulmonary disease (COPD). The sensor was tested on healthy volunteers and patients with asthma.

Minimally detectable concentration of NH3 was found to be 0.01 ppm, with a detection limit of 0.003 ppm.

The linear relationship between the concentration of NH3 and the output of the laser was found to be quadratic.

The sensor was also able to detect NH3 at concentrations as low as 0.001 ppm.

A compact, robust, and reproducible breath analysis system was developed, which can be used in clinical settings to monitor NH3 levels.

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