Adsorption of ammonia on metal and polymer surfaces

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Ammonia standard (9 ppm NH$_3$ in N$_2$) diluted with *indoor air* (10000 ppm H$_2$O), total flow 1000 sccm
Variables

Test tube coating: stainless steel 316L, electro-polished SS 316L, SilcoNert 1000, SilcoNert 2000, Dursan, PFA, FEP, PTFE, PELD, PVDF

NH$_3$ concentration: 10 ppb – 9 ppm (400 or 9000 ppb)
Flow rate: 0 – 2000 sccm (200 or 1000 sccm)
Temperature: 295 – 333 K (295 K)
Water content: 0 – 1 % (25 ppm)
Gas generation setup

\[ \text{N}_2 \]  \quad \text{MFC} 190 \quad \text{Test tube} \quad \text{To CRDS} \\
\quad \text{NH}_3 \quad \text{MFC} 10 \quad \text{3-way valve} \quad \text{By-pass} \\
\quad \text{H}_2\text{O} \quad \text{MFC} 0 \quad \text{3-way valve} \\

9 ppm in N\text{_}2

1 %
A) Test tube is flushed with indoor air (≥1 h) and pure N\textsubscript{2} (≥0.5 h)

B) Vacuum line and ring-down cavity (except test tube) are exposed to NH\textsubscript{3} (in N\textsubscript{2})

C) Concentration of ammonia is measured after ~1 h

D) Actual real-time adsorption measurement at 6548.79 cm\textsuperscript{-1} in 3 phases:

1) Ammonia gas flow via by-pass line
2) Ammonia flow switched to go via test tube
3) Slow recovery of ammonia signal
Shaded area = Adsorption + Gas exchange

Dursan, 420 ppb
A (SN2000) = 530 ppbs
A (316L) = 13500 ppbs
## Adsorption on metal / coated surfaces

<table>
<thead>
<tr>
<th>Metal / coating</th>
<th>Adsorption* $(10^{12}$molecules/cm$^2$)</th>
<th>St. deviation $(10^{12}$molecules/cm$^2$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SilcoNert 2000</td>
<td>5.7</td>
<td>0.6</td>
</tr>
<tr>
<td>SilcoNert 1000</td>
<td>14.6</td>
<td>0.9</td>
</tr>
<tr>
<td>EP SS316L</td>
<td>72</td>
<td>11</td>
</tr>
<tr>
<td>Dursan</td>
<td>101</td>
<td>5</td>
</tr>
<tr>
<td>SS316L</td>
<td>138</td>
<td>21</td>
</tr>
</tbody>
</table>

*Average of 3 measurements  
NH$_3$ conc = 420 ppb, p (tube) = 176 mbar
## Adsorption on polymer surfaces

<table>
<thead>
<tr>
<th>Polymer</th>
<th>Adsorption* $(10^{12}$molecules/cm$^2$)</th>
<th>St. deviation $(10^{12}$molecules/cm$^2$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PVDF</td>
<td>1.0</td>
<td>0.1</td>
</tr>
<tr>
<td>PELD</td>
<td>4.4</td>
<td>0.6</td>
</tr>
<tr>
<td>PTFE</td>
<td>7.5</td>
<td>1.9</td>
</tr>
<tr>
<td>FEP</td>
<td>8.6</td>
<td>0.3</td>
</tr>
<tr>
<td>PFA</td>
<td>13.9</td>
<td>1.0</td>
</tr>
</tbody>
</table>

*Average of 3 measurements  
NH$_3$ conc = 8750 ppb, p (tube) = 119 mbar
Langmuir isotherm

Adsorption (molecules/cm$^2$) vs. Concentration (µg/m$^3$)
Effect of water

SS 316L

NH₃ adsorption (molecules / cm²)

H₂O concentration (ppmv)
Comparison to PTR-MS data*

**CRDS:**

SS > Dursan >> SN2000 > PFA

**PTR-MS:**

SS >> Dursan >> SN2000 > PFA

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**Ammonia transport through different tubings**

*SilcoTek Corporation, Sulfinert = SilcoNert 2000*
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