Introduction

Biofilms are a consortia bacteria or fungus that can accumulate on a surface, forming a polymer-like matrix. They are prevalent within the environment and can be detrimental to medical and industrial settings. Understanding the nature of their interactions with metal oxide surfaces will prove to be crucial in developing a means of controlling their impact in these fields.

This presentation describes the use of attenuated total-reflection infrared spectroscopy (ATR-FTIR) to monitor bacterial biofilms adhesion onto model metal oxide sol-gel films. The role of hydroxamate siderophore models in the initial adhesion of bacteria to TiO$_2$, Fe$_2$O$_3$ surfaces has been investigated. The interaction of a model hydroxamate ligand, acetohydroxamic acid (AHz), as a function of pH and ionic strength using ATR-FTIR is presented. Results are compared with complexes in solution, such as those formed with Fe$_3$O$_4$.

ATR-FTIR: Metal Oxide/AHz pH 7,10

- CH$_3$ vibrations (~1400 and ~1000 cm$^{-1}$) similar in solution and complex
- Similar shifts (NO at ~1000 cm$^{-1}$) and appearance of C=O stretch (~1595 cm$^{-1}$) are evident
- At pH 10 AHzs are deprotonated and a sharpening of amide II band at 1545 cm$^{-1}$ (complexation $\rightarrow$ shift lower cm$^{-1}$)

Hydroxamate (AHz)/Metal Oxide Summary

Table 5. Preliminary ATR-FTIR Characterization Summary for AHz/Metal Oxide Complexes.

<table>
<thead>
<tr>
<th>pH</th>
<th>Peak Assignment</th>
<th>ATR/Metal Oxide Complexes</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>1170 cm$^{-1}$</td>
<td>Fe$_2$O$_3$/AHz</td>
</tr>
<tr>
<td>10</td>
<td>1700 cm$^{-1}$</td>
<td>TiO$_2$/AHz</td>
</tr>
</tbody>
</table>

Future Work

- Characterize in more detail AHz/metal oxide interaction including dissolution and complexation studies
- Characterize interaction with bacteria models

Acknowledgements

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Conclusions

Preliminary results indicate hydroxamate siderophore analogs have a high affinity for Fe$_3$O$_4$ and TiO$_2$. ATR-FTIR data indicates binding is similar to Fe(III)-AHz complex in solution, providing evidence of the potential impact of siderophores in bacterial binding and biofilm formation.

Approach

- Large adsorbate ATR-FTIR signals can be obtained using sol-gel films

Table 2. Selected metal oxide sol-gel substrates

<table>
<thead>
<tr>
<th>Metal Oxide</th>
<th>Relevance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cr$_2$O$_3$</td>
<td>model for stainless steel</td>
</tr>
<tr>
<td>TiO$_2$</td>
<td>medical implants, mineral</td>
</tr>
<tr>
<td>MnO$_2$</td>
<td>mineral</td>
</tr>
</tbody>
</table>

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