Titania-based Metal Photo-catalysts for Organophosphate Neutralization

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Titania-based metal photo-catalysts for organophosphate neutralization

Katelyn Alley (BS Chem ’21), Quinn Cunneen (BS Chem ’20) and Dario Prieto

Background & Significance

- Organophosphates (OP) inhibit the breakdown of neurotransmitters and are extremely toxic
- Silica-supported metal catalysts can neutralize OP in presence of $\text{H}_2\text{O}_2$
- $\text{H}_2\text{O}_2$ is hazardous to transport, unsustainable to produce
- Silica decomposes during synthesis

Potential solution: Titania

- Robust porous oxide with high SSA
- Two crystal phases (Rutile, Anatase) and a mixed phase (Aeroxide)
- $\text{H}_2\text{O}_2$ production under a UV irradiation

From:

Higher metal loadings with Titania

<table>
<thead>
<tr>
<th>Metal</th>
<th>Incipient Wetness, ml/g</th>
<th>Surface Area, m²/g</th>
<th>Metal loadings, atom/nm²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silica</td>
<td>0.7</td>
<td>370</td>
<td>0.00076</td>
</tr>
<tr>
<td>Anatase</td>
<td>0.4</td>
<td>50</td>
<td>0.0032</td>
</tr>
<tr>
<td>Rutile</td>
<td>0.4</td>
<td>50</td>
<td>0.0032</td>
</tr>
<tr>
<td>Aeroxide</td>
<td>0.8</td>
<td>65</td>
<td>0.0049</td>
</tr>
</tbody>
</table>

UV light increases the rate of reaction

- Reaction can occur without UV light but the addition of UV light increases the reaction rate
- Materials prepared with EDTA and Nitrate show same reactivity
- Addition of titania to silica-based catalysts increases the reactivity

Metal loading affects activity

- The photoactive properties remain constant regardless of the material
- Activity change is due to the metal

Conclusion

- The materials are active in organophosphate neutralization without an oxidant
- No obvious changes in the band gap
- Light increases reaction
- The catalysts deactivate

Upcoming work

- Extend method to Fe, Co, and Zn
- Effect of metal precursor and loading on surface area and metal structure

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From:

Im currently a junior at Montana Technological University pursuing my degree in Biochemistry. I was born and raised in Butte, Montana and decided to pursue my degree at my hometown college. After graduation, I plan on pursuing a Ph.D. in chemistry. In the future, I would like to work as an educator to inspire the next generation of scientists.

Katelyn Alley Biochemistry 21’