Problem: The depletion of fossil fuels along with the increasing demand for energy has given rise to the development of sustainable energy technologies like fuel cells. Fuel cells require catalysts in order to have the reaction move forward and catalysts require supports at both the cathode and anode of the fuel cell.

Goal: Synthesize 3D Graphene Nanosheets (GNS) and determine which kind (based on a set of 3 factors) is optimal using different characterization techniques. The factors looked are weight ratio of GNS:Si support, Si based support, and reduction method.

Results

<table>
<thead>
<tr>
<th>Name</th>
<th>D (nm)</th>
<th>G (nm)</th>
<th>D/G</th>
</tr>
</thead>
<tbody>
<tr>
<td>TeOS</td>
<td>173.83</td>
<td>145.5</td>
<td>1.19</td>
</tr>
<tr>
<td>Si</td>
<td>22.77</td>
<td>24.7</td>
<td>0.92</td>
</tr>
<tr>
<td>Chemical</td>
<td>27.6</td>
<td>17.8</td>
<td>1.55</td>
</tr>
<tr>
<td>Thermal</td>
<td>46</td>
<td>48.6</td>
<td>0.95</td>
</tr>
</tbody>
</table>

Methods

Methods used:
- Synthesis of Gox
- Sacrificial Support Method
- Optimizing Surface Area Support: Silica, Si, TeOS
  - Chemical Reduction (Hypersine)
  - Thermal Reduction (F/Si, 800°C)
- 3D-Graphene
- Doping 3D-Graphene with Pd
- Activity: Ethanol Oxidation

Summary:
- Highest electrochemical surface area (ESCA) did not have higher electrochemical activity. (SiO₂ Chemically Reduced had ECSA of 313m²/g while thermally reduced SiO₂ had ECSA 270m²/g but thermally reduced had higher electrochemical activity.
- Modified Hummer’s Method gave high quality Graphene Oxide
- Raman Spectra showed Chemically SiO₂ Reduced had most defects

Future Work:
- Test catalyst and support in a fuel cell
- Test Crystalline Si Support’s electrochemical activity