Graphene like think films
Synthesis from Bio-char using Wet Chemical Treatment Process

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Outline

- Introduction
  - Bio-char
  - Current progress
  - Bio-char applications
- Experimental Methods
- Results
  - TGA,
  - Raman
  - AFM
- Conclusions
Bio-char?

- **Bio-char is a solid material obtained from the carbonization of biomass.**
  - Usually a by product from pyrolysis or gasification process under reducing atmosphere

**Advantages**

- appreciable carbon sequestration value

**Applications**

- soil amendment, carbon sequestration, adsorbents.
Recent Interests

- Increased interest to utilize bio-char as super capacitor, nano-composites.
- Limitation - Low specific surface area, pore size distribution, porous structure and electrical conductivity, surface functional groups significantly affect the electrochemical performance of carbon materials.
Why Use Bio-char?

- High cost of commercially available carbon based materials such as graphene, CNT, and carbon onions from metal carbide.

- Renewed interest in alternative energy
  - Biomass pyrolysis produces bio oil and bio-char
Experimental Methods

- **Wet Chemical Treatment**
  - Oxidation with HNO3
    - $100^\circ$C and 90hrs
    - Solids washed, centrifuged and dried
  - Reduction with Hydrazine Hydrate
    - $100^\circ$C and 24hrs
    - Solids washed centrifuged and dried.

- **Characterizations**
  - CHN, particle size using zeta sizer, TGA, Raman, AFM
## Preliminary Results

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Units</th>
<th>Biochar</th>
<th>Treated Biochar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon</td>
<td>%</td>
<td>85.75</td>
<td>51.7</td>
</tr>
<tr>
<td>Hydrogen</td>
<td>%</td>
<td>1.42</td>
<td>1.92</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>%</td>
<td>0.48</td>
<td>7.4</td>
</tr>
<tr>
<td>Size Distribution</td>
<td>nm</td>
<td>800-1000</td>
<td>80-200</td>
</tr>
</tbody>
</table>
### Particle size distribution by Zeta Sizer

#### Peak Analysis by intensity

<table>
<thead>
<tr>
<th>Peak</th>
<th>Area</th>
<th>Mean</th>
<th>Width</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>30</td>
<td>80.9 nm</td>
<td>20</td>
</tr>
<tr>
<td>2</td>
<td>70</td>
<td>160.3 nm</td>
<td>91.3</td>
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</table>

#### Peak Analysis by volume

<table>
<thead>
<tr>
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<th>Area</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>69.2</td>
<td>78.9 nm</td>
<td>53</td>
</tr>
<tr>
<td>2</td>
<td>30.8</td>
<td>171.1 nm</td>
<td>63.1</td>
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</tbody>
</table>

#### Peak Analysis by number

<table>
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<th>Width</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>100</td>
<td>65.4 nm</td>
<td>39.1</td>
</tr>
</tbody>
</table>
Thermogravimetric Analysis (TGA)
Raman Spectroscopy

- Treated Bio-char
- Bio-char after oxidation
- Bio-char before treatment
Atomic Force Microscopy (AFM)
Conclusions and Future work

- Demonstrated the wet chemical treatment process for bio-char
- Results indicate the formation of thin layers
- The approach has several advantage over conventional GO oxidation and reduction and is industrially scalable
- The potential application as nano-composites/ filler materials
- Detailed characterization including SEM, TEM and XRD will be studied
- Optimization and scale up study will be conducted
Acknowledgements

- Jeniffer Deluhery
- Illinois Sustainable Technology Center
- MRL