NANOCOMPOSITES FROM REGENERATED CELLULOSE AND NANOCLAY

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Motivation

- Nanocomposites are materials that are created by introducing nanoparticles into a macroscopic matrix
- Polymer/Layered silicate (PLS) nanocomposites have been widely used. PLS nanocomposites exhibit remarkable improvement on the physical, thermal, optical and barrier properties
- Cellulose is the most abundant natural polymer and it’s renewable, biocompatible, biodegradable and environmentally friendly

Materials and Preparation

- Regenerated cellulose: nanocomposites matrix materials
  - High mechanical properties
  - Strong hydrogen bond
  - Strong hydrophilic property
  - Partially crystalline structure (~40%)
  - Low processibility
- Montmorillonite (MMT): nanocomposites filler materials
  - High aspect ratio layered silicate
  - Layer thickness: 1nm
  - Lateral dimensions: 100-200nm
  - Anionic and hydrophilic surface
- N-methylmorpholine-N-oxide (NMMO)
  - Hard to dissolve
  - A specific solvent like NMMO is needed
  - Strong N-O dipoles can substitute the intermolecular hydrogen bonds of cellulose

Results and Discussion

- Morphology of MMT in cellulose matrix

<table>
<thead>
<tr>
<th>Sample</th>
<th>Young's modulus (GPa)</th>
<th>Tensile strength (MPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pure MMT</td>
<td>1.1</td>
<td>20</td>
</tr>
<tr>
<td>MMT 1%</td>
<td>1.2</td>
<td>28</td>
</tr>
<tr>
<td>MMT 2%</td>
<td>1.3</td>
<td>35</td>
</tr>
<tr>
<td>MMT 3%</td>
<td>1.5</td>
<td>42</td>
</tr>
<tr>
<td>MMT 4%</td>
<td>1.7</td>
<td>50</td>
</tr>
<tr>
<td>MMT 5%</td>
<td>1.9</td>
<td>60</td>
</tr>
</tbody>
</table>

- Interaction force between MMT and cellulose

Conclusions

- MMT reinforced regenerated cellulose nanocomposites can be prepared using NMMO method
- Affinity between MMT and cellulose has a relationship with hydrophobicity and interaction force
- Both of the intercalated and exfoliated MMT structures are observed in regenerated cellulose matrix
- MMT reinforced regenerated cellulose nanocomposites have enhanced mechanical properties compared with pure regenerated cellulose
- The Halpin-Tsai model can be used for studying regenerated cellulose/MMT nanocomposites

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