Workshop I: Nanotubes

Introduction

Molecular wires for crossed-wire memory devices

Nanotube Computer

see http://cmliris.harvard.edu/html_natalya/research/research.htm

Metal vs insulator vs. semiconductor

- No gap → Metal, no gap, conducting
- Large gap → Insulator, large gap, no conduction
- Small gap → Semi-conductor, small gap, some conduction
Structure of nanotubes

\[ R = na + mb \]

\((m,n)\) specifies Tube type

Armchair tubes:
\( n = m \), metallic

Zig-zag tubes:
\( m = 0 \), metallic if \( n \) is a multiple of 3

Chiral tubes:
Metallic if \( n - m \) = non zero integer multiple of 3


Activities

1) For each of the three types of tube, make the smallest tube you can that will be both stable and metallic.

2) Suppose we want to make a small insulated wire, by wrapping a non-metallic tube around a metallic tube. Assume the metallic tube is a (5,5) nanotube. What would make a good surrounding tube? (The spacing between carbon sheets in graphite is 3.35Å.)

3) You want to make a pea-pod of noble gas atoms in a nanotube. What tube would you use for each of the noble gasses? The radii of these elements are given in Figure 15.34 in Oxtoby and Nachtrieb as:

<table>
<thead>
<tr>
<th>Element</th>
<th>Radius (Å)</th>
</tr>
</thead>
<tbody>
<tr>
<td>He</td>
<td>0.92</td>
</tr>
<tr>
<td>Ne</td>
<td>1.12</td>
</tr>
<tr>
<td>Ar</td>
<td>1.53</td>
</tr>
<tr>
<td>Kr</td>
<td>1.68</td>
</tr>
<tr>
<td>Xe</td>
<td>1.89</td>
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</tbody>
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