Abstract

Copper nanowires (Cu NWs) synthesis and controlling the aspect ratio in a solution based approach was presented. Also, we show spike growth on Cu NWs, which significantly improves the surface area. Here, we investigate feasibility of using nematic liquid crystalline (LC) media for alignment of nanowires. Our ultimate goal is to make Cu NWs interconnect on carbon doped oxide (CDO) wafer by a combination of photolithography and nematic liquid crystal (LC) phase.

Introduction

Nanomaterials are the basic components from which emerging and future nanotechnologies will be constructed. Controlled alignment and assembly of NWs is critical for realizing future nanoscale devices.

Modern IC’s are made of multilayered copper integrated circuits insulated by low-k (CDO) dielectric material. Electroplating is a traditional method for making interconnect. We are attempting to make interconnects with NWs as explained in the Figure 2.

Figure 1. Schematic showing arrangement of NWs in various phases.

When NWs are dispersed in a solvent, above a particular concentration (Cp), rods or nanowires self-assemble to form a nematic LC phase, where all nanowires or rods are orientationally ordered.

Figure 2. Schematic for making Cu NWs interconnects on CDO wafer.

Synthesis: Cu NWs were synthesized by using Cu(NO3)2 as a precursor, Ethylenediamine (EDA) as a surfactant and Hydrazine as a reducing agent in NaOH solvent.

Aspect ratios were (L/D) controlled by carrying out the synthesis at various temperatures. When the Cu precursor concentration is doubled, spikes growth on nanowires surface can be observed (See Figure 3.b.), which significantly increases the surface area.

Figure 3. Cu NWs synthesized at 60 °C (a) and UV vis spectrum (b).

Table 1. Average length and diameter of Cu NWs synthesized at various temperatures.

<table>
<thead>
<tr>
<th>Temperature (°C)</th>
<th>Average Length (µm)</th>
<th>Average Diameter (nm)</th>
<th>Aspect ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>60</td>
<td>32 ± 7</td>
<td>230 ± 30</td>
<td>125-150</td>
</tr>
<tr>
<td>70</td>
<td>15 ± 5</td>
<td>500 ± 70</td>
<td>23-35</td>
</tr>
<tr>
<td>75</td>
<td>5 ± 0.9</td>
<td>260 ± 60</td>
<td>18 - 20</td>
</tr>
<tr>
<td>80</td>
<td>2.7 ± 0.6</td>
<td>130 ± 35</td>
<td>2 - 20</td>
</tr>
</tbody>
</table>

Figure 4. Cu NWs synthesized at various temperatures a) 60 °C b) 70 °C c) 75 °C and d) Spike growth on Cu NWs at high concentration of Cu precursor at 60 °C.

Cu NWs surface was modified by treating with 1-Dodecanethiol. After surface modification Copper NWs suspended in n-hexane solvent suggests Cu NWs surface is hydrophobic.

Figure 5. Surface modified Cu NWs.

Here we show reproduced results of Ag NWs (with an average length of 4±2 µm) synthesized by microwave assisted method.

Conclusions

We have optimized conditions for synthesizing various aspect ratio Cu NWs. In addition, we show the results of Ag NWs synthesized by a counter top microwave assisted method. We are continuing our further work on aligning Cu NWs by nematic LC phase for building nanowire interconnects.

Bibliography


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