**Density of Bi-2212 in 85x7 Superconducting Wire**

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**Introduction:**

Superconductivity is a fascinating and challenging field of physics. Superconductivity is the flow of electricity without any resistance in certain metals, alloys, and ceramics. This phenomenon occurs when the temperature approaches absolute zero. Current research involves experimenting with conductors which will allow for the flow of greater currents through smaller wires. Superconductivity is being applied to many diverse areas such as: medicine, theoretical and experimental science, military, transportation, and energy production. Bi-2212 (Bi, Sr, Ca, Cu, O) Bismuth Strontium Calcium Copper Oxide is a ceramic superconductor. The silver sheathed Bi-2212 round wire is fabricated as a multifilamentary conductor by the powder-in-tube (PIT) method, but it may be heat treated at final size by partial melting to develop a high optical current density. This wire can be used for stronger and more efficient electromagnets.

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**Purpose:**

The purpose of our research is to compare the density of Bi-2212 filaments in silver-sheathed Bi-2212 wires of varying diameters that have been heat treated at different pressures and non-heat treated wires. This information will help determine the optimal diameter to increase the electrical flow in the Bi-2212 wire.

We studied two sets of wires of varying diameters. The first set of wires was non-heat treated, which is called green wire. The second set of wires was heat treated at 821 °C under 100 bars of pressure for twelve hours.

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**Procedure:**

To study the microstructure, the wire samples were placed into a small round polymer puck. Next, the puck was ground down using varying grits of sand paper to create a smooth, unscratched surface for imaging. The puck was then placed in the VibroMet machine for approximately three hours for the final polishing. High quality polishing creates optimal pictures for image analysis. Images were obtained using the Olympus BX41M-LED Microscope. Once images were taken, Photoshop was used to stitch the images together and create the polymer puck using the mounting press. Drilling holes into the polymer puck for wire placement. Polishing the puck in the dry polisher.

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**Analysis:**

Photoshop was used to measure and calculate the number of black and white pixels of the samples. These pixel counts were used to determine the area of Bi-2212 and silver in each wire. This data, along with measurements of the length, mass, and volume, were used in formulas to determine the density of the Bi-2212 in each wire.

**Density of Bi-2212 in 85x7 Wire**

<table>
<thead>
<tr>
<th>Green Wire</th>
<th>Partially Heat Treated Wire (821 °C/12 h under 100 bar)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal Wire Diameter (mm)</td>
<td>Average Wire Diameter (mm)</td>
</tr>
<tr>
<td>0.7</td>
<td>0.707</td>
</tr>
<tr>
<td>0.8</td>
<td>0.812</td>
</tr>
<tr>
<td>0.9</td>
<td>0.922</td>
</tr>
<tr>
<td>1.0</td>
<td>1.032</td>
</tr>
</tbody>
</table>

*The theoretical density of Bi-2212 phase is 8.6 g/cm³*

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**Conclusion:**

Our findings show the density of Bi-2212 increases significantly after heat treatment at 821 °C under 100 bars for twelve hours. In the green wire, the 1 mm diameter wire had the highest density of Bi-2212.

Further analysis should be conducted on similar samples in order to gather more data. Heat treating Bi-2212 at greater pressure is another avenue of interest. Scientists are eager to determine the precise effects of higher density within the energy research field.

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