Three-Dimensional Filament Structure of Ag/BiSCCO 2212 Multi-filament Round Wire

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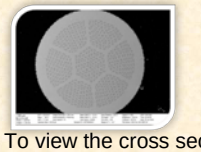
Introduction

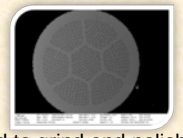
- A superconductor is a material which is "an element, inter-metallic alloy, or compound that will conduct electricity without resistance below a certain temperature, T_c" (www.superconductors.org).
- BiSCCO 2212, Bismuth Strontium Calcium Copper Oxide ($Bi_2Sr_2CaCu_2O_x$) round wire is an isotropic, high temperature superconductor with a critical temperature of 90 K for use in high field magnets beyond the limit of conventional Nb-based conductors at 4.2 K.
- The purpose of our research is "…to visualize the non-uniformities of 2212 filament structure in partial-melt processed multifilament Ag/Bi-2212 round wire, and further show that the porosity, non-superconducting phases, and occasional disappearance of filaments are strong current-limiting mechanisms in state of the art Bi-2212 round wire." (Shen)

Process

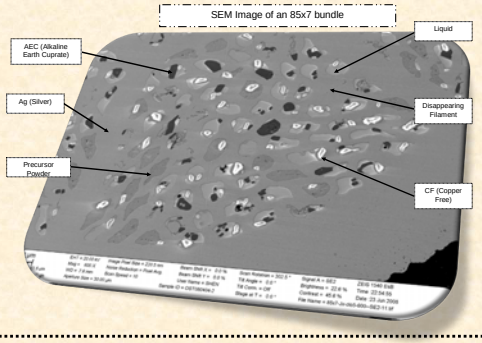
- We studied ten 10mm wires, mounted within a "puck". We had five samples of 27x7 and five of 85x7. (The first number indicates how many filaments in a bundle and the second number tells how many bundles in the wire.)
- For each type of wire we had one green wire (untreated) and four wires quenched (dropped in brine to freeze the microstructure that was occurring at the following temperatures: 874ºC, 880ºC, 882ºC, and 884ºC).



Green Wire

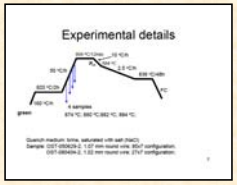


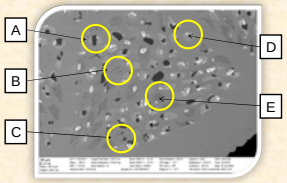
- To view the cross sections we had to grind and polish the samples. Using silicon carbide sandpaper, with grits of 300, 400, 600, and 800. After the initial cross sectioning, we removed 20µm of material from the samples, then polished to reveal the next cross section.
- After polishing each cross section, we photographed the samples using an optical microscope. Then SEM (Scanning Electron Microscope) images were taken.



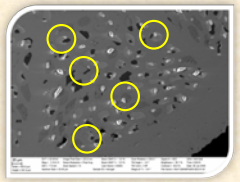
85x7 Quenched at 884ºC

Bi-2212 Round Wire Quenched at 884ºC

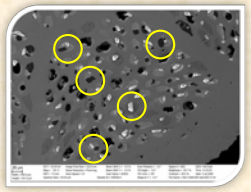




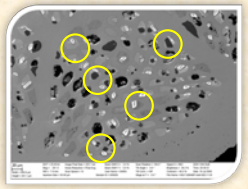
SEM 1 (0 µm)



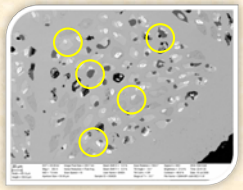
SEM 2 (20µm)



SEM 3 (40 µm)

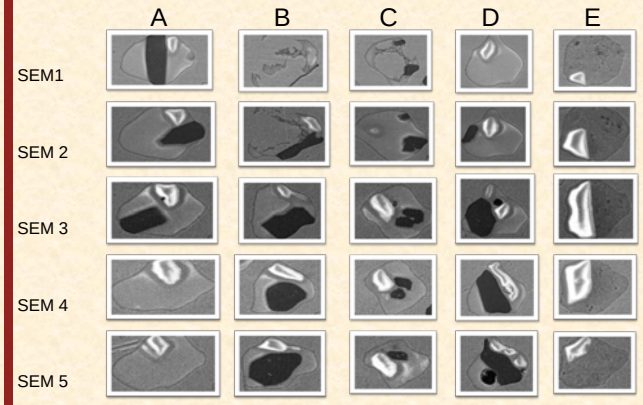


SEM 4 (60 µm)



SEM 5 (80 µm)

Filament Changes



Results and Discussion

There is evidence of all partial-melt stages within each filament, showing heterogeneous melting. This is shown in the SEM images. This information is important because this will give the scientists further knowledge of how the current flows within a polycrystalline network.

Conclusion

Further research will include:

- Determining if "sausaging" leads to the non-uniformity of the filaments we observed in the sample quenched at 884 ºC.
- How the non-uniformity we observed can be reduced, especially in the pores.
- Determining the cause of the disappearance of filaments.
- Determining if the gas is trapped in the filaments or if large AEC grains nucleated.

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