The Quest for a Better Core for Bi-2212 Magnets

Jennifer Borges
Oak Ridge High School
Orlando, Florida

Jeanne Murphy
James Walden Johnson
College Prep Middle School
Jacksonville, Florida

Arno Godeke
Research Scientist
Lawrence Berkeley National Laboratory

Jianyi Jiang
Research Faculty II
Applied Superconductivity Center

Eric Hellstrom
Professor ASC
Florida State University

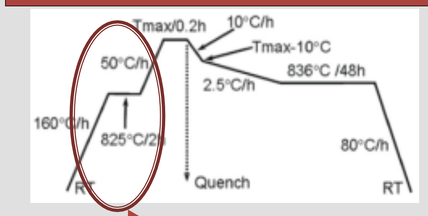
Introduction and Purpose

Recent publications by the Applied Superconductivity Center [1,2] indicate that Bi-2212 ($Bi_2Sr_2Ca_1Cu_2O_{8-x}$) imbedded in a AgMg outer sheath can increase its critical current density J_c by a factor of 8 when put through a heat treatment (HT) and over pressure treatment (OP) with O and Ar gas . The Bi-2212 core must also undergo the heat treatment as well.

Arno Godeke sent us a sample of core, Berkalloy, material that had been through the Bi-2212 HT at 1 bar pressure. We put a sample through the HT and pressure of 100 bar in 99% Ar and 1% O_2.

We were puzzled as to why the 100 bar HT had so much more oxidation.

Standard Bi-2212 Heat Treatment (HT)



The O partial pressure the Bi-2212 treatment during warm up is 0.7 not 1 bar.

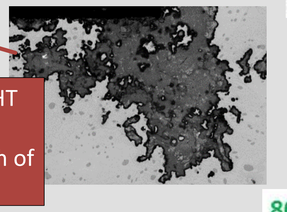
Berkalloy with100 bar Bi-2212 OP-HT
Oxidation is uneven

100 bar OP-HT

Cross section of groove Mag 40X.

100 bar sample in 1% O_2 and 99% Ar. Coloration on sample is darker and uneven due to oxidation .

Cross section of 100 bar OP-HT groove Mag 300 X
EDS indicates dark area, depth of 18 µm composed of O and Al

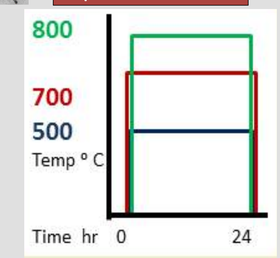


Berkalloy1 bar Bi-2212 HT
No oxidation visible

1 bar HT

Cross section of groove Mag 40X.

Experimental HT



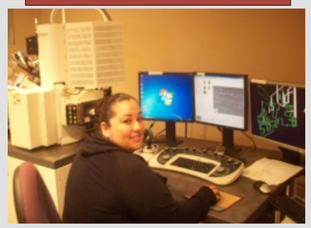
Our quest was to determine which HT would give the alloy a thin Al_2O_3 oxidation coating which would prevent further oxidation of the core .

Procedure

1. Berkalloy was cut, polished, and annealed for 24 hours in flowing oxygen at 500°C, 700°C, and 800°C, respectively.
2. The as-received and annealed samples went through a standard Bi-2212 100 bar OP-HT.
3. The metal samples were placed into a small round polymer puck which was ground down using varying grits of sand paper then placed in the VibroMet machine for approximately six hours for the final polishing.
4. Images were obtained using the Zeiss 1540 XB Scanning Electron Microscope (SEM) and the different element concentrations were determined using Electron Dispersive and X-ray spectroscopy (EDAX).

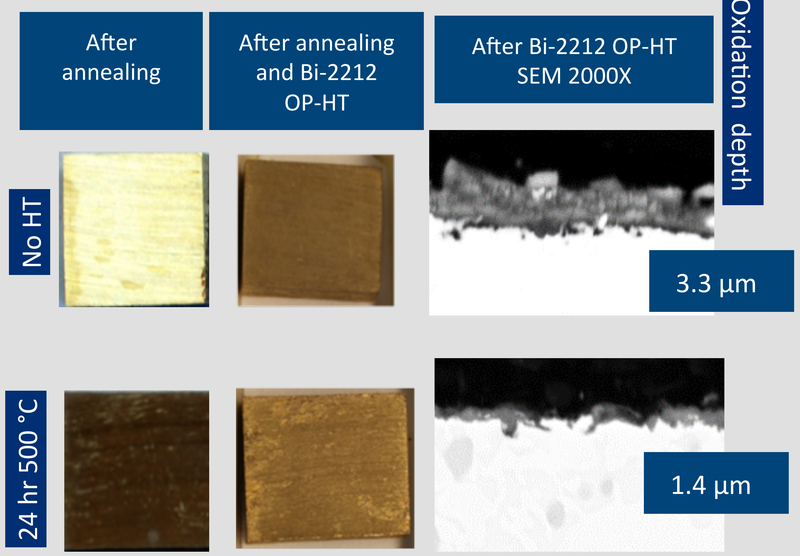
Jeanne grinding the sample

Jennifer using SEM



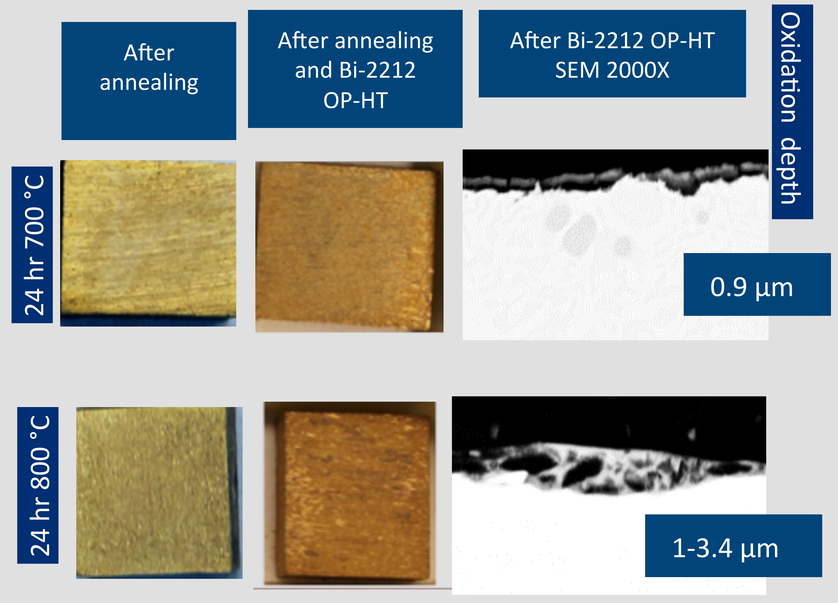
Analysis

Cross Sections of Berkalloy



Analysis Continued

Cross Sections of Alloy 954



Conclusion and Future Work

- For Berkalloy an annealing treatment of 700° C for 24 hours treatment gave us the thinnest and most uniform oxidation.
- Separation of the oxidized layer was noticed with the 700°C and 800°C samples. It was believed that the polishing process caused the layers to separate (Scaling).
- Other alloys, are also undergoing treatments to verify if they would make better cores for superconductors.

Acknowledgements

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References

1 D.C. Larbalestier, J. Jiang, et al., *Isotropic round-wire multifilament cuprate superconductor for generation of magnetic fields above 30 T.* Nature Materials, 13, 375-381 (2014)
2 .J. Jiang, et., "Doubled critical current density in Bi-2212 round wires by reduction of the residual bubble density," *Supercond. Sci. Technol.*, vol. 24, p. 082001, 2011