Heat Treatment and Analyzing of High Temperature Superconductor $Bi_2 Sr_2 CaCu_2 O_X$ (BSCCO 2212)

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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, Tc" (www.superconductors.org)

•**BSCCO2212**, Bismuth Strontium Copper Oxide ($Bi_2 Sr_2 CaCu_2 O_X$) is one of the main superconductors the ASC at the NHMFL works with.

•**Tc** (critical temperature) is "…the temperature at which the electrical resistivity of a metal drops to zero…" thus creating a superconducting material. (http://hyperphysics.phy-astr.gsu.edu)

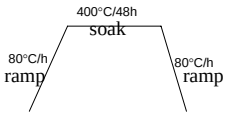
•**Purpose of our research** is to identify how the properties of BSCCO2212 samples are affected by oxygen content, which can be adjusted by annealing the reacted samples in different atmospheres (PA-post anneal) at 400°C for 48 hours. Different atmospheres change levels of oxygen in the sample, which affects the Tc and other properties such as critical current density (Jc) and critical field (Hc).

PROCESS

•Using staticically designed experiments two samples were chosen from a set of 32 samples produced by Oxford Superconductor Technology. Sample T521-3 has the highest critical current density (Jc), and T524-2 the lowest Jc.

•Using a calibrated (calibration finds the "hot spot") gold furnace, samples were heat treated in different atmospheres.

•The ramp and soak cycle process heats the furnace gradually to a certain temperature (ramp) then kept at that temperature (soak) for a certain amount of time.



• In this experiment, the first ramp heated the furnace to 400° C at a rate of 80° per hour. The sample soaked at 400° C for 48 hours. The furnace returned to room temperature after the soak.

•Samples are placed in the Superconducting Quantum Interference Device (SQUID) to identify the Tc by measuring the change in magnetic moment with respect to temperature and the Physical Property Measurement System (PPMS) to measure resistivity change with respect to temperature.

•**Preparing samples of T521-3 and T524-2 for the SQUID:**

•Cut each sample to a size of 4mm X 5mm

•Place each sample between two wooden dowels. Then the sample is inserted into a clear plastic capsule.

•Insert the sample into a plastic drinking straw, which houses the sample during measurement.

•**Preparing samples of T521-3 and T524-2 for the PPMS**:

•Cut each sample to a size of 1mm X 4mm

•To etch the silver off of the BSCCO, each sample is carefully placed in a solution of 2 parts 30%hydrogen peroxide to 5 parts 25% ammonium hydroxide.

•Each sample is mounted with varnish onto a plastic buffer.

•The mounted etched sample is varnished onto a conduction puck and then using silver paint, four wires connect the sample to the current and voltage junctions.

Samples of BSCCO to be heat treated in the gold furnace.

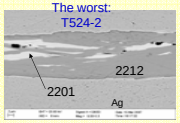
Mounting the samples of BSCCO to be placed in the PPMS.

Once the sample is mounted in this probe, it is inserted in the SQUID.

Microstructure of Samples before Post Anneal

The best: T521-3

The worst: T524-2



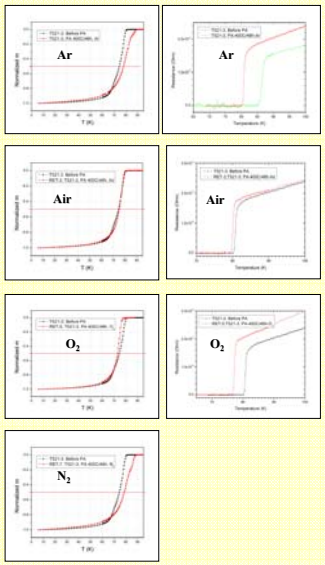
Sample	Composition	Sr/Ca	Tc	Critical Current Density (4.2K)
T521-3	$Bi_{2.17}Sr_{1.94}Ca_{0.89}Cu_{2.00}O_x$	2.18	80K	4064A/mm^2
T524-2	$Bi_{2.10}Sr_{1.67}Ca_{1.22}Cu_{1.97}O_x$	1.37	74.5K	1196A/mm^2

T521-3: more 2201 intergrowths, less amount of 2201

T524-2: almost no 2201 inter growths, large amount of 2201

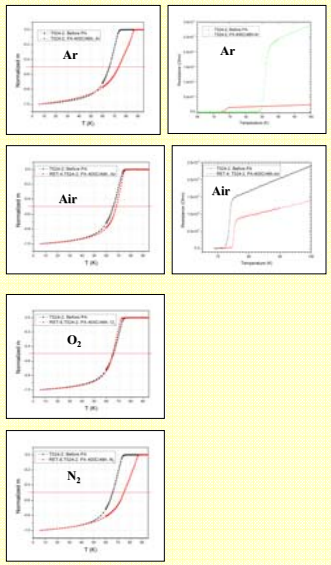
T521-3

SQUID (Magnetic method) PPMS (Electronic method)



T524-2

SQUID (Magnetic method) PPMS (Electronic method)



RESULTS

Changes in Tc:

T521-3

Atmosphere	Before PA (Post Anneal)	PA (Post Anneal)	Δ Tc
Argon	80 K	87.5 K	7.5 K
Air	80 K	81 K	1 K
Oxygen	80 K	77.5 K	-2..5 K
Nitrogen	80 K	87.5 K	7.5 K

T524-2

Atmosphere	Before PA (Post Anneal)	PA (Post Anneal)	Δ Tc
Argon	74.5 K	86 K	11.5 K
Air	74.5 K	75 K	0.5 K
Oxygen	74.5 K	73 K	-.05 K
Nitrogen	74.5 K	86 K	11.5 K

CONCLUSION

As the level of oxygen in the samples is reduced, the Tc is elevated. Future research should include tests to determine the Jc (critical current density) and the Hc (critical field). Therefore, the correlation between Tc, Jc and Hc will be established and the desirable performance of BSCCO-2212 conductor can be achieved accordingly.

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