APh77 - Laboratory in Applied Physics
High-Tc Superconductivity Experiment
Supplemental Information

Brian Standley
May 2005

Contact information

Email: standley@caltech.edu
Cell phone: (626) 376-6004
Office phone: x4873
Office location: 272 Watson (building 95)

To contact me first try my cell phone. If that doesn't work try my office. Appropriate times to call: 9am to 1am on weekdays, 12pm to 3am on weekends. I read my email frequently, but I might not respond for a while if it isn't urgent.

Handout corrections

1. The starting materials will form a light grey powder when mixed rather than a black powder as stated in the handout.
2. The handout mentions GWBasic in the Resistivity-Temperature Measurements section. This is out of date. We now use LabVIEW to control the measurement equipment and record the data.

Procedure for doing the experiment

1. Answer the pre-lab questions. Chapter 12 of Kittel's "Introduction to Solid State Physics" is a good place to look for an introduction to superconductivity. There are (at least) two ways to calculate the levitation height due to the Meissner effect: 1) read through "Ampere's Force Experiment: Derivation" listed on http://standley.caltech.edu/aph77/ and then compute the numerical integral at the end or 2) follow the method outlined in exercise 7.43 of Griffiths' "Introduction to Electrodynamics." Both approaches involve a method of images based on the boundary condition that results from the superconductor's perfect diamagnetism: $B_\perp = 0$. I have both texts in my office available for borrowing if needed.
2. Read the lab handout and the two technical notes on about the lock-in amplifier listed on http://standley.caltech.edu/aph77/.
3. Meet with the instructor (me) in his or her office. At this point the instructor will review the pre-lab questions, show you how to operate the equipment, and go over the safety precautions.
4. Fabricate the samples according to the procedure given the lab handout. The gas flow for the sintering process should be as low as possible while still detectable by the ear. This can be acheived by setting the regulator to ~ 5 PSI and then opening the distributor valve ~ 2 turns.
5. Do the Meissner effect experiment to verify that the sample is superconducting.

6. Use the x-ray diffractometer to investigate the crystal structure (or lack-there-of) of one of the samples. Two sided adhesive tape is available in the lab to contain the powder.

7. Schedule a meeting with the instructor to go over how to attach leads to a sample for the resistance measurement. This process involves non-conductive epoxy and silver paint, but *no conductive epoxy or soldering.*

8. Attach leads to one of the samples, load it into the insert, and make a resistance (induced voltage vs. temperature, really) measurement. Detailed instructions are given on the "desktop" of the computer in the lab. A connection diagram is shown below in Figure 1.

9. Continue through the rest of the procedure given in the handout.

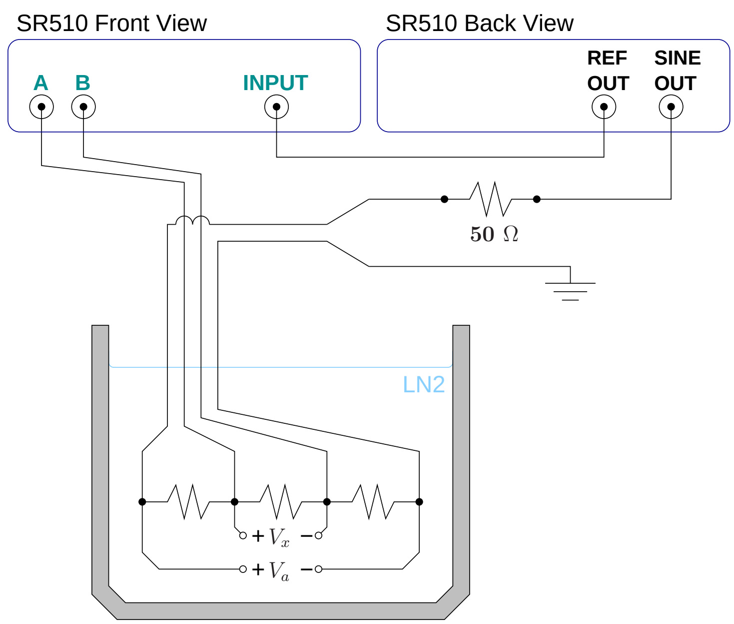

Figure 1: Wiring diagram for a four point probe measurement using a lock-in amplifier.

Hints

1. Keep in mind when calculating the amounts of starting materials that oxygen is not conserved in the chemical reaction which forms the YBCO. Indeed, the amount of oxygen remaining in the sample is an important parameter of the fabrication process.

2. Don't be alarmed if your sample won't levitate the magnet at first. Resintering, as suggested in the handout, will likely improve the sample enough to make it superconducting.

3. The leads connecting the thermocouple to the multimeter are fragile, yet must run between the rim of the dewar and the groove at the edge of the insert when making the resistance measurement. Please be careful not to break the leads in this configuration.

4. The LN2 dewar is fragile and will *implode* if broken. Please be careful with the dewar.