High Temperature Superconductors

Brandi Tungett
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ABSTRACT

The purpose of this experiment is to investigate the characteristics of superconductors. We found the critical temperature to be about 127 K, and we found the resistance to be around 0.0002 Ω at this point.

INTRODUCTION

The purpose of this experiment is to investigate the characteristics of superconductors. The superconductors were supercooled using liquid nitrogen, then their critical temperatures were found. A super-conductor is a substance that can conduct an electrical current without losing energy or energy. The resistance was measured as the superconductor heated to help determine the effects of a superconductor.

THEORY

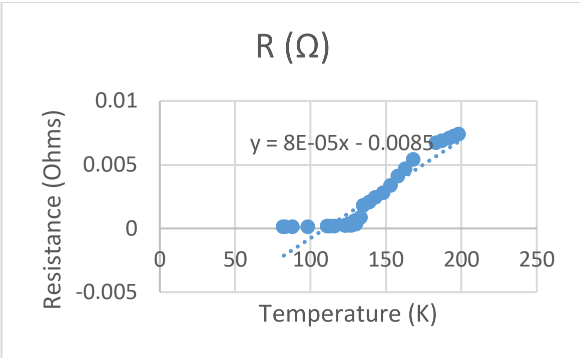
Prior to 1986, all superconducting materials had to be cooled below 35 K in order to superconduct. Technology advances helped new superconducting materials be created with higher temperatures. Today, the type with the highest transition temperature has a temperature around 125 K. Liquid nitrogen has a boiling point of 77K and can be used to make these materials superconducting. This helps with a wider application of superconductors. However, these materials are often fragile and it is hard to make wires out of them that are required for large magnets. To experiment with them in this lab, we used a special kit containing a high temperature superconductor and a rare earth permanent magnet.

As the temperature of a superconductor approaches its critical temperature, all magnetic fields inside the conductor cease. This phenomenon is called the Meissner effect. The Meissner effect occurs is due to the magnetic dipoles on the small magnetic to be induced and causes the magnet to float over the superconductor. One can use the Meissner effect to study the critical temperature of a superconductor.

PROCEDURE

To begin this experiment, we first found the critical temperature. To do this, we carefully poured enough liquid nitrogen to almost cover the disk and used tweezers to set the disk in the nitrogen until the liquid nitrogen stops boiling. Once it stopped boiling and the voltmeter read 6.42 Mv, we took out the disk and quickly but carefully put the small magnet on top of the disk. We removed it as the disk had become superconducting and had reached a temperature of 77K. Because the disk was now superconducting, the magnet levitated over the disk. As the disk warms, superconductivity ceases, so we find the critical temperature Tc to be just as the magnet drops. This experiment was repeated multiple times. The next thing we did was measure the resistance of the magnet. To do this we used 4 wires coming out of the housing. These specific wires are a means of measuring resistance while eliminating contact resistance. For these measurements, a current of 0.1 amp is used on the leads and we hooked this current source to the current leads, and we used the thermocouple reader to monitor temperature, and a digital voltmeter to measure the voltage across the super conductor. By knowing the voltage and current, from Ohm’s law we calculated the resistance of the conductor.

RESULTS/ANALYSIS



The critical temperature is around 127 K, as can be observed on the graph, and was observed experimentally.
Using the critical temperature as a testing point the error can be calculated as follows:

$$R = \sqrt{\left(\frac{\Delta V}{V}\right)^2 + \left(\frac{\Delta I}{I}\right)^2}\, R$$

Using estimated values for error from the equipment, and solving for resistance:
ΔV=0.00001V
V=0.00008V
ΔI0.05A
I=0.4A
R=0.0002Ω
Plugging all of this in we get 3.35 x 10^{-5} Ω.

CONCLUSION

In conclusion, we were able to see a superconductor and how it works in person, which was pretty cool. We found the critical temperature to be about 127 K, and we found the resistance to be around 0.0002 Ω at this point.