Special experimental projects
Physics Department
The Chinese University of Hong Kong, Hong Kong

Topic: Magnetic property of High T_C superconductors
designed by
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Topics you should know first:

1. Meissner effect & perfect diamagnetism
2. Type II superconductor
3. Flux pinning effect

Objectives:

1. Prepare two high TC superconductors: $YBa_2Cu_3O_7$.
2. Observe Meissner effect and diamagnetic property of a superconductor.
3. Determine the fraction of superconducting volume of a sample.
4. Measure $H_{C1}(T)$.
5. Study flux pinning effect.

Check-list for the project:

1. Learn basic properties of Type II superconductor (Ref. 1 & 2)
2. Prepare two samples: $YBa_2Cu_3O_7$ (YBCO). (Ref. 3)

First prepare YBCO powder. Heat powder at 950 ºC.
Then make one YBCO pellet. Sinter these pellets at 920 ºC.

3. Determine lattice constants of YBCO by x-ray diffraction (XRD) & check with given data. (Ref. 4)
4. Measure magnetization (M, magnetic moment per unit volume) of YBCO as a function of temperature (T) by vibrating-sample magnetometer (VSM). (Ref. 5)

You can just crunch the pellet into small pieces for the measurement. Weight sample.
Note: There is correction factor for the sample temperature in VSM.
Do this experiment in two steps: (Ref. 6)

a. ZFC (zero-field-cooled): (Demagnetize the sample and magnet first.) First cool sample in zero magnetic field to at least 40 K and then apply a magnetic field H = 50 Oe. Measure M(T) for increasing T. Find T_C.

b. FC (field-cooled): Warm up sample to T > TC and then apply a magnetic field H = 50 Oe. Measure M(T) for decreasing T.

5. From the jump at T_C, estimate the fraction of superconducting volume of sample. (Ref.6)

At a fixed temperature $T << T_C$, obtain a hysteresis loop (M-H curve) with maximum H = 1000 Oe. Don't forget to demagnetize the sample and magnet before taking data.
Then get H_{C1} for this temperature. (Ref. 6)

6. Repeat step 8 for at least 3 more temperatures ($T < T_C$) and draw $H_{C1}(T)$ curve.
7. Measure resistance of one sample as a function of T and determine T_C.

8. Demonstrate the flux pinning effect using magnetic levitation experiments and discuss using the hysteresis loops you obtained.

References

1. J.D. Livingston, “Electronic properties of engineering materials” Ch. 6.
(TK7871 .L58 1999)
2. Lecture notes on superconductivity.*
3. Note on preparation of YBCO.*
4. XRD operation manual.
5. VSM operation manual.*
6. C. P. Poole, H. A. Farach, R. J. Creswick, “Superconductivity”,
Ch. 10 Magnetic properties (QC611.92 .P66 1995).
Ch. 5 Magnetic properties (QC611.92 .P66 2014)

* available on CoursePage.