

Fabrication and Characterization of High Temperature Superconductors

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Introduction:

Superconductor is a material can conduct electricity without resistance below a critical transition temperature. In 1911, superconductivity was first observed in Mercury cooled by liquid Helium at 4K. In 1957, BCS theory was proposed which explains the origin of superconductivity in these metals. In 1986, the Lanthanum, Barium, Copper and Oxygen compound, which is a brittle ceramic, was found to be superconducting at the highest temperature then known: 30 K. This is in fact the first superconducting copper-oxides discovered. In 1987, $\text{YBa}_2\text{Cu}_3\text{O}_7$, which is a ceramic with superconducting transition temperature at 93K, was found. The BCS theory, however, fails to explain high temperature superconductor.

Objectives:

1. To fabricate stoichiometric polycrystalline $\text{YBa}_2\text{Cu}_3\text{O}_7$ (YBCO) bulk superconductors.
2. To familiarize with structural characterization techniques such as scanning electron microscopy (SEM) and X-ray diffractometry (XRD).
3. To learn to use four-point-probe method and cryogenic equipment for R-T measurement of YBCO.

Fabrication of YBCO ($\text{YBa}_2\text{Cu}_3\text{O}_7$)bulk:

1. Measure the mass of the the Y_2O_3 , CuO and BaCO_3

	M.W.	%
Y_2O_3	225.8	99.9%
CuO	79.54	98.0%
BaCO_3	197.34	99.0%

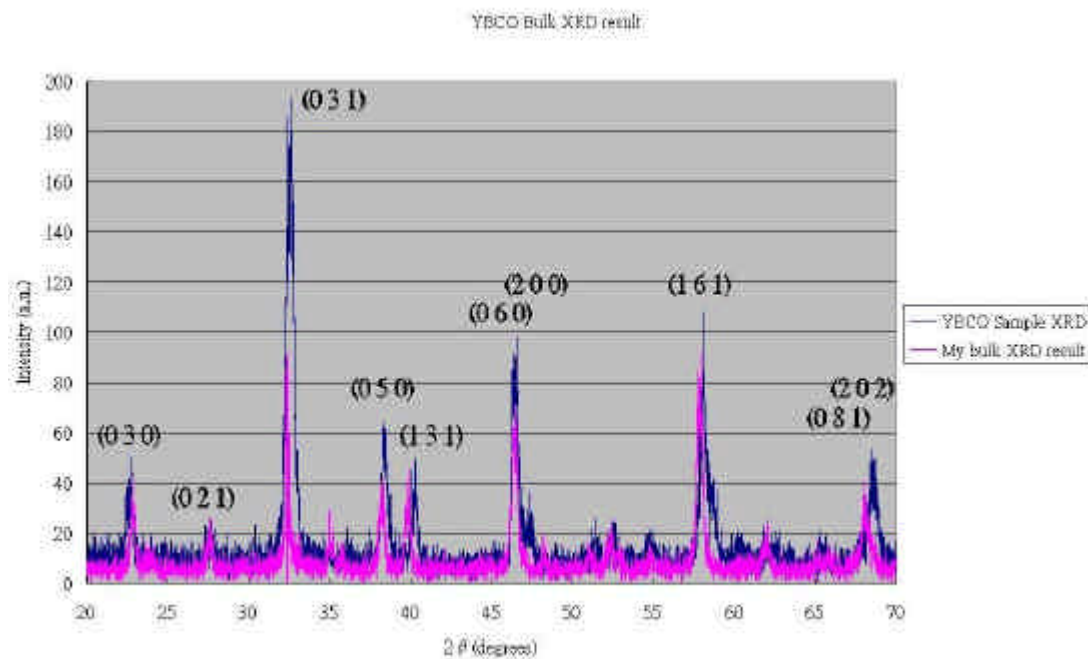
The mass of Y_2O_3 : 2.48629g, CuO: 5.356776g, BaCO_3 : 8.77067g

2. Milling the mixture of Y_2O_3 , CuO and BaCO_3 until they mixed well in microstructure.
3. Use high temperature oven 900 under flowing oxygen for 10 hours
4. Milling the mixture again

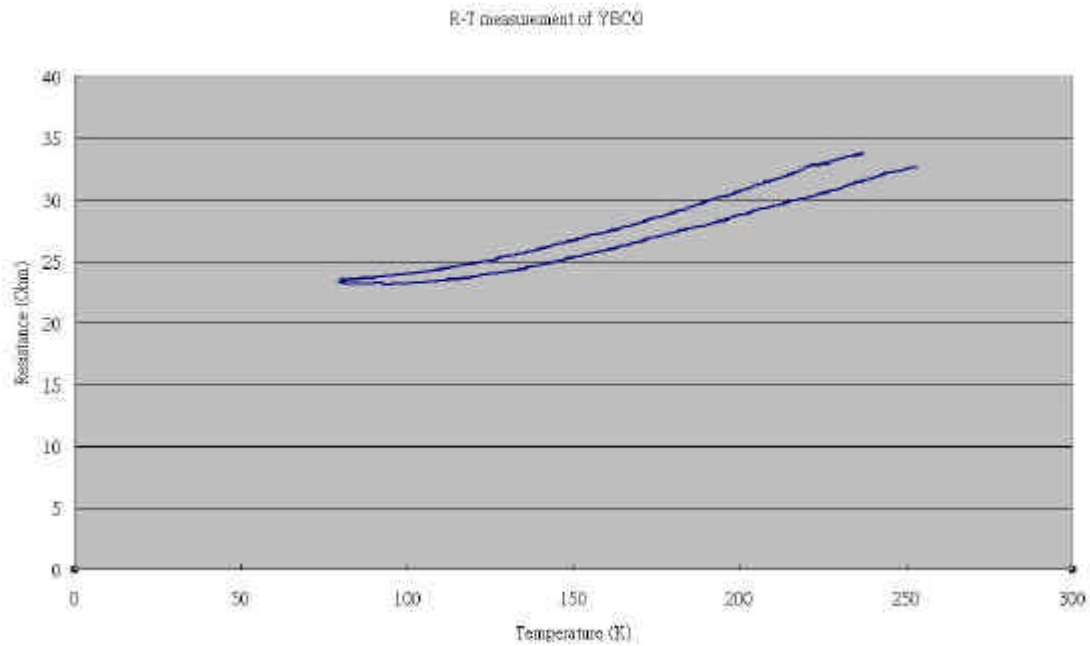
5. Use high temperature oven 930 under flowing oxygen for 15 hours
6. Milling the mixture again
7. Press the powder into dense and compact pellets by hydraulic press and specially made moulds, and use about 3.5T force to press the powder about 30 mins.
8. Use high temperature oven 955 under flowing oxygen for 5 hours
9. Use high temperature oven 500 under flowing oxygen for 2 days

Characterization of YBCO

Result from XRD:



Result of R-T:



Analysis:

The XRD show that the structure of bulk sample is similar to YBCO, but the R-T measurement show that there have no superconductivity, I think the bulk sample have not enough proportion of YBCO. The reasons behind my claim are:

1. The mass of mixture of Y_2O_3 , CuO and $BaCO_3$ is too high, so that inside the bulk there have not enough proportion of YBCO.
 2. The pressure I use are too large, so the oxygen can't diffuse inside bulk easily, so the proportion of YBCO not enough.
 3. The milling is not done well.
 4. The time of sintering should take longer time so that the reaction can proceed more.
- I will milling it again and sintering 2-3 times later, since milling and sintering need very long time, until now still done 2 times only.