

## MEASUREMENT OF SPECIFIC HEAT ANOMALY AND CHARACTERIZATION OF HIGH T<sub>c</sub> CERAMIC SUPERCONDUCTORS BY AC CALORIMETRY

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### ABSTRACT

The measurements of high T<sub>c</sub> ceramic superconductors by ac calorimetry revealed that the entire superconductive transition process can be analyzed more minutely than by the electrical resistivity and ac susceptibility measurements.

It was found that not only the amount of specific heat jump but also the shape of C<sub>p</sub> vs. T curve around T<sub>c</sub> provides important information for the quality evaluation.

### INTRODUCTION

The ac calorimeter measures the temperature amplitude of a very small sample heated by intermittently irradiating its one side with light, which is in inverse proportion to the specific heat of the sample. Taking advantage of the features of ac calorimetry-- a sample as small as 1x1x0.1mm, high sensitivity and high temperature resolution of 0.01°C-- we have conducted specific heat measurements of more than 30 high T<sub>c</sub> ceramics superconductor samples in the temperature range of 70-300K.

ac calorimetric measurements of ceramic superconductors provide the following important information :

Since the magnitude of specific heat anomaly  $\Delta C_p/T_c$  by superconductivity phase transition is proportional to the electron density that contributes to superconductivity, the electron specific heat coefficient can be obtained from this magnitude. Besides the specific heat curve in the neighborhood of  $T_c$ , it reflects the transient process from normal to superconductivity and provides information about the quality and inhomogeneity of the sample.

#### EXPERIMENTAL

Various types of well-sintered Y-Ba-Cu-O ceramics superconductors were measured by SINKU-RIKO's ac calorimeter model ACC-1 under following conditions;

sample size: 1-3 mm sq. x 0.1-0.3 mm thick 8-20 mg

temperature sensor: 0.25 mm dia. chromel-alumel thermocouple  
attached by Ag paste

measuring frequency: 1.8 Hz

measuring atmosphere: 10-30 torr He gas

heating or cooling rate: 5-10 K/hr

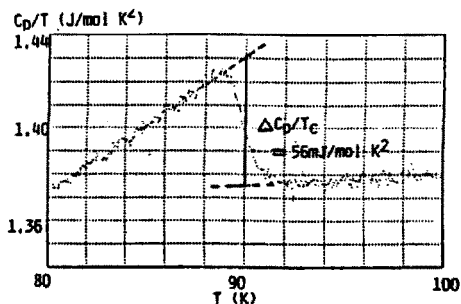
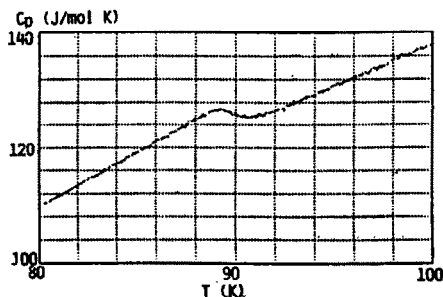
temperature amplitude by intermittent irradiation heating: 5-10mK

#### RESULTS AND DISCUSSION

The 90K class YBCO ceramics superconductors can be classified into four groups as follows;

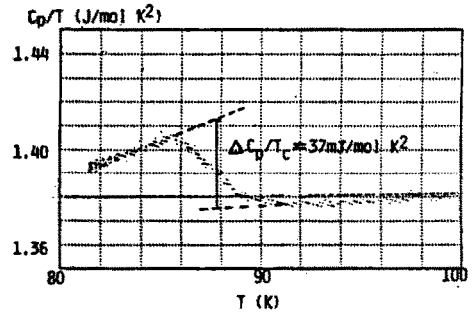
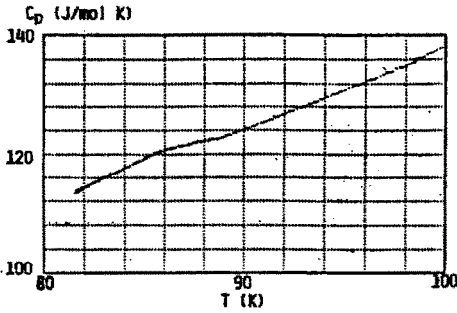
##### GROUP A. GOOD QUALITY SUPERCONDUCTOR

The specific heat vs. temperature curve has a distinct jump.  $\Delta C_p/T_c$  is greater than 40 mJ/mol K<sup>2</sup>.



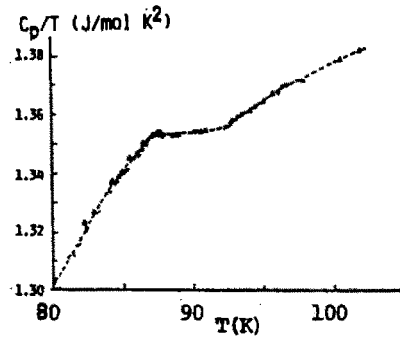
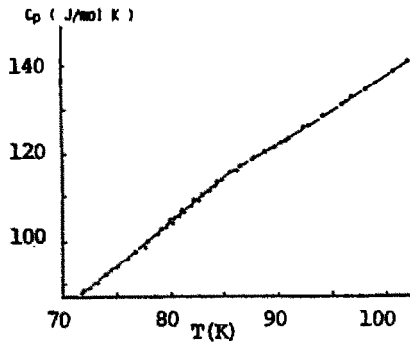
### GROUP B. ORDINARY QUALITY SUPERCONDUCTOR

The specific heat vs. temperature curve has a flat portion, while  $C_p/T$  vs. temperature curve shows a distinctive jump.  $\Delta C_p/T_c$  is 20 to 40 mJ/mol K<sup>2</sup> with most ceramics superconductors.



### GROUP C. DETERIORATED SUPERCONDUCTOR

The specific curve vs. temperature curve has a bending point, but  $C_p/T$  vs. temperature curve shows a flat portion.



### GROUP D. NON-SUPERCONDUCTOR

Ceramics without superconductivity at this temperature level and ceramics with broad superconductive transition temperature show following curves.

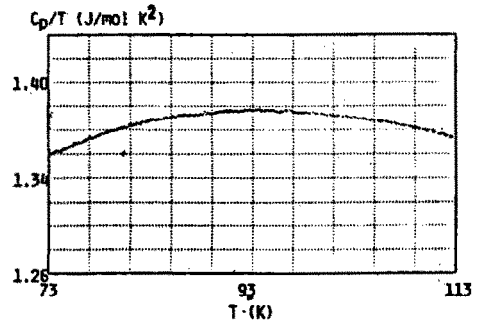
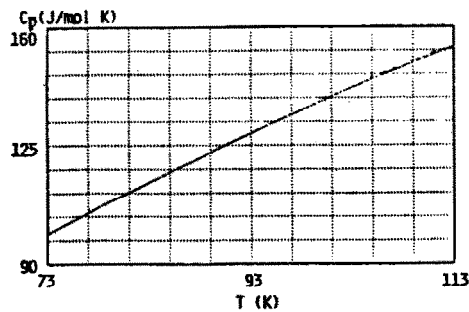




Photo 1. External view of ac calorimeter (model ACC-1VL)

The measuring results indicated that with ceramics of good quality, more information can be obtained by comparing the shapes of the specific heat vs. temperature curves rather than those of the  $C_p/T$  vs. temperature curves.

The quality of a superconductor evaluated by the amount of specific heat jump and by the shape of the specific heat curve around  $T_c$  is in fairly good correlation with the quality evaluated by the specific heat measurement below 10K, by the RRR values obtained by the electric resistance measurement and by ac susceptibility measurement.

#### REFERENCES

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