Journal of Optoelectronics and Advanced Materials Vol. 2, No. 5, 2000, p. 713-715

Section 10: Special topics

A DEVICE FOR CRITICAL CURRENT MEASUREMENT IN HIGH-T_C CERAMIC SUPERCONDUCTORS

I. Bradea, G. Aldica

National Institute for Materials Physics, Bucharest – Magurele, Romania

The processing of electrical contacts of low electrical resistance constitutes a serious problem in the case of high temperature superconducting ceramics. Bad electrical contacts generate an important heat flux if the current overcomes several ampere. Moreover, the contacts tend to detach during the experiment. To avoid this difficulty, we made a special device, based on the elastic steel blades at low temperatures (external adjustment permits total surmount of the detach tendency). If the sample has a convenient geometry (bar bells) and the electrical contacts are made inside of the little silver paste island, the resistance of the current contacts is below 0.1 Ω.

Keywords: High - Tc superconductor, Device, Critical current

1. Introduction

The critical current is a very important characteristic, as it governs the possible practical use of a material with high values of H_{c2} and T_c. Any fruitful application of a superconductor lies in its ability for carrying high currents in the presence of magnetic fields.

After the discovery of the superconductors having transition temperatures above liquid nitrogen temperature [1-3] there seems to be a wide scope for using these materials for applications provided their current carrying capacity is increased on par with conventional superconductors.

2. Description of device

The critical current is usually determined by the four probe measuring technique. [4,5]. The quality of the contacts has a considerable influence on the results of the measurements, and they must accordingly be prepared with great care and implies a special preparation of the samples.

The classical method of four points determinations is difficult because the current intensities are important. The junction sample-electrode presents an important electrical resistance – a result of this state is the apparition of a big thermal process on the ends of the sample. Bad electrical contacts generate an important heat flux and the contacts tend to detach during the experiment.

To avoid this difficulty, we made a special device based on the elastic steel blades at low temperatures. External adjustment permits total surmount of the detach tendency. The experimental arrangement is shown in Fig 1.

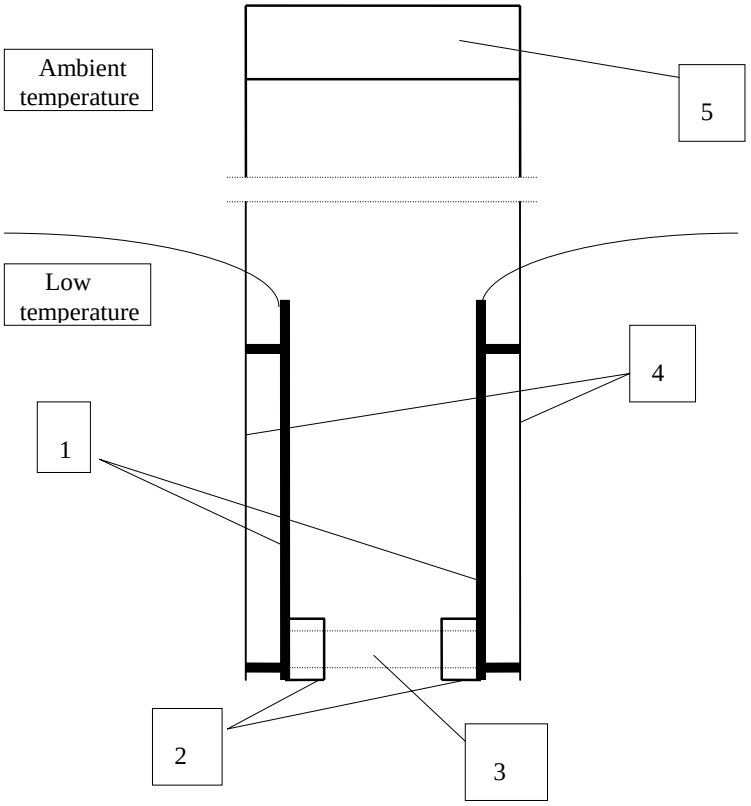

Fig. 1. Essential geometric elements of the device: 1-Electrodes, 2-Holder (knife) for the sample, 3-Sample, 4-Steel blades, 5-Exterior adjustable head.

The sample (3) is located on a mechanical support (2) machined from cooper inside a glass dewar which is filled with liquid nitrogen.

The dimensions of the sample are 3 x 3 x 10 mm^3.

A convenient geometry of the samples is presented in Fig 2. The electrical contacts are made inside of the little silver paste island. The potential leads are fixed to the sample with silver. The current is passed through cooper bands 1 x 15 mm^2 section soldered to the cooper electrode.

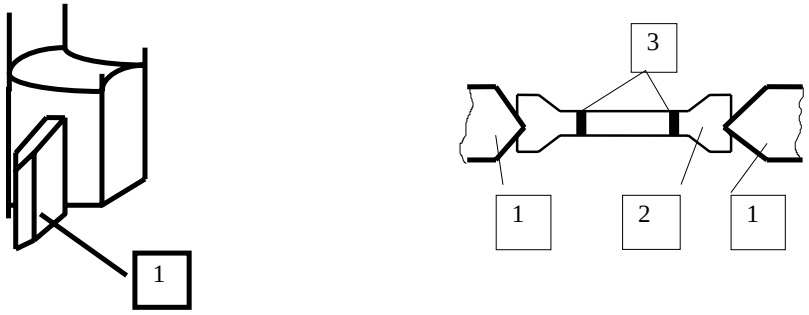

Fig. 2. 1- Holder (knife) for the sample, 2- Sample, 3- Potential contacts.

3. Experimental

The superconductor specimens in the $YBa_2Cu_3O_{7-x}$ system used were fabricated by a powder-ceramic method. The working configuration for the experiment is show in Fig. 2.

The critical current I_c was determined from the current versus voltage (I-V) characteristics at 77 K using a criterion of 1 μV/cm. The J_c value was derived from the I_c value using the cross sectional area of the ceramic sample.

We have doped the superconducting ceramics with $BaZrO_3$ up to 75% wt. and studied the changes of some physical property [6]. The most important finding is the enhancement of the critical current density (J_c), which has a maximum at around 5% doping level.

Fig. 3 indicates the characteristics of the terminal voltage E (μV/cm) versus critical current density J_c (A/cm^2) for some doping levels.

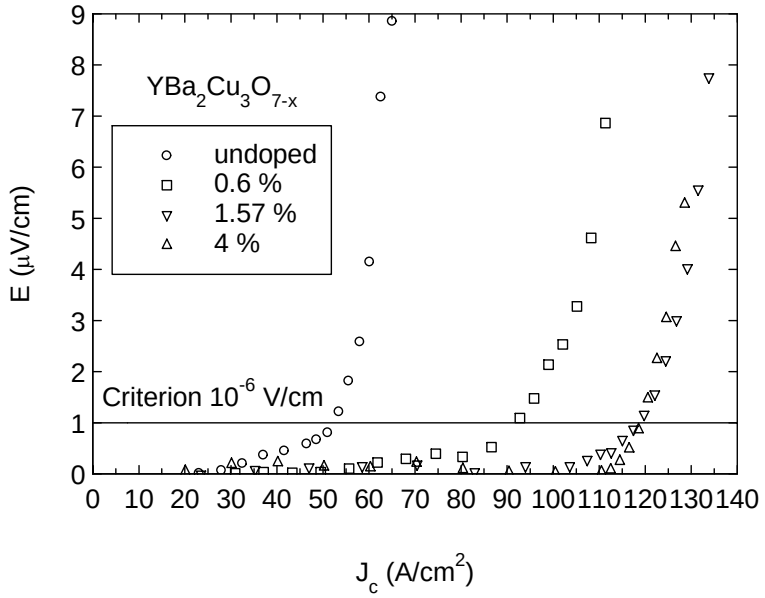

Fig. 3. V-I characteristics of a $YBa_2Cu_3O_{7-x}$ superconductor sample with $BaZrO_3$ doped.

4. Conclusions

The device presents a simple construction and permits total surmount of the detach the contact detaching during the experiment. The resistance of the current contacts as below 0.1 Ω. V-I characteristics similarly other methods were obtained.

Aknowledgements

The authors are grateful to the following colleagues: Dr. S. Popa for data analysis and Dr. M. Popescu for the material editing.

References

[1] M. K. Wu, J. Ashburn, C. J. Torng, P. H. Meng, L. Gao, Z. H. Huang, U. Q. Wang, & C. W. Chu Phys. Rev. Lett. 58 , 908 (1987).
[2] H. Maeda, Y. Tanaka, M. Fukutomi, T. Asano Jap. J. Appl. Phys. 27, L 209 (1988).
[3] Z. Z. Sheng & A. M. Herman Nature 332, 138 (1988).
[4] J. E. Kunzler, Rev. Mod. Phys. 33, 501 (1961).
[5] E. M. Savitskii, V. V. Baron, Yu. V. Efimov, M. Y. Bykova, L. F. Myzenkova, Superconducting Materials, Plenum Press, New York, 1973.
[6] G. Aldica, I. Bradea, J. Jaklovszky, A. Crisan, submitted to Physica C.