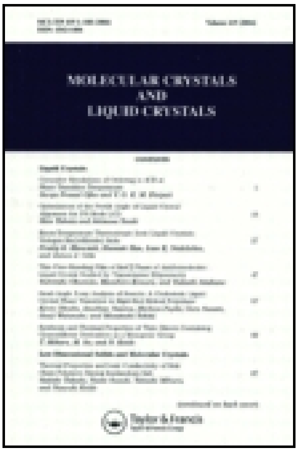

Molecular Crystals and Liquid Crystals Incorporating Nonlinear Optics
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/gmcl17

Grain Boundary Josephson Junction Using Screen Printed High-Tc Superconducting Films

Tomohiro Hashimoto [a], Yoshiyuki Uchida [a], Yasuo Akao [a] & Masayuki Nogami [a]

[a] Department of Information Network Engineering, Aichi Institute of Technology Yachigusa, Yakusa-cho, Toyota, 470-03, Japan

Version of record first published: 22 Sep 2006.

Mol. Cryst. Liq. Cryst., 1990, vol. 184, pp. 261–265
Reprints available directly from the publisher
Photocopying permitted by license only

GRAIN BOUNDARY JOSEPHSON JUNCTION USING SCREEN PRINTED HIGH-Tc SUPERCONDUCTING FILMS

TOMOHIRO HASHIMOTO, YOSHIYUKI UCHIDA, YASUO AKAO
and MASAYUKI NOGAMI
Department of Information Network Engineering,
Aichi Institute of Technology
Yachigusa, Yakusa-cho, Toyota 470-03, Japan

Abstract The dc Josephson characteristics in bridge type Josephson junctions using screen printed $YBa_2Cu_3O_y$ superconducting films were presented. Relations between the grain size and weak linked total cross sectional area in bridge junction were also presented. Fabrication techniques using granularly junction for Josephson device applications were proposed. A zero resistance temperature of the sample was observed at 81K. Hard coupling $YBa_2Cu_3O_y$ film and Y_2BaCuO_y substrate was observed by scanning electron microscopy. The current-voltage Josephson characteristics at different operating temperatures, different sintering temperatures and different bridge widths were measured. The critical current dependence of the sintering temperature and the total cross sectional area linked were expected.

INTRODUCTION

Since the discovery of High-Tc oxide superconductors over the liquid nitrogen boiling temperature 77K, Josephson junction superconducting devices are widely studied for future device applications. To realize the grain boundary characteristics in the Josephson junction is one of key pieces of information for device applications. It has been elucidated that the critical current density (Jc) increased by the microstructure of the films[1)]. In measurement using the four-probe method, the critical current (Ic) increased with increasing sintering temperature[2)]. But on the other hand, Ic decreased by separating of different phases[3)]. This paper describes that our present grain boundary junction serves as a bridge type Josephson junction and the film's density is estimated by the Jc-V characteristics.

EXPERIMENT

$YBa_2Cu_3O_y$ powders were obtained by calcining the mixture appropriate of Y_2O_3, $BaCO_3$ and CuO at 950°C for 5 hours in air. Pasty $YBa_2Cu_3O_y$ in propylen grycol was screen printed on Y_2BaCuO_y substrate through 200 mesh seat, followed by heating in air. The resistivity was measured by an automatic measuring system constructed in our laboratory. This system consists of four stands for the holding samples, in which two stands for measuring the resistivity. The temperature for measurement was changed from 25 to 250K. The resistivity and the current-voltage characteristics were measured by the four-probe method. All terminals were formed by indium-coated pressure contacts. The distance between the voltage terminals was constant to 2mm. Bridge type junctions were made by cutting the films mechanically, which was illustrated in Fig. 1. The current-

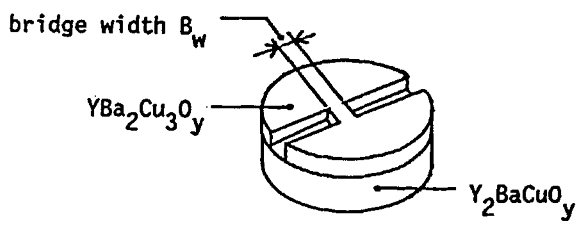

Figure 1 Configuration of bridge type junction.

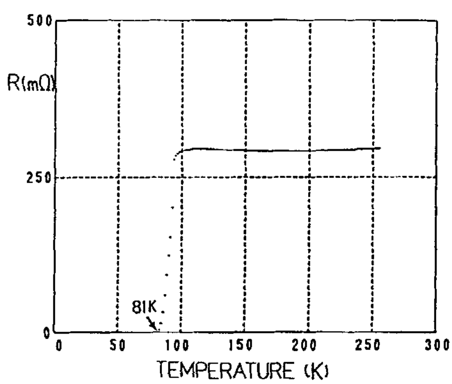

Figure 2 An example of the resistance measurements $YBa_2Cu_3O_y$ thick films.

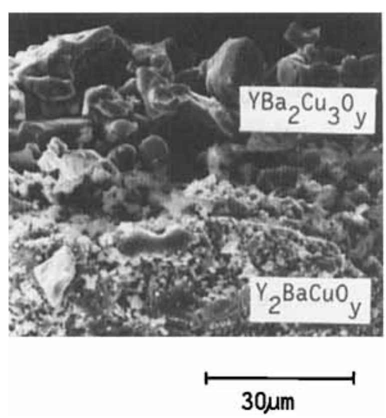

Figure 3 A scanning electron micrograph of the cross section of the samples.

voltage characteristics were measured with different bridge widths Bw. The microstructures of the films sintered at different temperatures were observed by a scanning electron microscopy.

RESULTS

Figure 2 shows one of the resistance measurements of the $YBa_2Cu_3O_y$ films. The critical temperature (Tc) is 81K. Figure 3 shows a scanning electron micrograph of a film's cross section. It shows that the 30μm thick $YBa_2Cu_3O_y$ film adheres to the substrate.

Figure 4 shows the current-voltage characteristics at different temperatures. The edge of the critical current is observed in I-V curves, of which the critical current increased with decreasing temperature. Ic was plotted in Fig. 5 as a function of the measurement temperature T, where the horizontal axis is nomalized by the Tc=81K. The result, that Ic is proportional to $(1-T/Tc)^{1.5}$, is a well-known characteristic inherent in the bridge type Josephson junction[4]. Therefore, it is concluded that our present grain boundary junction serves as a bridge type Josephson junction.

Figure 6 shows the I-V characteristics of the samples with different bridge widths Bw. We expected that Ic depended on the total cross sectional area linked at the grain boundary proportional

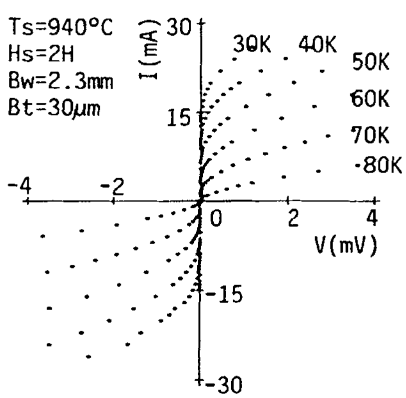

Figure 4 Current-voltage characteristics at different measurement temperatures T.

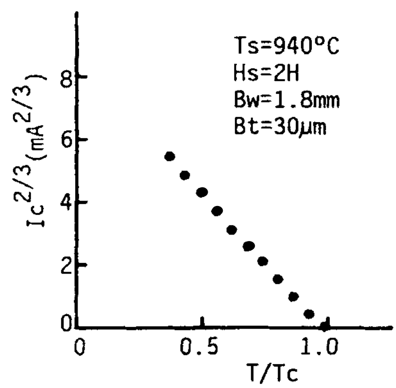

Figure 5 Critical current Ic as a function of the operating temperature T.

to the dimension of bridge width Bw and thickness Bt in the bridge junction. Figure 7 shows the I-V characteristics of the samples sintered at different temperatures. Figure 8 shows scanning electron micrographs of the surface of the films sintered at different temperatures. The grain size and weak linked total cross sectional area at the sintering temperature of 980°C are larger than those of 900°C.

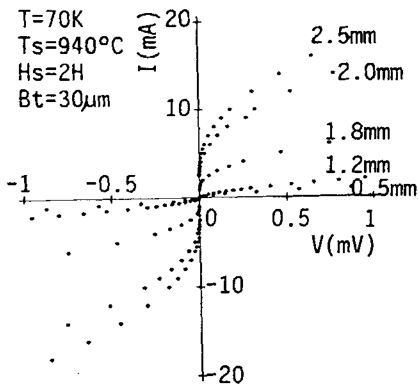

Figure 6 Current-voltage characteristics at different bridge widths Bw.

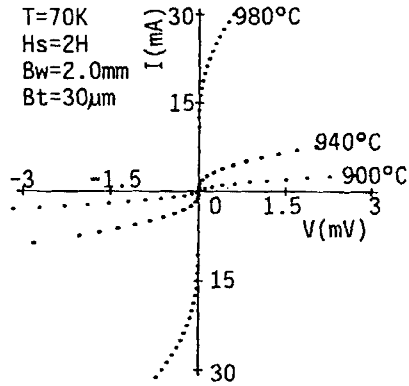

Figure 7 Current-voltage characteristics at different sintering temperatures Ts.

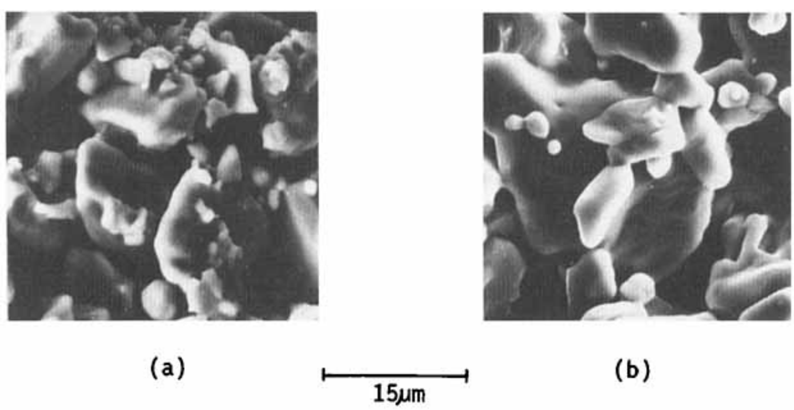

Figure 8 Scanning electron micrographs of the sample surface at different sintering temperatures Ts, (a) at 900°C, (b) at 980°C.

CONCLUSION

We concluded that the properties of the bridge type grain boundary Josephson junction could be controlled by preparatory conditions.

REFERENCES

1. N.Mizutani, A.Nanjyo, K.Shinozaki, M.Kato and H.Masuda, J. Ceramic. Soc. Jpn. in Japanese., 97, 1021-27 (1989).
2. K.Togano, H.Kumakura, H.Shimizu, N.Irisawa and T.Morimoto, Jpn. J. Appl. Phys., 27, 45-47 (1988).
3. A.Morimoto, T.Maeda, A.Moto, M.Kumeda and T.Shimizu, Jpn. J. Appl. Phys., 27, 407-10 (1988).
4. H.Tanabe, S.Kita, Y.Yoshizako, M.Tonouchi and T.Kobayashi, Jpn. J. Appl. Phys., 26, 1961-63 (1987).