Joint properties for RE123-coated conductor in CJMB method

Shintetsu Kanazawa[1], Yasuteru Mawatari[1], Toshihi-ro Kuzuya[1], Yusuke Amakai[1], Yoshinori Tayu, Naoki Momono, Shinji Hirai[1], Yoshinori Yanagisawa[2]
[1]Muroran Institute of Technology; [2]RIKEN Spring-8 Center

Introduction:

The joint between two RE123-coated conductors with crystalline joint by melted bulk (CJMB) method [1, 2] has been developed for NMR and MRI. In this method, a Yb123 sheet is used between the coated conductors as a superconducting intermedium. We reported that a superconducting joint with critical current of 21.2 A at 77 K was obtained, and the persistent coil has a low resistance about 1 pΩ in 77 K. However, the critical current is still small that is one tenth of original coated conductor. In this study, we investigated microstructure and critical current of joint to clarify the joint mechanism, toward realization of a high critical current above 100 A at 77 K. The critical current of Yb123 sheet before joint is 7-16 A along c-axis (vertical direction of tape surface), which value is the same with that for the joint using one bulk. Multiple junctions using multiple Yb123 sheets are necessary to increase the critical current that can be greatly improved by using many Yb123 sheets, such as several tens, but it is important to prevent degradation of the coated conductor itself during heat treatment of joint. If there is no deterioration of the coated conductor, the same critical current as original coated conductor can be obtained in joint.

[1] Xinzhe Jin, Yoshinori Yanagisawa, Hideaki Maeda and Yoshiki Takano, Superconductor Science and Technology **28** (2015) 075010 (6pp)
[2] Xinzhe Jin, Yoshinori Yanagisawa, and Hideaki Maeda, IEEE Transactions on Applied Superconductivity **28** (2018) 4602604 (4pp)

Experiments for joint

1. Critical current

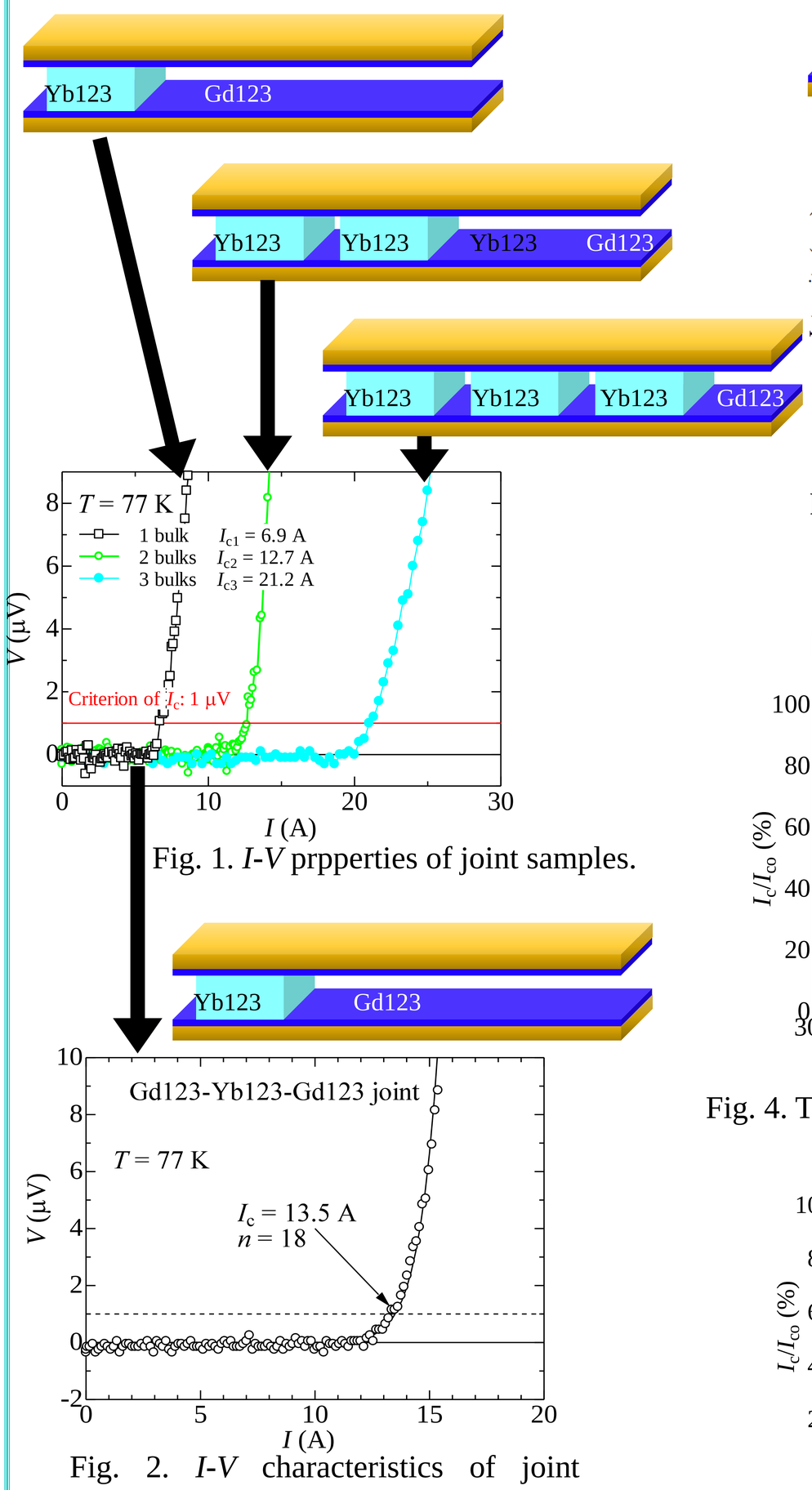


Fig. 1. *I-V* prpperties of joint samples.

Fig. 2. *I-V* characteristics of joint sample with single junction. The dashed line indicates 1 μV, corresponding to the criterion of critical current in this study.

2.XRD and recovery rate of I_c

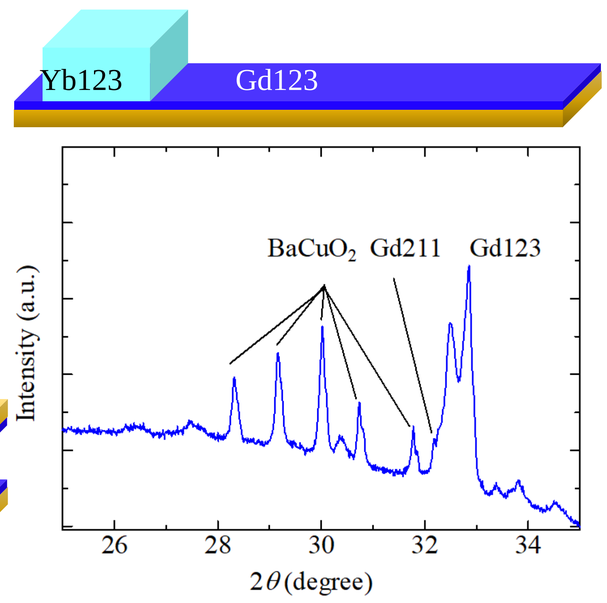


Fig. 3. XRD pattern for joint junction.

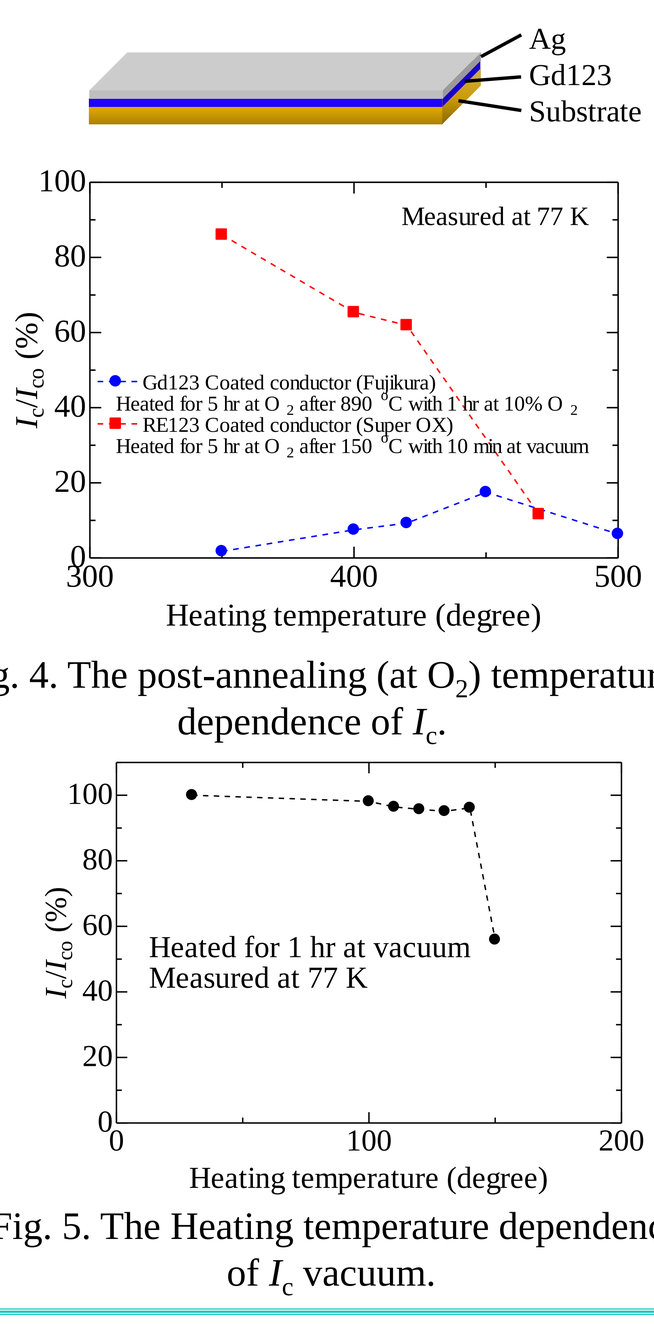
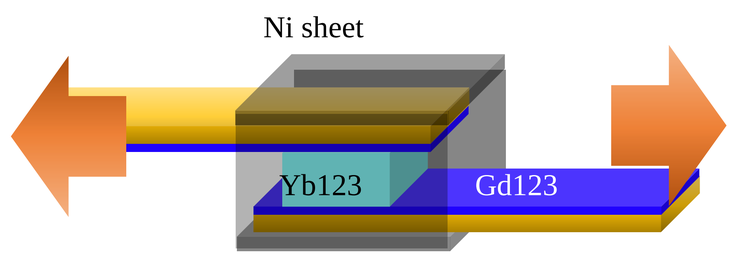


Fig. 4. The post-annealing (at O_2) temperature dependence of I_c.

Fig. 5. The Heating temperature dependence of I_c vacuum.

3. Tensile stress test



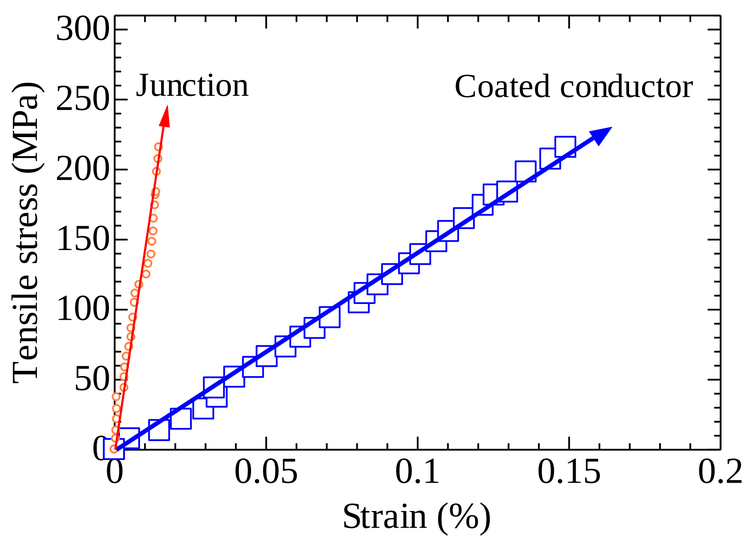


Fig. 6. Stress-strain properties for coated conductor and junction.

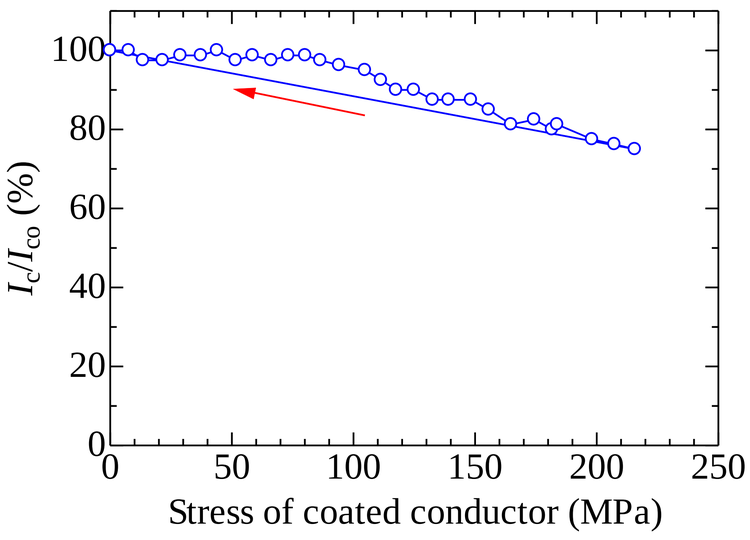


Fig. 7. Tensile stress dependence of critical current. The red arrowed line shows that critical current return to original value after loading of coated conductor about 220 MPa.

Results

The critical current of superconducting joint between RE123 coated conductors was improved to 13.5 A at 77 K in CJMB method. In the XRD patterns, Gd123, Yb123, Yb211, and $BaCuO_2$ phases appears. The recovery of critical current for Gd123 coated conductor in oxygen atmosphere was studied, and results show that improvement of critical current in the coated conductor is necessary. The joint sample has a high tensile stress tolerance by wrapping using Ni sheet. The critical current is reversible after loading of coated conductor about 220 MPa.