Joint properties for RE123-coated conductor in CJMB method

Shintetsu Kanazawa¹, Yasuteru Mawatari¹, Toshihiro Kuzuya¹, Yusuke Amakai¹, Yoshinori Tayu, Naoki Momono, Shinji Hira³, Yoshinori Yanagisawa²
¹Muranon Institute of Technology; ²RIKEN 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 29.2 A at 77 K was obtained, and the persistent coil has a low resistance about 1 μΩ at 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.


Experiments for joint
1. Critical current

Fig. 1. I-V properties 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 \( I_c \).

3. Tensile stress test

Fig. 5. The heating temperature dependence of \( I_c \) in vacuum.

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.