8P10

分割型高温超伝導マグネットのための接合抵抗分析研究および照射特性研究の現状

Current status of research of joint resistance analysis and irradiation characteristics for segmented high-temperature superconducting magnet

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1. Introduction

Segment-fabrication of high-temperature superconducting magnets has been proposed for large and complex fusion magnets using mechanical joint or press-welding of Rare-earth barium copper oxide (REBCO) tapes with indium [1]. Nondestructive testing of interface resistance inside REBCO tapes [1–3] has been developed to analyze joint resistance of the aforementioned joint. For the discussion of critical current (I_C) behavior during magnet operation and in maintenance, proton irradiation testing of REBCO tapes was performed at 95–105 K [4].

2. Interface resistivity evaluation

Interface resistance between REBCO and stabilizers inside REBCO tape has large impact for joint resistance and it varies depending on manufacturers and spool batch of REBCO tapes. As a nondestructive testing of the interface resistance, we have developed a contact-probing current transfer length method [2]. Interface resistivity (interface resistance for unit area) at 77 K for various REBCO tapes have been evaluated [1] as well as their temperature and magnetic field dependency [3]. Fig. 1 shows an example of interface resistivity of a copper stabilized REBCO tape as a function of magnetic field at 10 K. The behavior is different from joint resistance increasing with an increase in magnetic field. REBCO property close to the interface might affect the behavior.

3. Irradiation testing

For discussion of I_C behavior of REBCO tapes in magnet maintenance, cryogenic irradiation and I_C measurement with returning to room temperature (RT) are required whereas I_C measurement without returning to RT is needed for discussion of that during magnet operation. As a first step, we have prepared proton irradiation stage cooled with liquid nitrogen, which can keep temperature of REBCO tapes at 95–105 K. 2.4 MeV proton beam was irradiated to copper stabilized REBCO tapes, in which Bragg peak was located at Hastelloy substrate behind REBCO layer. Fig. 2 shows relationship between DPA and normalized critical current (= I_C/I_{C0} where I_{C0} is critical current without proton irradiation). So far, I_C of one REBCO tape sample was measured at 77 K in liquid nitrogen without returning to RT. I_C slightly increased after returning to RT for the same sample, which indicates defect recovery. I_C was also measured at various temperatures and magnetic fields after returning to RT, detail of which is shown in the poster presentation.

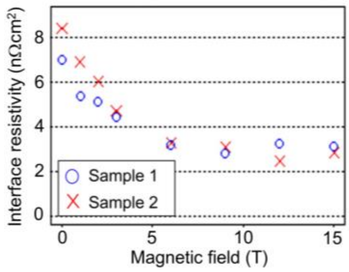

Fig. 1 Interface resistivity evaluation of a REBCO tape at 10 K.

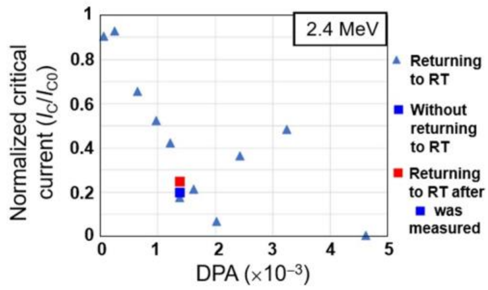

Fig. 2 Critical current at 77 K, s.f. as a function of DPA.

References

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