Electromechanical property evaluation in REC-DR GdBCO CC tapes under external magnetic field

Due to its promising potentials especially its low magnetic susceptibility, REBCO superconducting tapes attracts the attention of many potential applications such as power cables, motors and generators. In such applications, CC tapes were exposed to different stresses and strains from fabrication to operation. To achieve good designs of coils, the strain dependence of the critical current, I_c must be well understood. Therefore, electromechanical property evaluation of the CC tapes under magnetic field was conducted.

The design process of coils requires the understanding of the strain dependence of the critical current in the conductor and the ability to predict the strain state of the conductors in the coil. To ensure the performance of coated conductors in coil application, the evaluation of the electromechanical property under magnetic field is necessary and is one of the foremost things to do prior to device designing [1,2].

Coated conductor tapes sample fabricated using the reactive co-evaporation by deposition and reaction commonly known as RCE-DR were investigated in this study. The samples adopted the Hastelloy and stainless steel substrate, respectively. Moreover, they were brass laminated for further mechanical protection.

The samples were mounted on the Katagiri-type loading fixture for the evaluation of the electromechanical properties under different magnetic field intensities as shown in Fig. 1. In this manner, the magnetic field was applied in a perpendicular direction with respect to the CC tape's surface (B//c-axis). Magnetic field was produced by the 10 T cryo-cooled superconducting magnet at the HFLFM, IMR Tohoku University. The sample length, gauge length and voltage tap separation used were 40, 20 and 10 mm, respectively. While critical current I_c, was measured using the four-probe method by 1 μV/cm criterion.

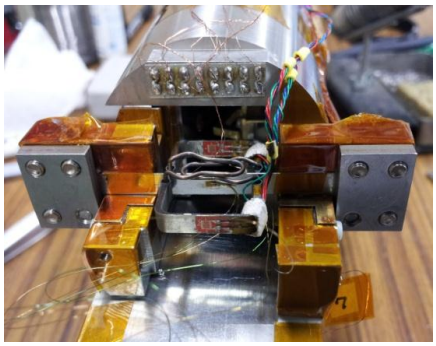

Fig. 1 CC tape sample mounted on the Katagiri-type tensile loading rig with double extensometer and strain gauges attached on the sample for sensing strain.

The RCE-DR CC tapes with Hastelloy substrate was initially improved from 0 T up to 1 T which shows reduced strain sensitivity as shown by the representative curve of brass laminated CC tape in Fig. 2. However, increasing the magnetic field further to 3 T made the I_c behaved strain sensitive. Also, it was observed that a minimal I_c/I_{c0} peak strain existed at 1 Tesla. These behaviors of I_c/I_{c0} were also observed on the samples with stainless steel substrate both copper stabilized and brass laminated too.

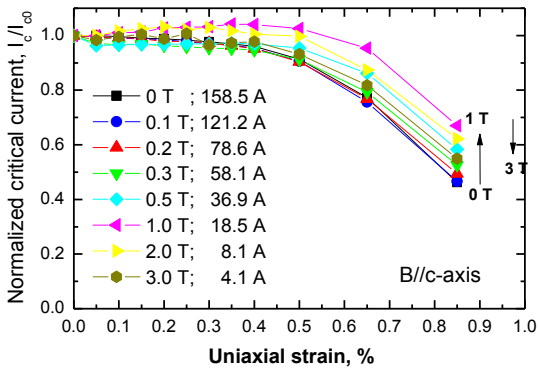

Fig. 2 Strain response of I_c/I_{c0} under magnetic field of brass laminated CC tape with Hastelloy substrate.

As a summary, it was observed that electromechanical property of CC tape strongly depends on the magnetic field especially when the field is directed perpendicular to the sample surface.

References

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