Current distribution of an HTS twisted stacked-tape cable conductor investigated by self-field measurements

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1. Introduction

■ A twisted stacked-tape cable (TSTC) is being developed at the Massachusetts Institute of Technology for high current applications such as magnets and power transmissions.

■ The TSTC conductor is composed of stacked REBCO tapes which are twisted along the longitudinal direction of the stacked tapes.

■ In this study, self-field measurements of the TSTC conductor were conducted in order to investigate current distribution in the conductor.

■ The current distribution in the TSTC conductor is discussed by using analytical models with the measured self-fields.

2. TSTC sample

■ The conductor has a hendecagon shape, the diameter of which is 650 mm.

■ The conductor is composed of a TSTC, which consists of 48 SuperOx REBCO tapes whose width is 6 mm, mounted in a copper former with copper braided sleeving.

■ At the termination, the TSTC is mounted on copper plates with a solder.

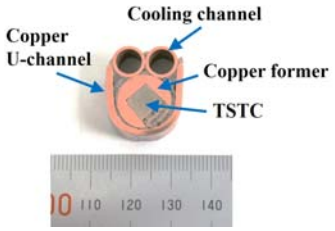

Fig. 1 Cross-section of the TSTC conductor.

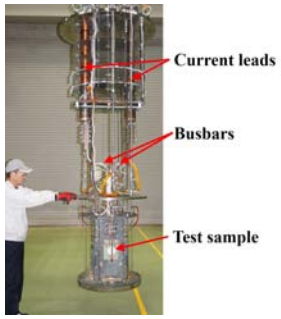

Fig. 2 Photo of the test sample with busbars.

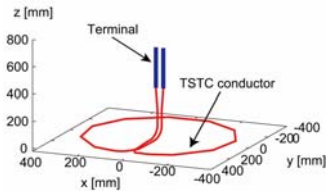

Fig. 3 Configuration of the TSTC conductor.

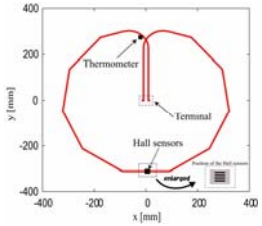

Fig. 4 Top view of the TSTC conductor

3. Experimental setup

■ Energization tests of the sample were conducted using the 13 T test facility of NIFS.

■ In the sample, the conductor was cooled by helium gas, the temperature of which was controlled from 4.4 K to approximately 50 K.

■ To measure self-fields generated by the conductor, Hall sensors were arranged on the sample.

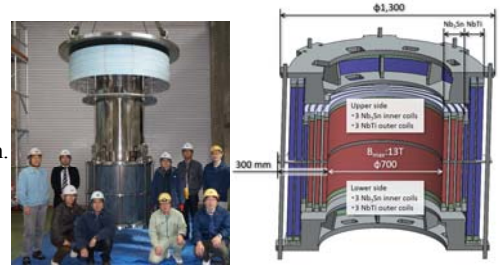

Fig. 5 Photo and schematic view of the 13 T superconducting coil.

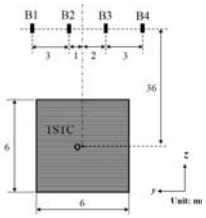

Fig. 6 The positions of Hall sensors and the TSTC.

4. Measurements

■ Self-fields of the sample were measured when the sample was energized with a trapezoidal current waveform and the sample temperature was controlled at 34 K.

■ No external magnetic field was generated for the sample.

■ The measurement results indicate that an HTS TSTC conductor can generate a stable magnetic field.

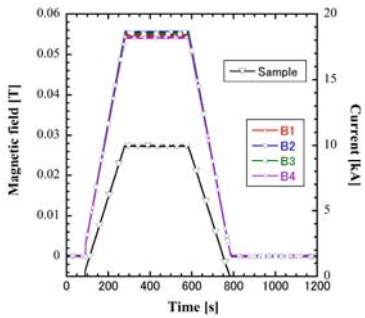

Fig. 7 Measurement results of self-fields at the trapezoidal current waveform.

5. Analysis

■ The current center in the TSTC conductor was analyzed using a line current model. This model is composed of one line current whose length is infinite.

■ The current value of one line is equivalent to the transport current of the TSTC conductor.

■ The line current position was specified so as to minimize the sum of the squared self-field difference ΔB_n between the measurement result B_n and the calculation result B_n^* at each position of the Hall sensors in the y-direction, which is $\Delta B_n = B_n - B_n^*$ where n is the number of the Hall sensors.

$$min\left\{\sum_{n=1}^{4} \Delta B_n^2\right\}$$

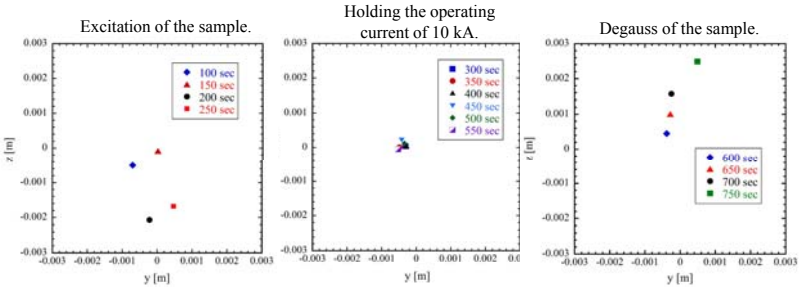

Fig. 8 The position of a current center in the TSTC conductor.

6. Conclusion

■ Self-field measurements of a single turn coil wound with a TSTC conductor were conducted using Hall sensors. Based on the measurement results, the current distribution of the TSTC conductor was analyzed using analytical models.

■ The analytical results indicate that the current distribution of the TSTC is uniform when the operating current is maintained at 10 kA and the temperature is controlled at 34 K.

■ The current distribution is not uniform at the excitation and the degauss with the ramp rate of 50 A/s.

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