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Effects of Friction Force on the Stress-Strain Characteristics of a High-Temperature Superconducting Coil Co-Wound Using Intentionally Scratched Stainless Steel and GdBCO Tape

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The high-field magnets experience the large amount of mechanical stress as a result of Lorentz forces. During the magnetization of the coil, strong Lorentz forces give rise to hoop stress, which can cause mechanical failure, resulting in the degradation of the coil performance. A recent study led to the discovery that scratching the GdBCO-coated conductor (CC) tapes ameliorated the degradation of the superconducting properties of the coil caused by Lorentz forces as a result of the friction between successive turns. Therefore, it is necessary to consider the frictional force between the superconducting tapes when calculating the hoop stress. In this study, the effect of the variation in the frictional force between successive turns of the coil on the stress-strain was investigated using intentionally scratched stainless-steel tape co-wound with GdBCO CC tape. The changes in the strain resulting from the Lorentz force were examined on the basis of the applied external force. Moreover, sudden-discharge, overcurrent, and charging-discharging tests were conducted and the charge/discharge characteristics during quenching were examined to evaluate the thermal and electrical stability of the coil.

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