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Effects of thermal cycle and winding tension on contact resistivity of an intra-Layer No-Insulation (LNI) REBCO coil

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We aim to develop a persistent-mode 1.3 GHz (30.5 T) LTS/HTS NMR magnet. For protecting the layer-wound REBCO innermost coil from quench, we have proposed the intra-Layer No-Insulation (LNI) method. This winding technique employs single-sided insulated copper sheets as inter-layer materials to provide the no-insulation state within each layer. For quench protection, the most influential parameter is the contact resistivity (ρct) between the conductors and the copper sheets. In previous work, an LNI-REBCO coil was protected from a 31.4 T quench, owing to a high ρct value of 10,000 μΩcm2. Thus, achieving the desired ρct of a coil is of great importance for designing and fabricating a magnet. In this light, we investigated the effects of winding tension and thermal cycles on the ρct value of LNI-REBCO coils.
We fabricated 8-layer LNI-REBCO coils (Coils A, B, and C) wound under winding tensions of 49 MPa, 98 MPa, and 147 MPa, respectively. Each coil was 50 mm in inner diameter and 41 mm in height. For these coils, we repeated the sequence of cooling to 77 K, charging, power supply shutdown, and warm-up. In each thermal cycle, the values of ρct were obtained from field decay curves after power supply shutdown.
In the first cooling tests, ρct of Coils A, B, and C were 1,750 μΩcm², 600 μΩcm², and 180 μΩcm², respectively; a lower winding tension gave a higher ρct. Along with the thermal cycles, ρct increased and saturated at high values of 16,000μΩcm², 6,500μΩcm², and 2,500μΩcm², respectively. We believe that this unique behavior is produced through stabilizing the winding contact condition by thermal cycling. For establishing a method to implement a desired ρct value, we will make a contact model experiment and structural analysis to better understand the phenomenon.

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