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Applicability of Large-Current HTS STARS Conductor to the Next-Generation Fusion Experimental Devices

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***Abstract*—Development of the large-current STARS (Stacked Tapes Assembled in Rigid Structure) conductor has progressed to apply to the helical fusion reactor magnets. It has the feature that REBCO tapes are simply stacked without twisting or transposition. The stack of tapes is embedded into a copper stabilizer and covered by a stainless-steel jacket with laser beam welding for mechanical reinforcement. A 20-kA-class nominal current is a present target considering the application to the next-generation fusion experimental devices. A 6-m STARS conductor sample was fabricated with a 600-mm diameter and a coiled structure of 3 turns. It was tested in 8 T, 20 K in a 700-mm-bore solenoid coil. A stable operation up to the nominal current of 18 kA was confirmed, which corresponds to the current density of 80 A/mm^2. A series of 100-times repetitive excitations was carried out with a 1 kA/s ramp rate. The low-resistive mechanical lap joints with indium insertion between the current feeders and the conductor terminals played an important role by ensuring no temperature increase from the terminals. A residual magnetic field was observed after the transport current became zero, which might be caused by a circulation current among the simply-stacked REBCO tapes with self-inductance imbalances. A simple circuit model for a two-tape cable shows a linear dependence of the circulation current as a function of the ramp rate, which matches well with the observation. A second experiment of the 6-m sample is planned with a precise measurement of the circulation currents. From the observed residual magnetic field in the 6-m sample, the level of circulation currents expected in a conductor used for large-scale coil windings in a fusion reactor is estimated, and its effect on stability is discussed.**

***Keywords (Index Terms)*—Helical fusion reactor, HTS magnet, REBCO, simple stacking, STARS conductor**

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