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Test and Analysis of Stacked-Tape-Wound Laboratory-Scale NI HTS TF Module Coil

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The no-insulation (NI) high temperature superconductor (HTS) toroidal field (TF) coil or its variations have been regarded as a potential option for a compact, high magnetic field tokamak due to compactness in size and robustness in operational reliability. However, its real application still faces multiple challenges, e.g., we have limited experience in design, construction, and operation of "toroidal"NI HTS coils. Here we report a reduced size NI HTS TF module coil that is fabricated, tested, and analyzed to explore the feasibility of NI HTS technology to D-shaped TF coil. The TF module coil is designed to be 1/20 of the Korea Superconducting Tokamak Advanced Research (KSTAR) TF coil in height which is ~ 200 mm. The coil is wound with non-twisted stacked HTS tapes of 5 which could represent an HTS cable. The coil is tested under 20 K of conduction-cooled environment to evaluate the performance and characteristic parameters by examining the magnetic field and characteristic resistance. Various current charging/discharging tests are conducted to compare the results with lumped circuit model and/or turn-distributed circuit model simulation considering the effect of the straight section of the D-shaped coil on the contact resistance. By applying the verified circuit model to an actual size TF coil, a range of feasible contact resistance is deduced to search for the possible candidates such as metal insulation that can improve the charging delay of the NI HTS TF coil.

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