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Analysis of the Defect-Irrelevant behavior of a No-Insulation HTS pancake coil including multiple superconductive joints

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One of the technical issues in the application of High Temperature Superconducting (HTS) tapes is the need to wind long tape sections with uniform electric properties along their length. In recent years, the No-Insulation (NI) winding technique for HTS coils is emerging as a valid alternative to conventional insulated coils, as it allows a more effective current redistribution from the most stressed regions toward the rest of the winding, thus reducing the possibility of hot spots formation. Moreover, it has been reported that a NI coil can work properly even in the presence of defective superconductive regions, with a minimal drop of performance as compared to its “defect-free” counterpart. This could open up the possibility of manufacturing coils by jointing together several tape segments of limited length. This procedure could be applied without affecting significantly the coil electromagnetic properties, while lowering the conductor cost.

In this work, the Defect-Irrelevant (DI) behavior of a single pancake NI coil is studied in the presence of multiple joints, intentionally inserted along the tape before winding the coil. The electrical resistance of each joint was set independently, realizing either high or low resistance joints; the presence of the latter in insulated coils would require to substitute a section or the entire winding. The coil was tested both in a liquid nitrogen bath and in a conduction-cooling operation, at different temperatures and varying the charging rate. The voltage signals over different winding sections were acquired during the experiments, as well as the magnetic field generated in the bore. The results obtained on the defective coil were compared with those expected for its non-defective counterpart, which were computed with a numerical model. Finally, an equivalent lumped parameter circuit of the defective coil was applied to derive its effective parameters and analyze its electromagnetic behavior.

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