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Wed-Mo-Po.09-04: Development and Testing of High Temperature Superconducting Vertically Stacked Cable for Fusion Applications

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High-temperature superconductors (HTS) are promising candidates for use in the high-field magnets required for compact fusion reactors, such as the Spherical Tokamak for Energy Production (STEP). United Kingdom Industrial Fusion Solutions (UKIFS), in collaboration with Seoul National University and PowerNix, is developing vertically stacked tape (VST) HTS cables using $ReBa_2Cu_3O_{7-x}$ coated tapes for high-field magnet applications. For larger fusion magnets, such as toroidal field coils operating at currents around 100 kA, cable-in-conduit conductor (CICC) configurations and low-loss joints are necessary. In the VST cable, hundreds of individual tapes are soldered together into a monolithic conductor block, ensuring efficient current sharing within the tapes and with the stabilizer (the copper former). The copper former, equipped with a cooling channel, is designed to optimize the arrangement and quantity of HTS tapes to achieve the desired operating current at 20 K while minimizing stresses in the cable. These stresses arise from transverse loads caused by electromagnetic forces during operation at 20 T and 100 kA.

Preliminary tests were performed on multiple short samples (1.0 meter) to characterize the thermal, electrical, and mechanical performance of the solders, individual tapes, and the cable as a whole. A longer-length cable (3.5 meters) currently in development is planned to be tested at the SULTAN facility at 100 kA in background fields of up to 11 T and at various temperatures ranging from 5 to 50 K. These tests will provide valuable performance data and demonstrate the feasibility of producing HTS coils and CICC for future fusion reactor applications.

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