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Thermal stability against local critical current degradation in an HTS pancake coil wound with an insulated conductor composed of no-insulated multiple tapes

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By using a High-temperature superconducting (HTS) tape, it is possible to realize a coil that can generate much higher magnetic field. However, it is a problem to increase the inductance in an HTS coil since the number of windings increases due to restriction on the current capacity of an HTS tape. For coils with large inductance, large induced voltage and noise are induced between the coil voltage taps. Thus, it is very difficult to quickly detect the abnormal voltage when quench occurs. Magnetic energy cannot be removed immediately because the time constant of the coil with large inductance is long. Therefore, reducing the inductance of the HTS coil is very important in terms of coil protection. There is another problem that is burnout of a coil due to the heat generated by a local critical current deterioration. At the current level of manufacturing technology for an HTS tape, it is not possible to manufacture long HTS tapes that do not completely include deterioration of local critical current density. To solve these problems, we focused on an insulated HTS conductor with stacked multiple HTS tapes without insulation between tapes to reduce the rate of decrease in the critical current of the winding.
Current and temperature distributions in an HTS pancake coil wounded with the insulated conductor consist of three parallel HTS tapes during excitation and demagnetization were examined using the partial element equivalent circuit (PEEC) method and thermal conductivity analysis. Loop current was induced in multiple tapes during excitation and demagnetization. However, loop current did not flow enough to generate heat that destabilized the superconducting state. Furthermore, it was found that the HTS coil wound with insulated conductor consist of multiple no-insulated tapes could maintain stability by commutation to the adjacent tapes even if there is a local critical current degradation.

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