Abstract: In this study, charge-discharge, sudden discharge, and thermal quench tests were performed on GdBCO pancake coils wound with Kapton tape (insulation coil), without insulation (no-insulation coil), and with thermal grease (thermal grease coil). All of the coils were successfully charged, discharged, and operated with full field performance below their critical currents. Above the critical current, permanent damage occurred to the insulation coil, and the insulation-free coil exhibited field saturation despite stable operation. Unlike the insulation coil, however, the thermal grease coil demonstrated stable operation. This was possible because excessive heat was rapidly dissipated by the thermal grease in the event of quenching, resulting in stable electrical conditions. In sudden discharge tests, the discharging delay of the thermal grease coil was greatly improved, suggesting that the thermal grease successfully acted as an insulator, limiting the current flow in the radial direction. Moreover, the thermal grease coil also exhibited superior thermal characteristics during the thermal quench test, with rapid cooling and low temperature rise, because thermal grease is also an effective heat transfer medium by filling microscopic air gaps on the uneven surface of the conductor. Overall, the use of thermal grease as insulation may be a potential solution to provide fast charging and discharging rates and superior thermal stability.

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