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Wed-Af-Po.06-02: Surface-shunt skeleton for overcurrent quench prevention in no-insulation REBCO magnets for single silicon crystal growth system

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No-insulation (NI) technology is widely adopted in REBCO coils due to its lower risk of electrical burnout, attributed to the turn-to-turn current-sharing feature. However, the contact resistance of NI coils is difficult to control under the influence of REBCO tape preparation process, coil winding and the cooling cycles. When contact resistance increases to a level that prevents bypass current during quench, the risk of burnout increases significantly, particularly in conduction-cooled, high-turn coils, which fails to provide stable conditions for high-quality single silicon crystal production. This study presents a method to prevent overcurrent quench in NI coils by utilizing a surface-contact shunt. A specialized coil skeleton is designed that contacts the coil bottom and functions as a parallel resistor, diverting current from the dissipative regions during overcurrent operation. It also providing a conductive cooling path, thus improving the cooling efficiency of operation process. Comparative experiments under 20 K conduction-cooled conditions are investigated to study the electromagnetic and thermal behavior of NI coils with and without the surface-shunt skeleton. The results demonstrate that the high-risk regions within the coil are effectively protected, suppressing the initiation and propagation of the quench. These findings validate the effectiveness of the proposed method and provide an effective solution for enhancing the operational safety of high-field NI REBCO coils.

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