

## Electromagnetic Properties of Iron-Based Superconducting Uninsulated Double Pancake Coils and Their Comparison with REBCO Coils

Iron-based superconductors show great potential for high-field magnet applications. The electromagnetic properties of iron-based superconducting (IBS) uninsulated coils are crucial for their future practical applications, yet characteristics such as charging delay and turn-to-turn contact resistivity ( $R_{ct}$ ) remain poorly understood. To address this, we fabricated metal-insulation (MI) and no-insulation (NI) iron-based superconducting double pancake coils (DPCs) and systematically tested their charging and sudden-discharging behaviors. Experimental results revealed that the  $R_{ct}$  of the IBS-MI coil is 6.3 times higher than that of the IBS-NI coil, along with a significantly shorter charging delay. Moreover, an interesting phenomenon was discovered: the  $R_{ct}$  of uninsulated IBS coils is much lower than that of the REBCO coils reported in previous studies. For rigorous verification of this finding, MI and NI REBCO coils were prepared and subjected to charging and sudden discharging tests. Through comparison, it is found that the  $R_{ct}$  of the REBCO-MI coil is 92 times greater than that of the IBS-MI coil, while the  $R_{ct}$  of the REBCO-NI coil is 5.6 times greater than that of the IBS-NI coil. The main reasons for this difference will also be analyzed in this paper. From an application perspective, the low  $R_{ct}$  of uninsulated coils also means high thermal stability and self-protection. This work lays the foundation for investigating the proportional and integral (PI) feedback control method to eliminate magnetic field delays and for validating the thermal stability of IBS uninsulated coils in future studies.

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