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Self-protecting behavior of an intra-Layer No-Insulation (LNI) REBCO coil under an LTS outer coil's quench

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Towards a persistent-mode 1.3 GHz (30.5 T) LTS/HTS NMR magnet, quench protection of a layer-wound HTS inner coil is of great importance. The intra-layer no-insulation (LNI) method we recently proposed can be effective in protecting such a layer-wound HTS coil. In fact, we demonstrated an LNI-REBCO coil was protected from a self-quench at a center field of >30 T under a background field. However, its behavior under an LTS outer coil's quench, a major quench scenario of the 1.3 GHz-NMR magnet, has been unclear. As a model experiment, we conducted a quench test on LTS/HTS small coils comprising a 90 mm-diameter NbTi outer coil and an 18 mm-diameter 24-layer LNI-REBCO inner coil.
We charged the LNI-REBCO coil to 368 A in liquid helium under a 5.5 T background field of the NbTi coil. In this state, we quenched the NbTi coil at t = 0 s. The REBCO coil voltage (Vre) started to decrease, while the measured center field (B0) remained constant for t < 0.15 s. At t = 0.15 s, Vre increased and B0 started to decrease, resulting in full discharge of both coils in 1 s. The peak of the REBCO coil current was estimated to be 848 A. These data show that the NbTi coil's quench induced large currents in the REBCO coil and it suffered a quench due to an overcurrent. After the test, we charged the REBCO coil in a self-field in liquid helium and observed that the voltage-current curve agreed with that before the quench, i.e., the LNI-REBCO coil was self-protected from the NbTi coil's quench.
We will conduct a numerical simulation on the detailed behavior of the LNI-REBCO coil and further experiments on a larger LNI-REBCO coil.

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