A new record field of 40.2T generated by a superconducting insert magnet

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Two National Academy reports (COHMAG and MagSci) have encouraged investment toward the achievement of ultra-high magnetic fields using superconducting magnets to reach 40 T and beyond. It is widely recognized that high temperature superconductors (HTS) are needed to achieve this goal. As such, a series of HTS test coils have been built and tested in background fields to forward the relevant magnet technology. Now an exciting new spin on HTS magnet technology, the "No Insulation" coil, has enabled MagLab researchers to more than double the magnetic field produced previously by test coils to 9.2T in a 31T background, achieving 40.2T overall.

This new test coil utilized recently developed HTS tape made by SuperPower, Inc. of Schenectady, NY that has a very strong but exceptionally thin (30 micrometer) substrate. The coil consists of twelve small pancake coils with an inner diameter of only 14 mm, an outer diameter of 34 mm, and an overall length of 53 mm. The test coil was inserted into the 31T, 50mm bore resistive magnet in the MagLab's DC field facility.

The "No Insulation" technique results in extremely compact magnets in which the superconducting current can bypass any flaws in the conductor (Fig.1). Not only is electrical insulation between conductor turns omitted, but a minimal amount of copper stabilizer is needed (5 micrometers in this case) due to the design's self-protecting nature in event of a quench of the magnet. All of this enabled a record current density of 905A/mm^2, which resulted in a record field of 40.2T (Fig.2).

Facilities: 31T/50mm bore resistive background magnet, National High Magnetic Field Laboratory, Florida State University

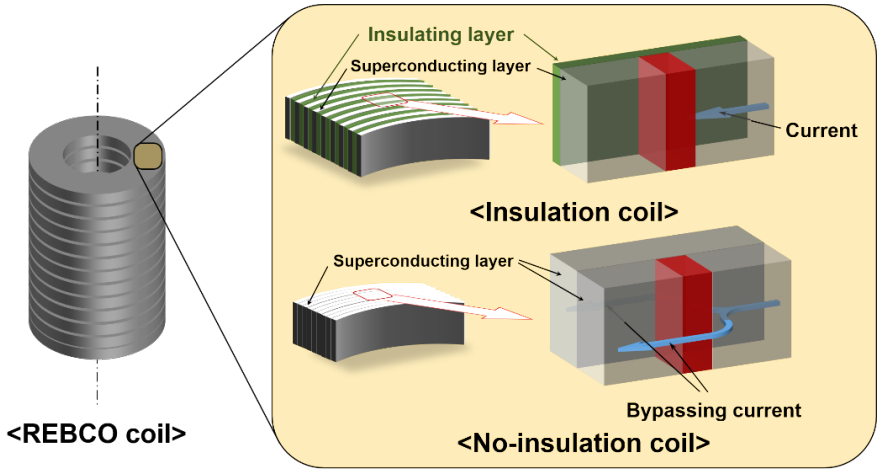

Fig. 1. Concept of the no-insulation winding technique

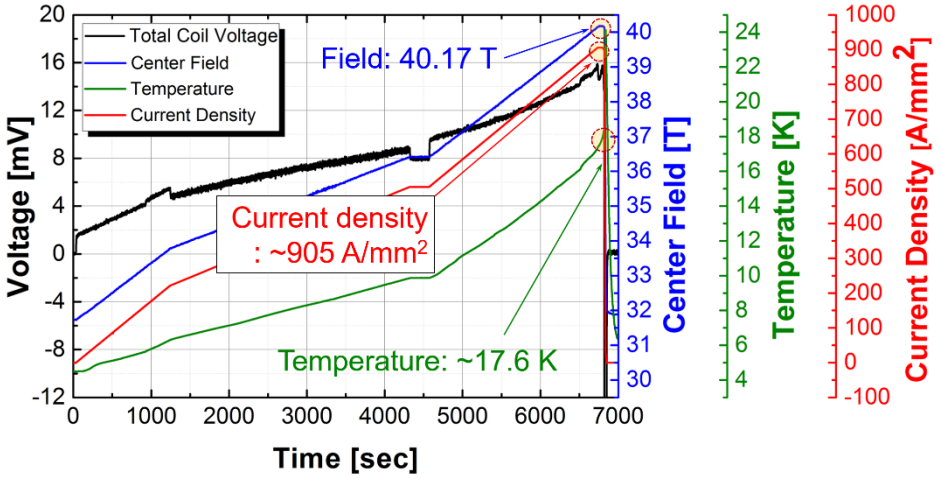

Fig. 2. Test results of the 9T insert coil, in the 31T background field. Due to a helium bubble, the magnet temperature was 17.6 K. No coil damage was observed after the sudden discharge at t = 6822 sec.