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Thu-Af-Or24-05: 25 K performance of conduction-cooled solenoids wound from exfoliated filament YBCO cables

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Conduction-cooled magnets are gaining popularity as Helium reserves diminish. High-temperature superconductors, such as YBCO, can theoretically deliver ultra-high, > 20 T, magnetic field while cooled by an inexpensive and efficient single-stage GM cryocooler. At 20 K common materials still maintain high thermal conductivity, which ensures fast cooldown and fast recovery of a magnet after quench. Conduction cooled operation requires dense, void-free epoxy impregnation of the winding, preferably by post-winding infusion with a low-viscosity epoxy. The second generation, 2G conductors often degrade after epoxy impregnation due to separation of the YBCO layer from the substrate.
Here we report on tests of test solenoids layer wound from stacks of exfoliated YBCO filaments. We use 15 m of 2 mm wide, 8 filament cable to wind the largest, 6 layer coil. The solenoids are impregnated after winding with a low viscosity epoxies, Stycast 1266 and Henkel W19. We do not detect any critical current degradation after multiple rapid cooldowns from room temperature to 77 K. At 77 K the six-layer coil generated the maximum 0.12 T field, 200 A current. The central field hysteresis is well explained by the critical state model which assumes that the winding magnetization originates from in-plane superconducting current, with negligible coupling current contribution.
The coils were tested in a custom conduction cooled system at 25 K. The largest 6 layer coil were excited up to 1,300 A, generating 0.7 T field in the center. Our results suggest, that temperature gradients in the winding play a critical role in the magnetic field dynamic.
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