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Sat-Mo-Or3-04: High-field and angular dependence study of the critical current surface in modern REBCO coated conductors

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Understanding the dependence of the critical current, I_c, on magnetic field intensity and orientation, as well as on temperature is essential for developing reliable models for REBCO tape-based magnet design. This knowledge is particularly critical for advancing ultra-high-field magnets (20–40 T) required for applications ranging from fusion and particle accelerators to high-field science. To address the rapid evolution of commercial REBCO tape properties, we investigated the I_c(B,θ,T) surface of tapes from leading manufacturers.
At the University of Geneva, transport critical current measurements up to 2 kA were conducted on full-width tapes at 4.2 K, 20 K, and 40 K in fields up to 19 T and at fixed orientations (θ=0°, 7.5°, 15°, 80°, 90°) relative to the tape surface. Complementary experiments at Tohoku University's High Field Laboratory employed laser-fabricated microbridges from the same tape batches, covering the 5–77 K range, with fields up to 24 T and continuous angular dependence data (−20° to 115°) using an in-field rotating stage. The comparison of full-width and microbridge measurements reveals consistent trends. The non-copper critical current density, calculated as the critical current divided by the tape cross-section area minus the Cu area, routinely exceeds 2 kA/mm^2 at 4.2 K and 19 T, and approaches 1 kA/mm^2 at 20 K and 19 T in perpendicular fields. However, significant variations in the angular dependence of I_c among different manufacturers reflect differences in processing methods, REBCO layer composition, and pinning center designs (e.g., 3D nanoparticles vs. 1D nanorods).
These results provide a robust foundation for achieving high-fidelity descriptions of the critical current surface over a wide range of fields and temperatures, leveraging a complementary approach that combines a limited number of experiments on full-width tapes with detailed angular scans on microbridges.

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