

ABSTRACT

REBCO CC is the leading candidate amongst the HTS materials to become the next generation of conductor technology for its exceptional J_c in a large range of temperatures and magnetic fields. Compared to LTS like Nb-Ti and Nb₃Sn which are typically fabricated as round-wire multifilamentary conductors, REBCO CC has a large filament size (4 mm), electromagnetic anisotropy, and poor quench propagation velocity, all which enable large screening current stresses and non-uniform quench margins to exist within magnets composed of it. To develop a consistent and scalable implementation of ultra-high field (> 45 T) REBCO CC solenoids which address these challenges, I began by investigating the deoxygenation of REBCO CC via heat treatment in order to homogenize the enthalpy margin required to uniformly quench a solenoid by tailoring the I_c throughout it. Consistent decreases of I_c were achievable even in long lengths and with many manufacturers but the current transfer resistance, vortex pinning behavior, and mechanical properties were altered which all present challenges to address in application. Following deoxygenation, I began investigating general mechanical and electromagnetic behavior which results from operation in large Lorentz forces and correlating it with preexisting and generated defects such as fluctuations in the pinning landscape, slitting damage, loss of texture, delamination, etc. These investigations revealed a variety of unfavorable microstructures resulting from slitting and provided a baseline for understanding the conductor we use in our LBC coil program. Beyond manipulating and characterizing the properties of REBCO CC, I have developed and improved multiple characterization tools and systems which are essential for superconducting materials research around the NHMFL, namely: I-V characterization, quench detection, a multi-zone over-pressure furnace controller for Bismuth Strontium Calcium Copper Oxide (Bi₂Sr₂CaCu₂O_{8+x}) (2212) synthesis, reel-to-reel REBCO characterization, etc. Overall, I have stepped through many facets of REBCO CC property modification and characterization, magnet construction, developed novel tools, methods, and an overall framework under which further REBCO research can be continued utilizing my developments.