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Lessons learned from ultra high-field, high-stress REBCO coil tests

The 'Little Big Coil (LBC)' experiments investigate key coated conductor characteristics in a high field and high stress environment by testing a REBCO coil in the bore of the NHMFL 31.1 T Bitter magnet. Indeed, LBC3 first demonstrated excessive screening current stress (SCS) resulting in wavy plastic conductor damage, while obtaining the record-high DC magnetic field of 45.5 T by generating 14.4 T in a 31.1 T background field. The important result of LBC 3 was that single slit tapes with slit edges pointing to the coil center barely damaged while those with opposite orientation showed large damage. To explore this apparent paradox, LBC4 was wound completely from single-slit tapes whose slit edges were all pointed towards the coil center. Indeed, almost no damage was seen on LBC4 attaining 44.0 T. Our *post mortem* showed that the key reason was a specific peculiarity of the MOCVD tapes used in our LBC coils. The edges of the tapes have markedly higher density of blocking CuO and *a*-axis grains that markedly lower the edge J_c below that of the more central slit edge even with its cracked edge. Measurement of the transverse J_c variability and implementation of the local edge J_c into the SCS model yielded stresses consistent with the transition from large SCS-initiated damage in LBC2 (42.5 T) and 3 (45.5 T) to much lower SCS damage in LBC4. We are now aiming to investigate key characteristics of recent laser-slit, thicker REBCO, and PLD conductors for compact superconducting fusion magnets through the LBC framework and compare them with mechanical slitting, thin REBCO, and MOCVD conductors that we have mainly used until now.

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