Overcoming Challenges in Utilizing High-Performance REBCO Tapes in Ultra-high Magnetic Field Applications

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***Abstract* — After a steady progress over two decades, there is a recent spurt in the use of REBCO tapes in several high magnetic field applications at 20 T and beyond. While today's REBCO tapes meet the specification of a critical current (I_c) of 150 A/4mm at 20 K, 20 T, their high cost (triple digits $/kA-m) limits widespread use. Since most ultra-high field applications use stacks of tapes to reach operating currents of 10+kA, one direct path to reduce cost is to use fewer tapes with substantially higher I_c in high magnetic fields. Using optimum Ba content in Zr- and Hf-added 4+μm films, REBCO tapes with 3 – 5x I_c, up to 1,830 A/4 mm at 4.2 K, 20 T have been demonstrated. The challenge in achieving this performance in long lengths is in assuring a consistent growth of BMO nanorods in the 4+ μm thick films. A problem in controlling the relative amounts of REBCO and BZO is that BZO nanorods are in fact solid solution $Ba^{2+}(Zr^{4+}_{1-z}RE^{3+}_{z})O_{3-\delta}$ perovskites. Overcoming the challenges in nanoscale control in long REBCO tapes necessitates the use of in-situ metrology methods for real-time monitoring of REBCO film growth and BMO defects. We have developed reel-to-reel 2D X-ray Diffraction and Raman Spectroscopy for such real-time monitoring. Along with machine learning methods, such metrology tools can provide critical feedback to control the nanoscale defect structure of high-performance REBCO tapes for uniform high in-field I_c.**

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