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The effects of nanostructure on Jc(B, T) in ReBCO coated conductors at multiple angles

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The critical current density (Jc(θ,B,T)) of ReBa2Cu3Oy¬ (ReBCO) coated conductors is essential knowledge for the safe design of high field superconducting ReBCO magnets. However, though the ReBCO windings in a real coil are oriented such that B is applied typically at a range of 0-18° from the tape plane depending on position in the winding, coated conductors are most often characterized with B⊠tape at either 77K or in-field at 4.2K. Due to the intrinsic electronic anisotropy of ReBCO coated conductors and the extra complications induced by non-isotopic artificial pinning center (APC) arrays and their strain-induced weak uncorrelated pinning below 45K, Jc becomes highly anisotropic. This complex pinning landscape makes it difficult to predict the angular dependence of Jc from tape to tape, especially as the dominant pinning type changes with increasing T and B. We recently reported the Jc(B⊠tape,T) results on 4 tapes representative of those used in the 32T all-superconducting magnet at the NHMFL that were all purchased to the same advanced pinning specification. Applying a Ginzburg-Landau model for vortex pinning and correlating its predictions with TEM images of the nanorod pins, we found that APC size, volume fraction and density varied significantly across the 4 conductors studied and correlated with the large variation seen in the Jc(B,T) properties and the characteristic pinning energies. We here extend that study to investigate the Jc(B,T) properties at 18° from the tape plane. In this case the nanorods are no longer parallel to B and we observe significant changes in the Jc properties compared to the B⊠tape orientation. Using an inductive method, we also report the results of Jc(B,T) over the full angular range in 4.2K<T<40K and B<30T. We report on the way that the pinning landscape changes at varying field and temperature ranges as the angle θ is varied.

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