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M2Or1B-01: [Invited] Combination of thermodynamic and pinning optimization routes for enhancing Jc

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For superconducting magnets and other applications, enhancing the critical current density (J_c) is required. There are several possible approaches for enhancing J_c in REBa₂Cu₃O_y coated conductors (CCs); one is by introducing and tailoring pinning centers to immobilize vortices. Another is by enhancing the thermodynamic critical field (H_c∝(xi;lambda;)⁻¹) through reducing the penetration depth (lambda;) and the coherence length (xi;). Previously, we have shown a large enhancement in J_c at not only self-field but also in-field by introducing a high density of incoherent BaHfO₃ nanoparticles (BHO NPs) of a tailored size into (Y_{0.77}Gd_{0.23})Ba₂Cu<sub>3<
((Y,Gd)123) CCs, which leaves the matrix unaltered with just slightly decreased superconducting properties[1]. Reducing lambda; and xi; would improve H_c and consequently J_c. If both thermodynamic and pinning optimization routes can be combined, J_c can be dramatically improved. In this work, we combined the thermodynamic route (decreasing lambda; and xi; by tuning the carrier density) with our previously developed methods to tailor the size and incorporate high densities of incoherent BHO NPs. We obtained J_c~150 MA/cm² at 4.2 K in self-field [2]. Moreover, the remarkably high pinning force in the nanocomposite (Y,Gd)123 CCs reached ~3.17 TN/m³ at 4.2 K and 18 T (H||c). Detailed microstructural and superconducting properties for nanocomposite RE123 CCs will be presented.

References

[1] M. Miura et al., NPG Asia Materials 9 (2017) e447.
[2] M. Miura et al., NPG Asia Materials 14 (2022) 85.

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