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M2Or4B-02: Innovative buffer Architectures for REBCO Coated Conductors

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The architecture of REBa2Cu3O7+δ (REBCO, RE = rare earth) coated conductors has been essentially unchanged for more than 20 years with a REBCO film deposited on an insulating oxide buffer stack on Hastelloy C276 substrate. In this work, we explored two innovative buffer stack designs, (1) double-sided conductor to improve critical current (Ic) and (2) electrically- conductive buffer stack for defect tolerant REBCO tapes. We have demonstrated a reel-to-reel manufacturing process for double-sided oxide buffer tapes in 30-m-lengths, utilizing an in-house electropolished Hastelloy substrate with an average surface roughness (Ra) < 1 nm on both sides, Out-of-plane texture and in-plane texture values on both sides are in the range of 3.3±0.3 and 7±0.5 degrees respectively. On an insulating buffer stack, 250nm thick alumina diffusion barrier layer on both sides has proven effective in withstanding higher Joule heating currents for REBCO growth by Advanced Metal Organic Chemical Vapor Deposition (MOCVD). Using the double-sided buffer stack, double-sided REBCO tapes with ˜ a 4.6-µm-thick REBCO film on each side have been achieved with a Ic > 1,050 A/4mm at 20 K, 20 T which is 7x the Ic of typical industrial REBCO tapes at 20 K, 20 T. IBAD titanium nitride (TiN) has been used as an electrically-conductive substitute for IBAD magnesium oxide (MgO) in standard superconductor buffer architectures. A strong biaxial texture has been achieved in IBAD TiN grown on Hastelloy C276 substrate. Additionally, Ti3AlN was utilized as a suitable oxidation-resistant epitaxial film with low resistivity in the electrically-conductive buffer stack. The conductive buffer enables efficient current shunting from the REBCO layer to the substrate, to effectively mitigate the impact of localized defects and enhance reliability in cryogenic environments. This innovation paves the way for the development of double-sided electrically conductive buffers for multiple benefits of high Ic, reduced cost ($/kA-m), and inherent defect tolerance capabilities.

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