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M1Or3A-06 [Invited]: Jc enhancement and changes in the pinning mechanisms in newly alloyed Nb3Sn for FCC application

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The construction of the Future Circular Collider (FCC) has very stringent requirements for Nb₃Sn conductor critical current density, J_c, with a target non-Cu J_c(16T, 4.2K) of at least 1500 A/mm². Nowadays the best commercial Nb₃Sn strands can only reach 1300 A/mm², consequently it will be necessary to significantly increase the high field J_c. To meet this challenge requires new approaches that can introduce additional pinning centers while maintaining a high irreversibility field, H_{Irr}. In this work, we focus on Nb₃Sn wires prepared using Nb-Ta-Zr and Nb-Ta-Hf alloys. Both Zr and Hf had been partially investigated in the '80 and '90 but only recently it has been shown that greatly enhanced pinning can be obtained in Nb₃Sn with Zr or Hf, while maintaining high H_{Irr} by incorporating Ta doping. In the Zr case, an internal oxygen source (SnO₂) is required, and ZrO₂ nanoparticles have been shown to form in the Nb₃Sn. However, we find that F_p and J_c at high field can be further improved with Hf additions without supplemental oxygen. The introduction of a significant point defect pinning contribution increases the maximum of F_p by more than a factor 2 and shifts its peak position from 4.6 to 5.8 T with respect to Ta-only doped wires. This leads to a layer J_c(16T, 4.2K) of about 3710 A/mm², corresponding to a potential non-Cu J_c(16T, 4.2K) of 2230 A/mm². We will also discuss the sensitivity of these properties to heat treatment, the different H_{Irr} and F_p behavior with respect to standard Ta/Ti-doped conductors and the recent high field characterizations of newer alloyed wires.
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