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Recent progress in newly alloyed Nb_3Sn conductors

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The requirements for Nb_3Sn conductor for the realization of the Future Circular Collider (FCC) are very stringent. Particularly challenging is the target non-Cu J_c -(16T, 4.2K) of at least 1500 A/mm^2. Nowadays the best commercial Nb_3Sn strands can achieve only 1300 A/mm^2, demanding a significant improvement of the high-field J_c performance. To meet the FCC J_c target we developed new Nb-Ta-Zr, Nb-Ta-Hf and other alloys to introduce additional pinning centers while maintaining a high H_{Irr} in Nb_3Sn. Although the employment of SnO_2 can lead to the formation of ZrO_2 or HfO_2 precipitates, the best performances were obtained in the oxygen-free Hf-Ta-doped Nb_3Sn thanks to its very small grain size of less than 100 nm. This approach more than doubles the maximum of F_p and shifts its peak from 4.6 T, typical of Ta-doped wires, to 5.8 T on the Hf-Ta-doped conductor. This leads to a layer J_c(16T, 4.2K) of about 3710 A/mm^2, corresponding to a potential non-Cu J_c(16T, 4.2K) of 2230 A/mm^2. The microstructural analysis suggests a correlation between grain size of the alloys and the A15 phase. In particular the presence of Hf causes an increase in the recrystallization temperature of the alloy that then leads to the formation of small-grain A15. In this presentation we will discuss the sensitivity of H_{Irr} and F_p to heat treatment with respect to standard Ta/Ti-doped conductors and we will show the most recent results on multifilamentary wires and on the optimization of the dopant content.

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