Poster-1-14

Improvement of J_c and further enhancement of B_{c2} in multifilamentary Nb_3Sn wires with internally oxidized nanoparticles

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The development of dipole magnets capable of providing 16T is an indispensable breakthrough needed for the 100TeV energy target of the proton-proton Future Circular Collider (FCC-hh). These magnets will require the use of Nb_3Sn superconducting wires with critical current densities (J_c) that are substantially beyond state-of-the-art. To reach the desired levels of J_c, we are investigating methods for the inhibition of the grain growth in Nb_3Sn by means of nanoparticles - ZrO_2 or HfO_2 - that form through an internal oxidation process. We have recently performed a study on monofilamentary wires [1] showing that the higher grain boundary density due to the grain refinement combined to the presence of point-pinning centers due to the nanoparticles lead to a significant enhancement of J_c. In this work, we present the results obtained on prototype multi-filamentary wires that we are developing to expand the use of the internal oxidation technique to industrial wires. These wires exhibit (1) values of J_c that exceed the target of $1'500 A/mm^2$ at 16T, 4.2K set for FCC; (2) record-high upper critical fields extrapolating above 29T at 4.2K. Results of studies on Nb_3Sn formation, Sn and O diffusion and elements distributions are also presented and discussed to interpret the results.

[1] Buta, Florin, et al. "Very high upper critical fields and enhanced critical current densities in Nb_3Sn superconductors based on Nb-Ta-Zr alloys and internal oxidation." Journal of Physics: Materials 4.2 (2021): 025003.