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Performance Enhancement of Nb3Sn Superconductors by Artificial Pinning Centres

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Presently available state-of-the-art Nb3Sn wires have not yet reached the required FCC performance, which heavily depends on the microstructure. New manufacturing techniques aim to push the material further to its limits through grain refinement and pinning enhancement by the introduction of artificial pinning centres (APCs).
In this study, two approaches that recently managed to achieve the FCC target critical current density are presented. One revolves around a novel manufacturing technique based on internal oxidation and formation of ZrO2 nano-precipitates, while the other relies on the introduction of defects by fast neutron irradiation. The influence of the resulting microstructure on the superconducting properties was examined through combined microstructural and magnetic analysis.
By means of scanning and transmission electron microscopy, information about the nature and density of pinning sites, gradients in the elemental composition, grain size distribution and inhomogeneities in the wire geometry was obtained. The superconducting properties including critical current density and critical temperature were determined by scanning Hall probe microscopy and SQUID magnetometry.
A correlation was established between the microstructure and superconducting properties. Similarities and differences between internal oxidized and neutron irradiated wires are discussed, which both show significantly improved properties compared to standard wires.

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