Advances in Nanoscale Analysis of Hf Doped Nb3Sn Wires Using Atom Probe Tomography

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Abstract — The Future Circular Collider (FCC) will require Nb3Sn dipole magnets that can operate up to 16 T [1], however, achieving this demanding specification will require conductors with an exceptionally high critical current density (Jc) of 1500 Amm−2 whilst maintaining a residual resistivity ratio (RRR) of 150. Despite a great deal of research into new manufacturing techniques and heat treatments for Nb3Sn wires, it remains a very challenging and ambitious target. All commercial Nb3Sn strands use Ta and/or Ti doping for high field performance but in this study, we look at the impact of also adding Hf, which has been shown to increase flux-pinning and thus may help Nb3Sn wires reach the FCC target specifications. To determine how Hf affects the superconducting properties of the Nb3Sn it is important to use a nanoscale microscopy technique to visualize how the Hf is modifying the Nb3Sn layer. This study uses Atom Probe Tomography (APT) to locate secondary phases, segregation at grain boundaries and discusses the origin of O in the sample.

Keywords (Index Terms) —Future circular collider, critical current, pinning force, atom probe tomography, backscattered detector, transmission electron microscopy, electron probe microanalyser, energy dispersive x-ray spectroscopy