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Wed-Af-Po3.21-03 [69]: Challenges and Perspectives of the Phase Formation of Internally Oxidized PIT-Type Conductors

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The generation of nano-scale precipitates from an additional alloying component in the Nb-alloy precursor of Nb3Sn-based wires is considered one of the promising techniques to refine the grain size of the superconducting phase and boost the Jc beyond the specification of a Future Circular Collider (FCC). Much effort by research groups could demonstrate that this technology is viable and can lead to the desired grain refinement if sufficient oxygen can be supplied to the Nb-alloy precursor.

However, the addition of oxygen as an additional reacting agent renders the already convoluted reaction scheme of high tin conductors even more complex. In order to understand and adjust the phase formation, two key features need to be addressed: (i) The relative diffusional velocity of oxygen and tin and (ii) the impact of oxygen on the phase formation of Nb-Sn intermetallics.

Due to their flexibility, Powder in Tube (PIT) concepts have been chosen to efficiently benchmark new conductor layouts. Bruker has developed, manufactured and tested more than 30 different designs in which oxygen and tin diffuse from the same or different locations within the filament. Nb1Zr or Nb2.5Ti was used as the initial alloys and oxygen was supplied from SnO2 or CuO powders. To assess the phase formation and grain size, bouquet conductors consisting of different monofilaments were introduced as an innovative tool for rapid prototyping.
The differences in phase formation between oxidized and reference samples could be illustrated. Based on this data, the effectiveness of the type, location and composition of the oxygen source to generate nano-scale precipitates or to refine the grain size was evaluated. The critical temperature and thereby the oxygen concentration in the Nb-alloy that remains after heat treating was analyzed to quantify the oxygen release provided by the different layouts.

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