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Lattice location of Ta and Ti in doped Nb_3Sn

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There has been renewed interest in Nb3Sn superconductor for its proposed application in the new fusion test reactor, ITER, and for next generation accelerators such as the LHC upgrade. Due to its brittle nature, an effective way to produce thin filaments of Nb3Sn in a wire is by an internal tin Restacked-Rod-Process (RRP®) where each filament is made of Cu-cladded Nb (or Nb-Ti or Nb-Ta) rods restacked around a Sn core in a Cu-cladded Nb tube acting as diffusion barrier. During the heat treatment Nb and Sn react forming a continuous layer of Nb3Sn. It has been known for some time that the addition of small amounts of Ti and Ta can improve the superconducting in-field properties of the final wires. Initial measurements on Nb3Sn ribbons using electron channeling and EXAFS indicated that these dopants are primarily located at the Nb lattice sites. However, more recent studies suggest that Ti could be occupying the Sn sites. This motivated a new set of EXAFS measurements on modern wires similar to those proposed for the new applications. EXAFS is a sensitive method for looking at the lattice locations of the dopants since it looks directly at their near neighbors, and the two lattice sites have distinctly different local environments. Four different samples were measured, two with Ti doping, one with Ta doping and one with both Ta and Ti doping. In all cases the Ti and Ta were found to be primarily in the Nb sites. For the three Ti cases there was no indication of any Ti in the Sn sites. For the Ta data, the EXAFS indicated that there was partial occupancy into the Sn sites with about 18% of the Ta in the Sn site for the Ta only sample, and 34% in the co-doped sample. The implications of this result will be discussed.

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