Contribution ID: **224** Type: **Poster presentation (105min)**

The effect of heat treatments on the RRR of Nb3Sn superconducting strands

Nb3Sn strands are used in the Toroidal Field (TF) coils of International Thermonuclear Experimental Reactor (ITER) project. Residual Resistance Ratio (RRR) is an important performance for superconducting strands. The RRR value of Nb3Sn strand after heat treatment should be higher than 100 in accordance with the ITER specification. High purity copper with RRR between 273K and 20 K above 250 is used for Nb3Sn strand fabrication required by ITER. A 1-2 μm thickness Cr layer is applied to prevent undesirable variations of inter-strand contact resistances in the heat-treated Cable-In-Conduit Conductor. Both internal-tin and bronze routed Nb3Sn strands have been manufactured successfully at Western Superconducting Technologies (WST). The study of different heat treatments on RRR values of the bared and Cr-plated Nb3Sn strands have been carried out. The temperature is from 200 ℃ to 700 ℃ and the duration time is from 50 hours to 200 hours. The results show that chromium will diffuse into copper matrix after the long duration reaction heat treatment which will cause the RRR values reduce for Cr-plated Nb3Sn strands. The width of penetration of the Cr into Cu stabilizer was estimated to be equal to 2-3 μm. The RRR value will increase for the bared copper and Nb3Sn strands with the temperature increasing. Cu/non-Cu also affects the RRR values. The strands with high Cu/non-Cu ratio (more stabilizing Cu) have high RRR values.

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