Effect of Thermo-Mechanical Processing on the Material properties at Low Temperature of a Large Size Al-Ni Stabilized Nb-Ti/Cu Superconducting Cable

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Abstract - For future high-resolution particle experiments, a prototype for a 60 kA at 5 T, 4.2 K class conductor is realized by co-extrusion of a large, 40-strand Nb-Ti/Cu superconducting cable with a precipitation type Al-0.1wt.%Ni stabilizer. Microalloying with nickel contributes to the strength of the stabilizer, and avoids significant degradation in residual resistivity ratio, owing to its low solid solubility in aluminum.
Sections of the conductor are work hardened to increase the mechanical properties of the as-extruded temper. Mechanical and resistivity characteristics are assessed as function of the amount of work hardening, at room temperature as well as at
4.2 K.

Thermal treatments, like resin curing after coil winding, can cause partial annealing of the cold-worked material and reverse the strengthening effect. However, targeted thermal treatments, applied at relatively low temperature can result in precipitation hardening. The depletion of nickel in the aluminum-rich matrix around the precipitates results in an increased strength and a decreased effect of nickel on the thermal and electrical resistivity of the material.

The present work aims at identifying an optimal work hardening sequence, and an optimal thermal treatment, possibly coinciding with a suitable coil resin curing cycle, for the Al-Ni stabilized superconductor.

Keywords - aluminum stabilized superconductor, Al-Ni alloy, mechanical properties, work hardening, thermal treatment, ultrasonic measurement
PACS: 81.20.Ev, 81.40.-z, 81.70.-q, 84.71.Ba

IEEE/CSC & ESAS SUPERCONDUCTIVITY NEWS FORUM (global edition), July 2013
Manuscript 3MOrC2-07 submitted to CEC/ICMC Proceedings in AIP Conference Proceedings, Reference No. ST343; Category 5; preprint accepted by SNF on July 18, 2013