Electromechanical Property and Pre-bending Effect in CuNb/Nb_3Sn Rutherford Cables and Coils

Satoshi Awaji [a*], Koki. Takahashi [a], Hidetoshi Oguro[b],
Masahiro Sugimoto[c], Hirokazu Tubouchi[c]

[a]*IMR, Tohoku University, Sendai, Japan*
[b]*Tokai University, Hiratsuka, Japan*
[c]*Furukawa Electric Co., Ltd., Nikko, Japan*

**Corresponding author: awaji@imr.tohoku.ac.jp*

Nb-rod processed CuNb reinforced Nb_3Sn Rutherford coils are used as middle section coils for the 25T cryogen-free superconducting magnet (25T-CSM), which generates the maximum center field of 24.6 T in a 52 mm room temperature bore [1]. The low temperature superconducting (LTS) coils, which consist of CuNb/Nb_3Sn and NbTi Rutherford coils, contribute a 14 T in a 300 mm bore as a background field for the 25T-CSM [2]. We used some advanced technologies related to Nb_3Sn conductors for the 25T-CSM.

The Rutherford cable consists of 16 CuNb/Nb_3Sn strands. We managed the bending strain below 0.5% of the Nb_3Sn strands of the Rutherford cable in the all process after the heat treatment to the coil winding. In particular, the pre-bending strain of ±0.5%, i.e. alternated bending strain, improves I_c about 35% at 14 T and 4.2 K [3]. In this case, we found that the bending strain can be calculated using not the cable thickness but the strand diameter because of a slip between strands with a relatively small compaction and a loose cabling of the Rutherford cable. The 14 T Nb_3Sn Rutherford middle coil with 300 mm inner diameter in the 25T-CSM was designed under the large hoop stress of 251 MPa and was successfully operated without any problems [2]. In the 25T-CSM, the anomalous temperature rise in Nb_3Sn coil was observed only in the 1st energize test but no training quench took place. It is considered that the loose cabling is effective to reduce the disturbance energy. The electromechanical properties and analysis of CuNb/Nb_3Sn Rutherford cable and coil will be presented.

[1] S. Awaji et al., *Supercond. Sci. Technol*., vol. 30, p 065001 (2017).
[2] H. Oguro et al., *Supercond. Sci. Technol*., vol. 29, p 084004 (2016).
[3] M. Sugimoto et al., *IEEE Trans. Appl. Supercond*. vol. 25, p 6000605 (2015).