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Wed-Mo-Po3.02-04 [14]: Development of high-current density HTS STARS conductor for the next generation helical fusion device

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Conceptual design studies of the helical fusion reactor FFHR-d1 are progressing at National Institute for Fusion Science (NIFS) for realizing steady-state fusion energy production. The continuously wound helical coils have the major radius R of 15.6 m, four times that of the presently working Large Helical Device (LHD) with R = 3.9 m. The High-Temperature Superconducting (HTS) large-current capacity conductor, named STARS (Stacked Tapes Assembled in Rigid Structure), has been developed to be applied to the helical coils of FFHR-d1. The operation condition is 100 kA current at 14 T magnetic field and 20 K temperature. The current density of the conductor is set at 25 A/mm2.
At NIFS and in the Japanese fusion community, discussion about the post-LHD project has started so that it would be implemented after completing the LHD project in about ten years. One of the candidates is to build a new middle-sized helical device (R = 3.3 m as the present reference) with a higher magnetic field associated with a magnetic configuration optimizing that of LHD. The HTS conductor is being considered to be applied to the helical coils of this device having the target condition of 18 kA at ˜10 T and 20 K. The current density is presently set at 80 A/mm2 in the maximum case. A STARS conductor could be a candidate by employing a simple stacking of REBCO or Bi-2223 tapes, while there are presently two other candidates, FAIR and WISE conductors. In this paper, development of 20-kA-class HTS-STARS conductor is discussed, focusing on the quench protection with such a high current density. The bridge-type mechanical lap joint technique is also progressing to apply the “joint-winding”method for facilitating the winding process of the helical coils by connecting segmented conductors on site.

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