Contribution ID: **906** Type: **Poster Presentation of 1h45m**

Test Winding of a 1-T Class Force-Balanced Coils Using High Temperature Superconducting Tapes

Monday 28 August 2017 13:15 (1h 45m)

High-temperature superconducting (HTS) tapes are expected to improve small sized high field magnets such as superconducting magnetic energy storage (SMES). The authors proposed the force-balanced coils (FBC) concept as a feasibility option for SMES. Although the FBC can minimize the mechanical stresses induced by the electromagnetic forces, the FBC has three-dimensional complex shapes of helical winding. Therefore, when the tensile strain, the bending strain and the torsional strain simultaneously apply to the HTS tapes, the critical current of the HTS coils decrease. The objective of this work is to clarify the critical current property of HTS tapes for the applying complex mechanical strain due to the winding process, winding configuration and electromagnetic forces through the development of a 1-T class HTS model helical coils based on the FBC concept. As a first approach, the authors developed a prototype winding machine whose motion was optimized to prevent from decreasing the critical current of the HTS tapes during winding process. The authors fabricated the one-turn helical coils wound onto the pure torus surface without the winding slot using YBCO and BSCCO wire. From the excitation test results with liquid nitrogen cooling, the authors confirmed the feasibility of the helical winding techniques without a decrease in the critical current. As a next step of this work, the authors are planning to carry out the test winding onto the winding slot whose shape has helical coil trajectory. In this case, the complex mechanical strain will directly apply to the HTS tapes compared with the winding case using the pure torus surface. This work discusses the critical current property dependence on the winding technique of the HTS coils thorough the test winding results and a numerical analysis of the applying mechanical strain.

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Session Classification: Mon-Af-Po1.06

Track Classification: E5 - Energy Storage - SMES