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[Invited] Experimental and theoretical study on power generation characteristics of 1 kW class fully high-temperature superconducting induction/synchronous generator using a stator winding with a bending diameter of 20 mm

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We report experimental and theoretical results of power generation characteristics of a 1 kW class fully High Temperature Superconducting Induction/Synchronous Generator (HTS-ISG) that consist of a stator winding using REBCO coated conductor and a rotor winding using BSCCO tape.
Recent advances of the HTS material technology make it possible to realize electric machines that show high efficiency and power density. In particular, REBCO coated conductor has excellent critical current characteristics even in a relatively high temperature region near atmospheric pressure boiling point of liquid nitrogen, and also has excellent mechanical resistance to bending diameter.
In this study, we designed and manufactured a prototype of 1 kW class fully-superconducting generator (4-pole), with reference to the results of fully superconducting 50 kW model motor [1]. The three-phase stator winding is made of REBCO coated conductors and the squirrel-cage rotor winding is made of BSCCO tapes. In particular, attention should be paid to the challenge of a structure in which the bending diameter of the stator REBCO coil is about 20 mm or less. For the first time, we succeeded in a superconducting power generation test in liquid nitrogen (77K) and observed a lot of unconventional generation characteristics. We will also make theoretical discussions to explain the experimental results. Furthermore, using the above test results as a benchmark, we will report on the status of studies on increasing the current capacity of the HTS-ISG by applying the Face-to-Face Double Stacked (FFDS) conductor, of which two REBCO tapes are joined each other with low resistance [2]. This study would provide a strong reference for the practical application of fully-superconducting generators.

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[1] T. Nakamura et al., IEEE Trans. Appl. Supercond., 29(5) (2019) 5203005
[2] T. Kiss et al., 30th ISS, WB6-6-INV, 2017

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