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AC Current Transport Characteristics of HTS Stator Coils in HTS Induction/Synchronous Motor

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We have been studying on a superconducting motor for highly efficient transportation equipment. Target motor of our study is a High Temperature Superconducting Induction/Synchronous Motor (HTS-ISM). Basic structure of the HTS-ISM is the same as that of so-called squirrel-cage induction motor, and HTS tapes are used in its rotor bars and end rings. Based on experiments and analysis, it has been clarified that the HTS-ISM possesses prominent performances such as high torque density and high efficiency thanks to the steady state synchronous operation. On the other hand, the torque density of the motor depends on the magnetomotive force, which is determined by the primary current. And then, in the case of copper windings, the primary current is restricted by Joule loss, and it is difficult to apply large current. Further, the maximum efficiency of the motor becomes worse due to such loss. Therefore, the HTS-ISM with HTS stator coil is crucial in order to realize higher torque density and higher efficiency. In this paper, we fabricate a three-phase BSCCO HTS stator coils and conducted its DC and AC current transport tests without rotor. We firstly show DC voltage-current characteristics of the HTS stator and show the success of 450 A application test at 77 K. Furthermore, we show one-phase and three-phase AC loss test results, and discuss on the rotation characteristics of the fabricated 50 kW class fully superconducting motor. We also try to reproduce the above results based upon electro-magnetic field analysis. These results would be important in designing highly efficient all superconducting HTS-ISM.
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