Study on High Temperature Superconducting Coil System for Magnetic Sail Spacecraft

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Magnetic sail propulsion system has been studied for exploring deep space because of an efficient and high thrust. Thrust is subjected to the interaction between solar wind momentums and the artificial magnetic field of an excited superconducting coil installed in the spacecraft. To obtain large thrust efficiently, the superconducting coil is indispensable for magnetic sail. Therefore, we investigate the superconducting coil system for the magnetic sail spacecraft.

Superconductors have nonlinear conducting characteristics. Especially, we need to estimate the critical current of the superconducting coil. We obtain the basic conducting characteristics from experiments using short length superconductor of Bi2223 and YBCO. Experimental results provide percolation transition models that express the conducting feature. We calculate the conducting characteristics of the large size coil for magnetic sail with the percolation transition models.

A large current runs into the superconducting coil cooled down by conduction cooling in the magnetic sail. Therefore, thermal design of the coil considering heat generation in the coil and cooling capacity of the cooler is very important. We obtain the thermal diffusivity of Bi2223 and YBCO from experiments and thermal analyses. Calculating 2D heat equation of the coil with the thermal diffusivity, we investigate the thermal stability of the coil.

Generally, a conventional power supply for a superconducting coil has very heavy weight. There is no high current power supply suitable to be installed in spacecraft. We examine lightweight and high current power supply systems for the magnetic sail. Then, we propose the DC/DC converter power supply system for the magnetic sail. Since the DC/DC converter has voltage ripples of which influence on the superconducting coil is not understood, we investigate the influence experimentally.

References

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