
Contribution ID: **622** Contribution code: **TUE-PO1-504-04** Type: **Poster**

# Reinforcement Structure of HTS Magnet to Increase the Magnetic Moment for Space Application

*Tuesday 16 November 2021 13:15 (20 minutes)*

Magneto plasma sail is a space propulsion system with a higher fuel efficiency for future deep space explorations. The thrust to power ratio of the magneto plasma sail can be greatly improved with a superconducting magnet by generating a larger magnetic field with less power consumption. The thrust of the magneto plasma sail is produced by the transfer of momentum from a solar wind plasma to a magnetic field generated by a High Temperature Superconducting (HTS) magnet in the spacecraft, and proportional to the magnetic moment of the magnet (current × magnet area). To obtain a large thrust to mass ratio, or acceleration, enough for space missions, our target is to develop a lightweight HTS magnet system with a large magnetic moment. However, as the magnetic moment or current increases, the electromagnetic force applied to the magnet, such as a hoop stress and axial compressive stress, increases, and a reinforcement structure for the magnet is required. We investigated a suitable reinforcement structure for the HTS magnet to maximize its magnetic moment within the capacity of a space vehicle.

We analyzed the mechanical stresses applied to HTS magnets with a variety of reinforcement structure during the excitation to clarify a suitable reinforcement structure of the HTS magnet for use in space. The suitable configuration of the HTS magnet was investigated to maximize its magnetic moment within an outer diameter of 5 m and total mass of 400 kg. As a result, we showed that a "ladder-type"reinforcement structure can greatly reduce the axial compressive stress as well as the hoop stress by preventing the transmission of force through magnets and maximize the magnetic moment.

This study proved the possibility to increase the thrust of the magneto plasma sail and leads to realizing a space propulsion system using the HTS magnet.

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**Session Classification:** TUE-PO1-504 Special purpose magnets I: Field gradients & other applications