16th IAA SYMPOSIUM ON VISIONS AND STRATEGIES FOR THE FUTURE (D4)
Innovative Concepts and Technologies (1)

Author: Ms. Qingyun Mao
Shanghai Engineering Center for Microsatellites, China, qymao88@hotmail.com

Mr. Yonghe Zhang
Shanghai Engineering Center for Microsatellites, China, yonghe.zhang@mail.sim.ac.cn
Dr. Jun Jiang
Shanghai Engineering Center for Microsatellites, Chinese Academy of Sciences (CAS), China, hitchevalier@hotmail.com
Mr. Bo Zhang
Shanghai Engineering Center for Microsatellite, China, ghostdang@163.com
Mr. Chengbo Qiu
Shanghai Engineering Center for Microsatellites, China, qiuchengbo2@163.com
Dr. Yamin Wang
Shanghai Engineering Center for Microsatellites, Chinese Academy of Sciences (CAS), China, wangyam09@163.com

TOPOLOGICAL STRUCTURE DESIGN OF NON-CONTACTING FLUX-PINNED INTERSATELLITE CONNECTION WITH PASSIVE STABILITY

Abstract

Superconductors, with their unique magnetic and electric properties below a critical temperature, have inspired many innovative conceptual designs of space application. Flux pinning is one of those characteristic properties, with which temperature could be utilized as the switch of contact-free connection between two satellites with passive stability. Potential space applications based on superconductor flux pinning include deformable network of satellites held together by a non-contacting interface, reconfigurable optical mirrors assembled from modules with a flux-pinned interface, and connection between two cooperative microsatellites capable of action-at-a-distance 6DOF actuation.

Until recently, superconductors have not reached their full potential in space applications. One of the challenges is action distance. As the magnetic flux is non-linearly diverging as a function of distance, the electromagnetic interaction between magnets/electromagnets/superconductors and superconductors is decreasing as the separation distance increased. Current research of flux pinning has been focused on the interaction model and dynamics of two modules with relative distance of only a few centimeters, due to limited stiffness at larger separation distance. To increase feasibility and broaden application field, research to approach longer action distance is essential.

In this paper, we focused on the design of flux-pinned interfaces, aiming to increase the stiffness at decimeter-scale or longer separation distance. First, we reexamined the flux pinning interaction model, including the frozen-image model and Bean model, and conducted simulations based on the initial interface structure. At the same time, we designed precise measurement methods of 6DOF stiffness based on the principle of torsion pendulum, to compare the simulation and experiment results. Then we established the key design parameters of flux-pinned interface and focused on the topological structure design, to optimize the parameters with the goal to increase both the stiffness and stability. The effective action distance and passive stability of flux-pinned connection between two modular cubesats would be verified on air-table ground testbed. This research would help lend insight for potential technologies to reach longer effective action distance for non-contacting intersatellite connection or actuation with passive stability.