IAF MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Space Vehicles – Mechanical/Robotic/Thermal/Fluidic Systems (7)

Author: Dr. Kikuko Miyata
Meijo University, Japan, kmiyata@meijo-u.ac.jp

Mr. Yusuke Ogawa
Meijo University, Japan, 1998handball8986@gmail.com
Dr. Masaki Yamagata
Kansai University, Japan, yamagata@kansai-u.ac.jp

PROPOSAL AND EVALUATION FOR PASSIVE TEMPERATURE STABILIZATION SYSTEM FOR BATTERY PERFORMANCE MANAGEMENT

Abstract

This paper proposes temperature change mitigation systems for maintaining Li-ion battery performance. The system mitigates temperature change by increment the heat capacity around the target temperature utilizing commercial phase change material without power resources usage. Recently, the Li-ion battery is popular as the power storage component of small spacecraft. However, their performance has a temperature-dependent tendency. For example, there are possibilities of thermal runaway under high-temperature environments and drastic performances drop because of the internal resistance increment under low-temperature environments. There are many pieces of research for high-temperature avoidance or construction of the safety system for thermal runaway problems; however, on the other hand, there are few studies to avoid low-temperature environments. In the case of CubeSat, the spacecraft temperature tends to be stabilized at a lower temperature comparing to microsatellites because of its low mass and power generation capacities. In addition, its low power generation characteristics prevent the utilization of additional heaters for thermal management during the eclipse. To solve the problems under these situations, there are requirements for the temperature stabilized system without power resource usage especially in a low-temperature environment. Therefore, we propose the passive temperature change mitigation system by using commercial phase change material. The adaption of the commercial component enables stable performance and cost maintenance of the key technologies. At first, we perform the individual experiment to measure the main characteristics of the battery and phase change material. Then, the proposed system is designed by utilizing numerical analysis considering a thermal mathematical model including experiment-based battery performance and phase change material characteristics model. Here, we perform some case studies to emulate the typical on-orbit constraints of the spacecraft. The battery charging or discharging profile has relationships to the heat generation of the battery itself. Therefore, we construct a simple spacecraft simulator to generate realistic battery current profiles. Finally, the effectiveness of the designed system is evaluated through some experiments emulating the design constraints environment.