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MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Smart Materials and Adaptive Structures (5)

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THERMAL CONTROL OF MULTIFUNCTIONAL POWER STRUCTURES USING PHASE CHANGE MATERIALS

Abstract

Spacecraft efficiency can be improved through the use of multifunctional structures. A spacecraft structure becomes multifunctional when in addition to meeting structural requirements it also performs functions associated with other subsystems of the spacecraft. With the structure performing these functions, some separate discreet structural components may no longer be required. Thus the parasitic structures that support them and the space in the bus for these parasitic structures are no longer required, reducing both mass and volume of the spacecraft.

A multifunctional power structure is a structure that performs functions associated with the electrical power system. This paper focuses on the inclusion of commercial lithium polymer batteries into a sandwich panel which comprises the structure of a wing mounted solar array. In addition to the aforementioned benefits, placing the batteries this close to the solar arrays will reduce the length of connections between the two and remove the need for inefficient connectors through the use of thin film circuitry.

As a wing array, the structure is exposed to large temperature extremes and is outside of the authority of the spacecraft's thermal control system. It is shown that the thermal environment is hostile to the batteries, which only operate efficiently and safely within a narrow temperature envelope. As such, a local thermal control system is required; with its authority targeted at preventing overcooling during eclipse.

A solution to this problem is to alter how the structure responds to the thermal inputs. This is done through the use of phase change materials. The latent heat of the phase change of the material is exploited to raise the heat capacity of the structure over a narrow temperature range, thus slowing the rate of temperature change. Through the use of numerical simulation, it is shown that phase change materials are feasible solution. It is also demonstrated that as the transition temperature rises, the amount of phase change material increases and that the optical properties of the structure can be altered to reduce the mass of phase change material required to plausible levels.