Paper ID: 27738
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MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Smart Materials and Adaptive Structures (5)

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SIMULATION ANALYSIS OF MATERIAL AND STRUCTURE OPTIMIZATION ON PHASE CHANGE THERMAL CONTROL OF SPACECRAFT ELECTRONIC EQUIPMENT

Abstract

Due to the effect of space environment temperature, the performance of high precision electronic equipment in spacecraft has the poor stability which could not keep the apparatus running normally. In this case, the research on the phase change material (PCM) should be carried out, thermal control structure is optimized, and position of the electronic equipment need to be optimized. In this article, the thermal control performance was measured and temperature evolution was obtained. According to the working environment characteristic and experiment condition, a transient mathematical model was developed to describe the phenomena of interface migration and heat transfer in phase change process, which was numerically solved and validated by the measured data. Then, the optimal performance of the PCM and thermal control structure was obtained. These results show that the proposed model is suitable for describing the PCM melting process, the optimal thermal control structure is composed of phase change and insulator material, where the temperature change rate could be decreased distinctly. Comparing with the alkane or rubber shape-stabilized PCM, this structure has the better thermal control performance because both the thermal insulation and absorbing processes could be occurred respectively. Then, when the Al-based diamond material is used, heat transfer rate could be increased and latent heat could be made full used. It is expected the developed model and relevant data in the present research will be beneficial to improve thermal control performance of spacecraft electronic equipment.