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THERMAL DESIGN OF CRYOGENIC COOLER BY USING GRAPHITE SHEET FOR ENHANCEMENT OF MICRO-VIBRATION ISOLATION PERFORMANCE

Abstract

Spaceborne pulse tube-type cooler is widely used for cooling the focal plane of an infrared detector to cryogenic temperature to minimize a thermal noise of the sensor. Thermal control to maintain the cooler within an acceptable operating temperature range and micro-vibration isolation to minimize a transmitted vibration level to vibration sensitive components are the important technical tasks to guarantee a cooling performance, reliability and pointing stability of the system. In general, thermal control of the cooler is implemented by a heat pipe to transfer heat from the cooler to radiator for radiative heat waste to deep space. Therefore, heat pipe with a higher heat transfer capability is desired from a thermal design point of view. However, if the stiffness of the heat pipe increases, it may lead to a decrease in the vibration isolation performance of the passive vibration isolators for PLOVIS-I and II (with space heritages through KOMPSAT-3A and 7 satellite program) supporting the cooler with low stiffness springs of the isolator. In this study, we proposed a new strategy of thermal design of cooler by using a graphite sheet with high thermal conducvitity and flexibility. This strategy to use a flexible graphite sheet could be more helpful to alleviate the mechanical design constraints at satellite level such as horizontal accommodation of the heat pipe for on-gorund test and location of the heat pipe mounting interface on the radiator to reduce the thermal gradient than applications of conventional heat pipe. In addition, flexible characterisitic of the graphite sheet contributes on the performance enhancement of micro-vibration isolation system because this enables to support the cooler with a much lower stiffness of isolation system than that of heat pipes. The feasibility of the newly proposed design strategy was validated through a thermal analysis and investigation on vibration transmissibity of the isolation system with the measured mechanical characteritics of stiffness and damping of the graphite sheets.