CRYOCOOLER LOAD INCREASE DUE TO EXTERNAL CONTAMINATION OF LOW-ε CRYOGENIC SURFACES IN SPACE

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Cryocooler loads can be roughly divided into three types: electrical power dissipation, conductive parasitics down supports and electrical cables, and radiation loads dependent on surface emittances and view factors of hot objects that surround the cryogenic surfaces. Of loads in the third category, the most sensitive ones are those associated with high-surface-area, low-emittance parts at cryogenic temperatures that view high temperature surrounds. For these parts, the relevant surround temperatures and surface emittances often change over time in unpredictable ways and create large uncertainties in the cryogenic load.

One of the most difficult challenges faced by the cryogenic system designer of space-instruments is trying to predict the long-term emittance of low-emittance surfaces as they are affected by contamination by condensed water films and outgassing products over the life of a mission. A key unknown is the actual effective vacuum level achieved in space in the interior of a typical science instrument.

This paper compiles available flight data on contamination effects experienced during multi-year space missions and ground tests to date as a help to those designing and conducting future long-life missions with cryocoolers. Although the data set is small, experience indicates that around a 10-20% load increase may be expected on-orbit due to contamination of low-ε surfaces.

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Prefer Oral Paper
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