

Development of Micro Column Arrays (MCA) for Thermal Management Applications

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Abstract—Work has begun on Micro Column Arrays for Thermal Management Applications using available FEMLAB simulation software to model MCA structures for spacecraft and the ISS and to investigate the effects of their size, density, and geometry on the temperature of the substrate.

THERMAL MANAGEMENT OF SPACECRAFT AND SPACE STATION environments is an important issue in both manned and unmanned exploration of space. Transporting heat away from spacecraft components and bringing heat to other systems often rely on large, liquid-based heat exchange systems. Such active systems add extra weight to the spacecraft and rely on mechanical components which can malfunction, thus affecting maximum payloads and mission lifetime. A possible alternative is a passive cooling system in which thin coatings or foils would collect or remove heat by radiative absorption or emission.

A technology for the successful fabrication of Micro Column Arrays (MCAs) on thin metal foils has recently been developed in conjunction with Integrated Micro Sensors, Inc. (IMS) of Houston, Texas. MCAs consist of densely packed micro cones separated by cone-shaped micro cavities and exhibit low reflectance (< 0.171) and high absorbance (> 0.978) over a wide spectral range in a very close approximation of blackbody behavior. The goal of this project is to explore the use of MCA structures on metal foils for heat acquisition and/or heat rejection through their near-blackbody nature.

In-depth simulation of their heat transport properties will be undertaken using a newly developed Transmission Line Matrix (TLM) methodology. In this approach a novel TLM link line is introduced to account for the enthalpy heat transport in a fluid or gas. Incorporation of an electrical diode in the new enthalpy link has been revealed to be an excellent way to account for the heat convection without altering the classical TLM algorithm arrangement. Full extension of this model to radiative heat dissipation and collection will be undertaken. We have not yet recruited a Post Doctoral fellow for this project.