Manufacturing & Prototyping

Phase Change Material Thermal Power Generator

NASA's Jet Propulsion Laboratory, Pasadena, California

An innovative modification has been made to a previously patented design for the Phase Change Material (PCM) Thermal Generator, which works in water where ocean temperature alternatively melts wax in canisters, or allows the wax to re-solidify, causing high-pressure oil to flow through a hydraulic generator, thus creating electricity to charge a battery that powers the vehicle. In this modification, a similar thermal PCM device has been created that is heated and cooled by the air and solar radiation instead of using ocean temperature differences to change the PCM from solid to liquid. This innovation allows the device to use thermal energy to generate electricity on land, instead of just in the ocean.

This work was done by Jack A. Jones of Caltech for NASA's Kennedy Space Center. Further information is contained in a TSP (see page 1). NPO-48630

The Thermal Hogan — A Means of Surviving the Lunar Night

Lyndon B. Johnson Space Center, Houston, Texas

A document describes the Thermal Hogan, a new shelter concept that would be used on the Moon to moderate the extreme nighttime temperatures, allowing survival of equipment with minimal heater power. It is lightweight, has few mechanical parts, and would be relatively easy to deploy on the Moon.

The Lunar Hogan has two parts: an insulated shelter and a thermal mass. The shelter is constructed of multilayer insulation (MLI) draped over a structural framework. Entry and egress are accomplished either by raising the structure or via a door constructed of the same MLI material as the shelter. The thermal mass can be manufactured from locally available materials, either by piling substantially sized rocks to a depth of 0.25 meter, or by filling a 0.25-meter-deep conductive honeycomb-like structure with lunar dust. For ease of transport, the structural framework and honeycomb can be collapsible. The door can be opened by pushing on it in either direction. Gravity would cause it to close and it could be sealed via magnetic strips on the doorframe.

This work was done by Neelay Fruitwala, Eugene Ungar, and John Cornwell of Johnson Space Center. Further information is contained in a TSP (see page 1). MSC-24898-1

Micromachined Active Magnetic Regenerator for Low-Temperature Magnetic Coolers

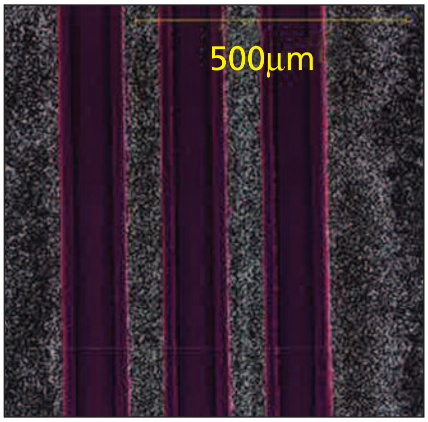
Fabrication improvements are evaluated and introduced.

Goddard Space Flight Center, Greenbelt, Maryland

A design of an Active Magnetic Regenerative Refrigeration (AMRR) system has been developed for space applications. It uses an innovative ^3He cryogenic circulator to provide continuous remote/distributed cooling at temperatures in the range of 2 K with a heat sink at about 15 K. A critical component technology for this cooling system is a highly efficient active magnetic regenerator, which is a regenerative heat exchanger with its matrix material made of magnetic refrigerant gadolinium gallium garnet (GGG).

Creare Inc. is developing a microchannel GGG regenerator with an anisotropic structured bed for high system thermal efficiency. The regenerator core consists of a stack of thin, single-crystal GGG disks alternating with thin polymer insulating layers. The insulating layers help minimize the axial conduction heat leak, since GGG has a very high thermal conductivity in the regenerator's operating temperature range. The GGG disks contain microchannels with width near 100 micrometers, which enhance the heat transfer between the circulating flow and the refrigerant bed. The unique flow configuration of the GGG plates ensures a uniform flow distribution across the plates.

The main fabrication challenges for the regenerator are the machining of



Microchannels in a 150-µm thick GGG disk fabricated by ultra-short pulse laser micromachining.

high-aspect-ratio microchannels in fragile, single-crystal GGG disks and fabrication and assembly of the GGG insulation layers. Feasibility demonstrations to date include use of an ultra-short-pulse laser to machine microchannels without producing unacceptable microcracking or deposition of recast material, as shown in the figure, and attachment of a thin insulation layer to a GGG disk without obstructing the flow paths. At the time of this reporting, efforts were focused on improving the laser machining process to increase machining speed and further reduce microcracking.

This work was done by Weibo Chen and Michael D. Jaeger of Creare Incorporated for Goddard Space Flight Center. Further information is contained in a TSP (see page 1). *GSC-16220-1*