



## Improved Cryostat for Cooling a Wide Panel

Less technician time and lower consumption of helium translate to lower cost.

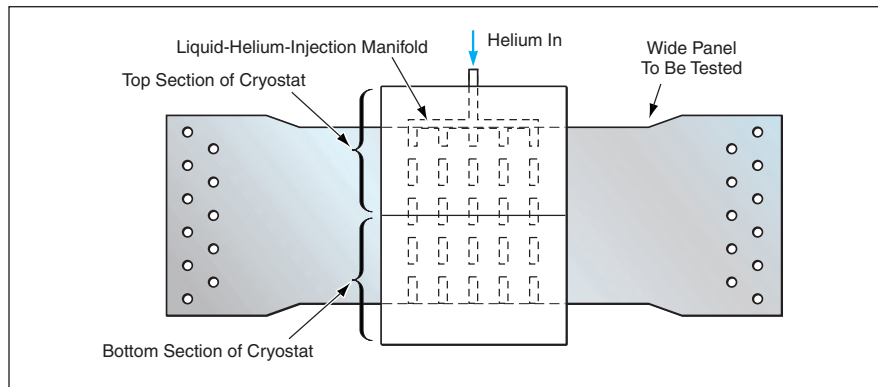
Marshall Space Flight Center, Alabama

An improved cryostat has been developed for cooling a wide panel evenly over its surface to a temperature of  $-423\text{ }^{\circ}\text{F}$  ( $\approx -253\text{ }^{\circ}\text{C}$ ) by use of liquid helium. Originally, the cryostat was to be used in measuring apparent strains in wide aluminum/lithium panels as functions of temperature in order to develop data for temperature compensation of the readings of strain gauges on a tank containing liquid hydrogen. Relative to the cryostat used previously for this purpose, the improved cryostat can be prepared for a test in less time, and it loses less helium during each test.

Each wide panel to be tested is instrumented with thermocouples in preparation for a test. The previous cryostat was made of two aluminum halves that, for each test, were sandwiched together and sealed around the instrumented wide panel to be tested. The panel was thus enclosed in a plenum. The cryostat and adjacent panel areas protruding from the cryostat were then coated with a thermally insulating foam.

During a test, liquid helium was made to flow into the plenum through a port on the bottom. The helium vaporized and expanded, filling the plenum with cold helium gas, which eventually flowed out of the plenum through a port on the top. The nature of the flow was such that a significant portion of the helium did not come into contact with the wide panel; hence, cooling was less efficient than it might otherwise have been.

After completion of each test, the foam and the cryostat were separated from the panel. The cryostat was cleaned and prepared for installation



The **Liquid-Helium-Injection Manifold** in the improved cryostat forces the helium to flow in a pattern in which it cools the panel more efficiently than in the previous cryostat.

on another instrumented wide panel for the next test. It took 28 hours to install the cryostat onto the instrumented panel, apply the foam, and perform ancillary operations in preparation for a test. The volume of liquid helium consumed during each test was 750 liters.

The improved cryostat (see figure) includes an upper section and a lower section, both of which include permanent housings made of a thermally insulating foam 2-in. ( $\approx 5\text{-cm}$ ) thick. A liquid-helium-injection manifold is attached to the inside of the top section. The bottom section includes an outlet for helium gas. The manifold contains slots that, when the cryostat is installed on the panel, are located approximately 1 in. ( $\approx 2.5\text{ cm}$ ) from the wide panel. The array of slots spans a substantial portion of the area of the panel. The top and bottom sections of the cryostat are sealed to the panel by use of polytetrafluoroethylene cord and

aluminum tape.

Liquid helium is fed into the manifold from the top. The helium leaves the manifold through the slots and thus impinges directly on the panel. Hence, all the helium entering the cryostat must come into contact with the panel before leaving the cryostat. After a test, the cryostat is removed from the panel and reinstalled onto another panel for the next test. Installation of the cryostat on an instrumented panel takes a negligible amount of time, in comparison with the 28 hours associated with the previous cryostat. The amount of liquid helium consumed during a test in the improved cryostat is 500 liters — 250 liters less than before.

*This work was done by W. B. Clifton of Lockheed Martin Corp. for Marshall Space Flight Center. Further information is contained in a TSP (see page 1). MFS-31697*

## Current Pulses Momentarily Enhance Thermoelectric Cooling

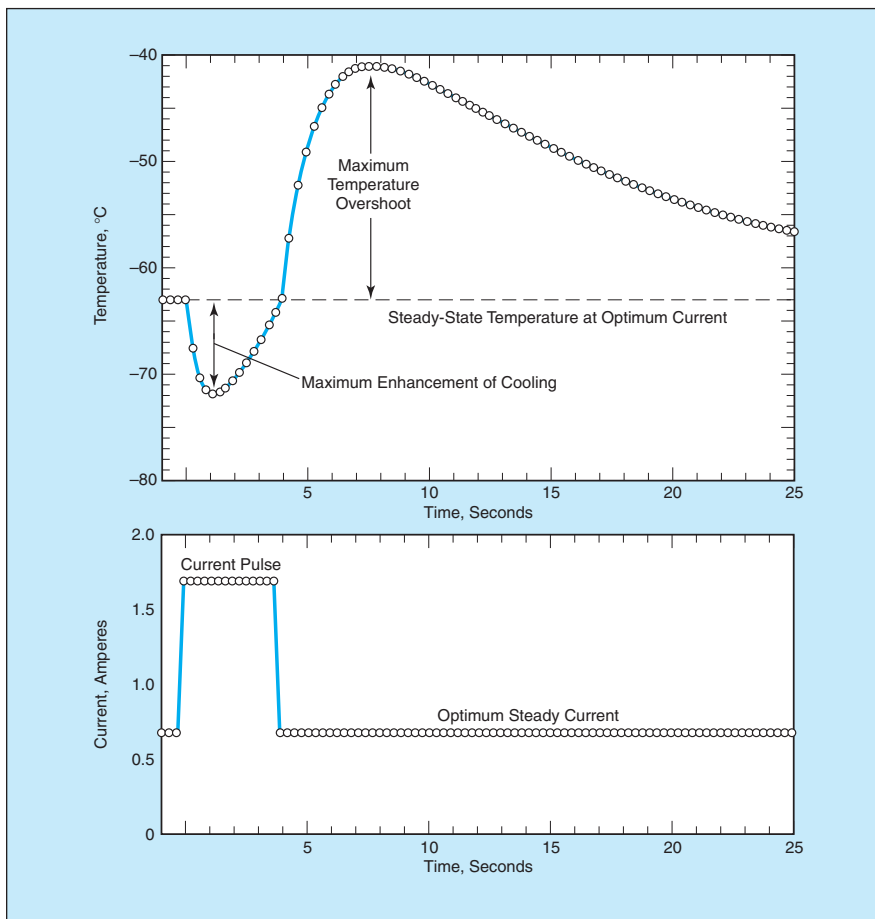
Transient cooling could be attractive for some semiconductor devices.

NASA's Jet Propulsion Laboratory, Pasadena, California

The rates of cooling afforded by thermoelectric (Peltier) devices can be increased for short times by applying pulses of electric current greater than the currents that yield maximum steady-state

cooling. It has been proposed to utilize such momentary enhancements of cooling in applications in which diode lasers and other semiconductor devices are required to operate for times of the order

of milliseconds at temperatures too low to be easily obtainable in the steady state. In a typical contemplated application, a semiconductor device would be in contact with the final (coldest) somewhat



A Pulse of Current greater than the optimum steady current was applied to a thermoelectric device, giving rise to transient enhancement of cooling followed by transient heating followed by gradual decay toward the steady state.

taller stage of a multistage thermoelectric cooler. Steady current would be applied to the stages to produce steady cooling. Pulsed current would then be applied, enhancing the cooling of the top stage momentarily.

The principles of operation are straightforward: In a thermoelectric device, the

cooling occurs only at a junction at one end of the thermoelectric legs, at a rate proportional to the applied current. However, Joule heating occurs throughout the device at a rate proportional to the current squared. Hence, in the steady state, the steady temperature difference that the device can sustain increases with current

only to the point beyond which the Joule heating dominates. If a pulse of current greater than the optimum current (the current for maximum steady cooling) is applied, then the junction becomes momentarily cooled below its lowest steady temperature until thermal conduction brings the resulting pulse of Joule heat to the junction and thereby heats the junction above its lowest steady temperature.

A theoretical and experimental study of such transient thermoelectric cooling followed by transient Joule heating in response to current pulses has been performed. The figure presents results from one of the experiments. The study established the essential parameters that characterize the pulse cooling effect, including the minimum temperature achieved, the maximum temperature overshoot, the time to reach minimum temperature, the time while cooled, and the time between pulses. It was found that at large pulse amplitude, the amount of pulse supercooling is about a fourth of the maximum steady-state temperature difference. For the particular thermoelectric device used in one set of the experiments, the practical optimum pulse amplitude was found to be about 3 times the optimum steady-state current. In a further experiment, a pulse cooler was integrated into a small commercial thermoelectric three-stage cooler and found to provide several degrees of additional cooling for a time long enough to operate a semiconductor laser in a gas sensor.

*This work was done by G. Jeffrey Snyder, Jean-Pierre Fleurial, and Thierry Caillat of Caltech, and Gang Chen and Rong Gui Yang of MIT for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-30553*

## Hand-Held Color Meters Based on Interference Filters

These inexpensive units measure luminous flux in several wavelength bands.

NASA's Jet Propulsion Laboratory, Pasadena, California

Small, inexpensive, hand-held optoelectronic color-measuring devices based on metal-film/dielectric-film interference filters are undergoing development. These color meters could be suitable for use in a variety of applications in which there are requirements to quantify or match colors for aesthetic purposes but there is no need for the high spectral resolution of scientific-grade spectrometers. Such applications

typically occur in the paint, printing, and cosmetic industries, for example.

The figure schematically depicts a color meter of this type being used to measure the color of a sample in terms of the spectrum of light reflected from the sample. Light from a white source (for example, a white light-emitting diode) passes through a collimating lens to the sample. Another lens collects some of the light reflected from the sample and

focuses the light onto the input end of optical fiber. Light emerging from the output end of the optical fiber illuminates an array of photodetectors covered with metal/dielectric-film interference filters like those described in "Metal/Dielectric-film Interference Color Filters" (NPO-20217), *NASA Tech Briefs*, Vol. 23, No. 2 (February 1999), page 70. Typically, these are wide-band-pass filters, as shown at the bottom of the figure.