Highly Efficient Multilayer Thermoelectric Devices

Temperature differences as great as 50 K can be produced at or near room temperature.

Goddard Space Flight Center, Greenbelt, Maryland

Multilayer thermoelectric devices now at the prototype stage of development exhibit a combination of desirable characteristics, including high figures of merit and high performance/cost ratios. These devices are capable of producing temperature differences of the order of 50 K in operation at or near room temperature. A solvent-free batch process for mass production of these state-of-the-art thermoelectric devices has also been developed.

Like prior thermoelectric devices, the present ones have commercial potential mainly by virtue of their utility as means of controlled cooling (and/or, in some cases, heating) of sensors, integrated circuits, and temperature-critical components of scientific instruments. The advantages of thermoelectric devices for such uses include no need for circulating working fluids through or within the devices, generation of little if any noise, and high reliability. The disadvantages of prior thermoelectric devices include high power consumption and relatively low coefficients of performance.

The present development program was undertaken in the hope of reducing the magnitudes of the aforementioned disadvantages and, especially, obtaining higher figures of merit for operation at and near room temperature. Accomplishments of the program thus far include development of an algorithm to estimate the heat extracted by, and the maximum temperature drop produced by, a thermoelectric device; solution of the problem of exchange of heat between a thermoelectric cooler and a water-cooled copper block; retrofitting of a vacuum chamber for depositing materials by sputtering; design of masks; and fabrication of multilayer thermoelectric devices of two different designs, denoted I and II.

For both the I and II designs, the thicknesses of layers are of the order of nanometers. In devices of design I, nonconsecutive semiconductor layers are electrically connected in series. Devices of design II contain superlattices comprising alternating electron-acceptor (p)-doped and electron-donor (n)-doped, nanometer-thick semiconductor layers.

This work was done by Ali Boufelfel of Sigma Technologies International, Inc. for **Goddard Space Flight Center**. *For further information, contact the Goddard Innovative Partnerships Office at (301) 286-5810. GSC-14786-1*

Very High-Speed Digital Video Capability for In-Flight Use

Flight-qualified video system provides very-high-speed color digital-video imaging up to 10,000 pictures per second at flight speeds up to Mach 2.

Dryden Flight Research Center, Edwards, California

A digital video camera system has been qualified for use in flight on the NASA supersonic F-15B Research Testbed aircraft. This system is capable of very-high-speed color digital imaging at flight speeds up to Mach 2. The components of this system have been ruggedized and shock-mounted in the aircraft to survive the severe pressure, temperature, and vibration of the flight environment. The system includes two synchronized camera subsystems installed in fuselage-mounted camera pods (see Figure 1).

Each camera subsystem comprises a camera controller/recorder unit and a camera head. The two camera subsystems are synchronized by use of an M-Hub™ synchronization unit. Each camera subsystem is capable of recording at a rate up to 10,000 pictures per second (pps). A state-of-the-art complementary metal oxide/semiconductor (CMOS) sensor in the camera head has a maximum resolution of 1,280×1,024 pixels at 1,000 pps. Exposure times of the electronic shutter of the camera range from 1/200,000 of a second to full open. The recorded images are captured in a dynamic random-access memory (DRAM) and can be downloaded directly to a per-

Figure 1. **Two Very-High-Speed Digital Video Cameras** are mounted in forward and aft camera pods, respectively, on the F-15B Research Testbed aircraft. The cameras are positioned to obtain photogrammetric data of simulated space-shuttle external-tank thermal-insulation foam debris released from a fixture under the centerline of the aircraft at flight speed up to Mach 2.