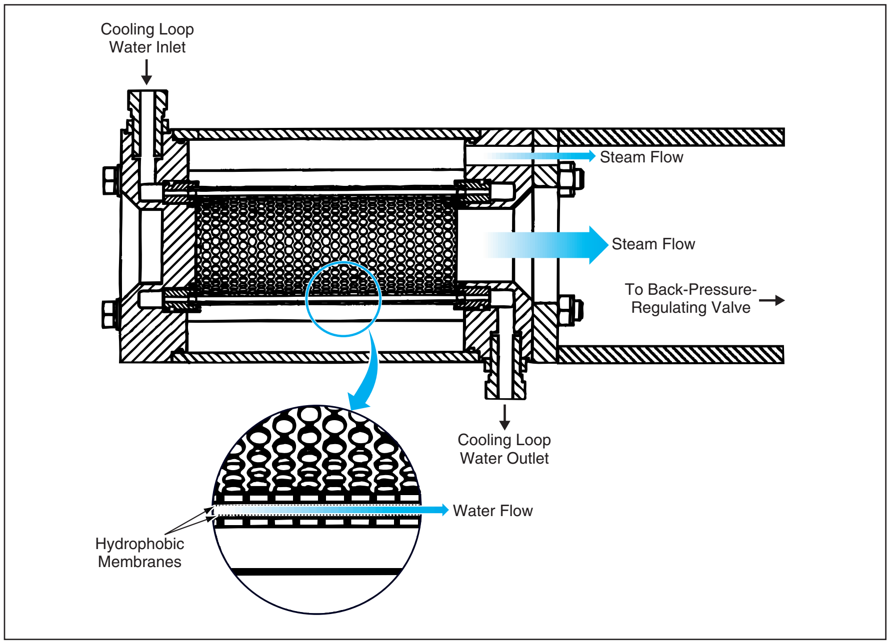
Membrane-Based Water Evaporator for a Space Suit

This design incorporates recent advances in hydrophobic micropore membranes.

Lyndon B. Johnson Space Center, Houston, Texas

A membrane-based water evaporator has been developed that is intended to serve as a heat-rejection device for a space suit. This evaporator would replace the current sublimator that is sensitive to contamination of its feedwater. The design of the membrane-based evaporator takes advantage of recent advances in hydrophobic micropore membranes to provide robust heat rejection with much less sensitivity to contamination. The low contamination sensitivity allows use of the heat transport loop as feedwater, eliminating the need for the separate feedwater system used for the sublimator.

A cross section of the evaporator is shown in the accompanying figure. The space-suit cooling loop water flows into a distribution plenum, through a narrow annulus lined on both sides with a hydrophobic membrane, into an exit plenum, and returns to the space suit. Two perforated metal tubes encase the membranes and provide structural strength. Evaporation at the membrane inner surface dissipates the waste heat from the space suit. The water vapor passes through the membrane, into a steam duct and is vented to the vacuum environment through a back-pressure valve. The back-pressure setting can be adjusted to regulate the heat-rejection rate and the water outlet temperature.



Hydrophobic Membranes provide the basis for a simple, robust device for space-suit heat rejection.

This work was done by Eugene K. Ungar and Charles J. McCann of **Johnson Space Center** *and Mary K. O'Connell and Scott Andrea of Lockheed Martin Corp. For further information, contact the Johnson Commercial Technology Office at (281) 483-3809.*
MSC-23317

Compact Microscope Imaging System With Intelligent Controls

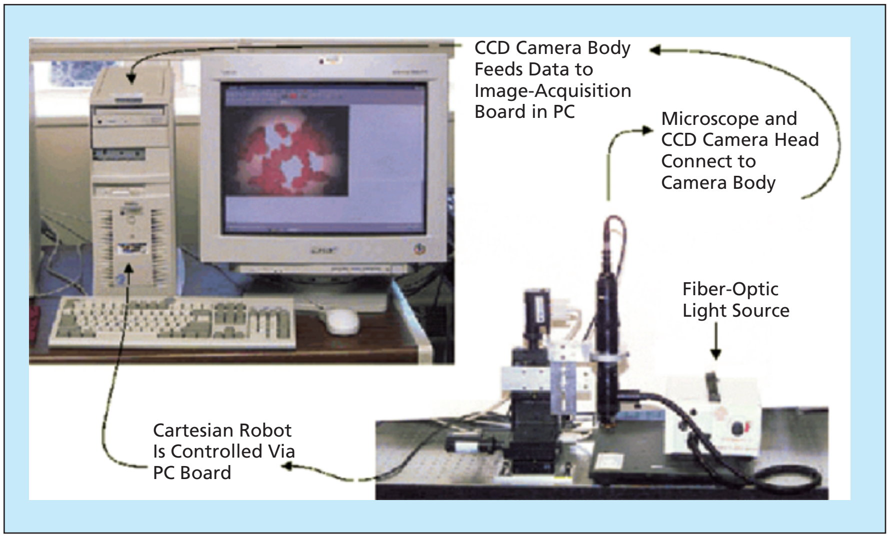
This system automates tasks that, heretofore, required the full attention of human technicians.

John H. Glenn Research Center, Cleveland, Ohio

The figure presents selected views of a compact microscope imaging system (CMIS) that includes a miniature video microscope, a Cartesian robot (a computer-controlled three-dimensional translation stage), and machine-vision and control subsystems. The CMIS was built from commercial off-the-shelf instrumentation, computer hardware and software, and custom machine-vision software. The machine-vision and control subsystems include adaptive neural networks that afford a measure of artificial intelligence.

The CMIS can perform several automated tasks with accuracy and repeatability — tasks that, heretofore, have required the full attention of human technicians using relatively bulky conventional microscopes. In addition, the automation and control capabilities of the system inherently include a capability for remote control. Unlike human technicians, the CMIS is not at risk of becoming fatigued or distracted: theoretically, it can perform continuously at the level of the best human technicians. In its capabilities for remote control and for relieving human technicians of tedious routine tasks, the CMIS is expected to be especially useful in biomedical research, materials science, inspection of parts on industrial production lines, and space science.

The CMIS can automatically focus on and scan a microscope sample, find areas of interest, record the resulting images, and analyze images from multiple samples simultaneously. Automatic focusing is an iterative process: The translation stage is used to move the microscope along its optical axis in a succession of coarse, medium, and fine steps. A fast Fourier transform (FFT) of the image is computed at each step, and the FFT is analyzed for its spatial-fre-



The **CMIS Takes Less Room** than does a conventional microscope. Unlike a conventional microscope, the CMIS offers capabilities for remote control and for automation of routine tasks.

quency content. The microscope position that results in the greatest dispersal of FFT content toward high spatial frequencies (indicating that the image shows the greatest amount of detail) is deemed to be the focal position.

In addition to automatic focusing, the machine-vision system is capable of performing the following other functions:

- *Adaptive Thresholding*: This function enables the choice of the best contrast needed for other image processing.
- *Auto-Imaging Scanning*: The microscope can scan along any or all of three Cartesian coordinate axes within a sample in order to find an object of interest.
- *Identification and Classification of Objects*: The system can find, classify, and label objects [e.g., living cells of one or more type(s) of interest] within a predetermined area of interest.
- *Motion Detection*: Movements of objects in a predetermined area of interest can be observed and quantified.
- *Transition Mapping*: In a sample containing small particles (e.g., colloids or living cells), small transitions between groups of particles can be detected. Examples of transitions include those between order and disorder, large and small objects, light and dark regions, and movement and non-movement. For example, in the case of a colloidal suspension containing a liquid and an adjacent solid phase, this function can be helpful in locating the zone of transition between the two phases.

This work was done by Mark McDowell of **Glenn Research Center**. *Further information is contained in a TSP (see page 1).*

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Commercial Technology Office, Attn: Steve Fedor, Mail Stop 4-8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-17484.

Chirped-Superlattice, Blocked-Intersubband QWIP

Collection efficiency and, hence, quantum efficiency are expected to increase.

NASA's Jet Propulsion Laboratory, Pasadena, California

An $Al_xGa_{1-x}As/GaAs$ quantum-well infrared photodetector (QWIP) of the blocked-intersubband-detector (BID) type, now undergoing development, features a chirped (that is, aperiodic) superlattice. The purpose of the chirped superlattice is to increase the quantum efficiency of the device.

A somewhat lengthy background discussion is necessary to give meaning to a brief description of the present developmental QWIP. A BID QWIP was described in "MQW Based Block Intersubband Detector for Low-Background Operation" (NPO-21073), *NASA Tech Briefs* Vol. 25, No. 7 (July 2001), page 46. To recapitulate: The BID design was conceived in response to the deleterious effects of operation of a QWIP at low temperature under low background radiation. These effects can be summarized as a buildup of space charge and an associated high impedance and diminution of responsivity with increasing modulation frequency.

The BID design, which reduces these deleterious effects, calls for a heavily doped multiple-quantum-well (MQW) emitter section with barriers that are thinner than in prior MQW devices. The thinning of the barriers results in a large overlap of sublevel wave functions, thereby creating a miniband. Because of sequential resonant quantum-mechanical tunneling of electrons from the negative ohmic contact to and between wells, any space charge is quickly neutralized. At the same time, what would otherwise be a large component of dark current attributable to tunneling current through the whole device is suppressed by placing a relatively thick, undoped, impurity-free $Al_xGa_{1-x}As$ blocking barrier layer between the MQW emitter section and the positive ohmic contact. [This layer is similar to the thick, undoped $Al_xGa_{1-x}As$ layers used in photodetectors of the blocked-impurity-band (BIB) type.]

Notwithstanding the aforementioned advantage afforded by the BID design, the responsivity of a BID QWIP is very low because of low collection efficiency, which, in turn, is a result of low electrostatic-potential drop across the superlattice emitter. Because the emitter must be electrically conductive to prevent the buildup of space charge in depleted quantum wells, most of the externally applied bias voltage drop occurs across the blocking-barrier layer. This completes the background discussion.

In the developmental QWIP, the periodic superlattice of the prior BID design is to be replaced with the chirped superlattice, which is expected to provide a built-in electric field. As a result, the efficiency of collection of photoexcited charge carriers (and, hence, the net quantum efficiency and thus responsivity) should increase significantly.

This work was done by Sarath Gunapala, David Ting, and Sumith Bandara of Caltech for **NASA's Jet Propulsion Laboratory**. *Further information is contained in a TSP (see page 1).*
NPO-30510