Using Thin-Film Thermometers as Heaters in Thermal Control Applications

NASA’s Jet Propulsion Laboratory, Pasadena, California

A cryogenic sensor maintains calibration at \( \approx 4.2 \) K to better than 2 mK (<0.5 percent resistance repeatability) after being heated to \( \approx 40 \) K with \( \approx 0.5 \) W power. The sensor withstands 4 W power dissipation when immersed in liquid nitrogen with verified resistance reproducibility of, at worst, 1 percent. The sensor maintains calibration to 0.1 percent after being heated with 1-W power at \( \approx 77 \) K for a period of 48 hours.

When operated with a readout scheme that is capable of mitigating the self-heating calibration errors, this and similar sensors can be used for precision (mK stability) temperature control without the need of separate heaters and associated wiring/cabling.

This work was done by Hyung J. Cho, Konstantin Penanen, Kalyani G. Sukhatme, and Warren A. Holmes of Caltech, and Scott Courts of Lake Shore Cryotronics for NASA’s Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-46882

Directional Spherical Cherenkov Detector

Incident particles could be sorted by direction, speed, and electric charge.

John H. Glenn Research Center, Cleveland, Ohio

A proposed radiation-detecting apparatus would provide information on the kinetic energies, directions, and electric charges of highly energetic incident subatomic particles. The apparatus was originally intended for use in measuring properties of cosmic rays in outer space, but could also be adapted to terrestrial uses — for example, radiation dosimetry aboard high-altitude aircraft and in proton radiation therapy for treatment of tumors.

The apparatus (see figure) would include a spherical Cherenkov detector surrounded by stacks of pairs of detectors. Each such pair and stack would be used in identifying incident particles and would respond to particles incident within a solid-angle range that, in conjunction with the number of such stacks, would define the angular resolution of the apparatus. The number of stacks and the number of pairs of detectors in each stack may be unlimited.

The detectors in each stack would typically have areas >1 cm\(^2\) and could be made, variously, from compensated silicon or from such wide-bandgap semiconductors as semi-insulating silicon carbide. Sheets of tungsten, lead, nickel, iron, and/or alloys thereof, serving as energy-moderating materials, could be inserted between detectors to enable discrimination of particles by energy. A scintillation counter could be used as a...
AlGaN Ultraviolet Detectors for Dual-Band UV Detection

This technology can be used in multicolor imaging for flame temperature sensing and counter-camouflage/biosensing applications.

Goddard Space Flight Center, Greenbelt, Maryland

This innovation comprises technology that has the ability to measure at least two ultraviolet (UV) bands using one detector without relying on any external optical filters. This allows users to build a miniature UVA and UVB monitor, as well as to develop compact, multicolor imaging technologies for flame temperature sensing, air-quality control, and terrestrial/counter-camouflage/biosensing applications.

The structure is designed for back illumination and contains six AlGaN layers with different doping, Al percentage, and two contacts — A and B. The cut-off wavelength of AlGaN can be tuned from 200 nm to 365 nm by changing the Al percentage. There are three band-edges in this structure that correspond to AlxGa1–xN, AlyGa1–yN, and AlzGa1–zN — x, y, and z should be designed to be x>y>z for back illumination.

When photons are injected from the backside, they will be absorbed at different layers depending on the wavelength of the photons. Electrically, the device is a back-to-back pin structure along the vertical direction. When B is biased positively, and A is connected to the ground, the bottom pin is forwardly biased and acts as a current variable resistor with resistance becoming negligible when the bias on B is high enough. While the bottom pin is forward biased, the top pin junction is reverse biased and acts as a detector. Because the depletion mainly happens in the n-AlxGa1–xN layer, only the photons absorbed in n-AlxGa1–xN will be converted into photon-current. When the bias is applied in an opposite manner, in which B is biased negatively and A is connected to the ground, the bottom pin is biased in reverse and acts as an active detector. The depletion region is mainly in n-AlxGa1–xN and the photons with wx<wp<wy can be converted into photocurrent. When wp<wz, all photons will be absorbed in the bottom n+AlxGa1–xN layer. Most of the photoelectrons will be recombined locally without generating photocurrent.

By charging the polarity of the bias, the detector can selectively detect two different wavebands: w<wp<wz, when positive bias is applied on A, and wx<wp<wy when negative bias is applied on A. The detector is blind to wp<wx (no photocurrent) and wp>wz (no absorption). Practically, wx, wy, and wz are tunable between 250 nm to 300 nm. The percentage of Al in the p+ layer in the center can be any number between y and z. As a result, the two detection bands do not have to be continuous.

This work was done by John D. Wrbanek, Gustave C. Fralick, and Susan Y. Wrbanek 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, Innovative Partnerships Office, Attn: Steve Fedor, Mail Stop 4–8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-18362-1.