Probe Station and Near-Field Scanner for Testing Antennas

Multiple antennas on the same substrate can be evaluated quickly and inexpensively.

John H. Glenn Research Center, Cleveland, Ohio

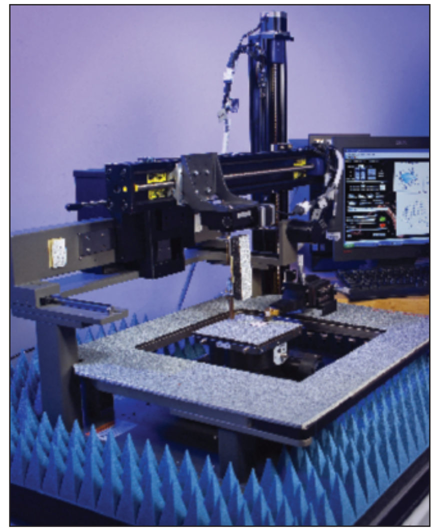
A facility that includes a probe station and a scanning open-ended waveguide probe for measuring near electromagnetic fields (see figure) has been added to Glen Research Center's suite of antenna-testing facilities, at a small fraction of the cost of the other facilities. This facility is designed specifically for nondestructive characterization of the radiation patterns of miniaturized microwave antennas fabricated on semiconductor and dielectric wafer substrates, including active antennas that are difficult to test in traditional antenna-testing ranges because of fragility, smallness, or severity of DC-bias or test-fixture requirements. By virtue of the simple fact that a greater fraction of radiated power can be captured in a near-field measurement than in a conventional far-field measurement, this near-field facility is convenient for testing miniaturized antennas with low gains.

This facility makes it possible to test a complete set or any subset of a multiplicity of antennas on the same substrate in one session. The multiple antennas can all be of the same design or different designs. Unlike in prior antenna-testing facilities, there is no need for wafer-level dicing or packaging to isolate individual antennas from a multiple-antenna substrate before testing, and no need for special text fixtures. Hence, alternative prototype antenna designs can be evaluated in rapid succession to converge on an optimum design in less time (and, hence, at less cost) than in prior antenna-testing facilities.

In this facility, radio-frequency (RF) signals and DC bias voltages and currents are supplied to an antenna under test (AUT) through RF and DC probes, respectively, that are parts of the probe station. The equipment in this facility includes a commercially available RF probe station, a coplanar-waveguide ground-signal-ground microwave probe that makes contact with the AUT, the aforementioned scanning open-ended waveguide probe, an automatic network analyzer (more specifically, a vector network analyzer)/microwave receiver, and a computer.

The mechanisms for scanning the open-ended waveguide probe are a three-axis slide mechanism and a rotation mechanism that, under computer control, positions this probe for acquisition of data at prescribed grid points on a plane very close to the AUT. This near-field scanning scheme enables capture of a maximum amount of energy radiated by one or multiple small antennas while they are DC-biased, without need for any special fixture.

The system is controlled by user-friendly operational, data-acquisition, and data-analysis software. The dimensions of the near-field scan area and the distance between grid points are specified by the user via the computer keyboard as inputs to a software-generated control panel. After each scan, the data-analysis software processes the measurement data and displays the far-field radiation pattern of the AUT, computed from the near-field measurements.



The Open-Ended Waveguide Probe Is Scanned in a plane slightly above the AUT and is operated in conjunction with an RF contact probe and the vector network analyzer to gather data on the near radiation field.

This work was done by Afroz Zaman, Richard Q. Lee, William G. Darby, Philip J. Barr, and Félix A. Miranda of **Glenn Research Center;** *and Kevin Lambert of Analex Corp. 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-17877-1.

Photodetector Arrays for Multicolor Visible/Infrared Imaging

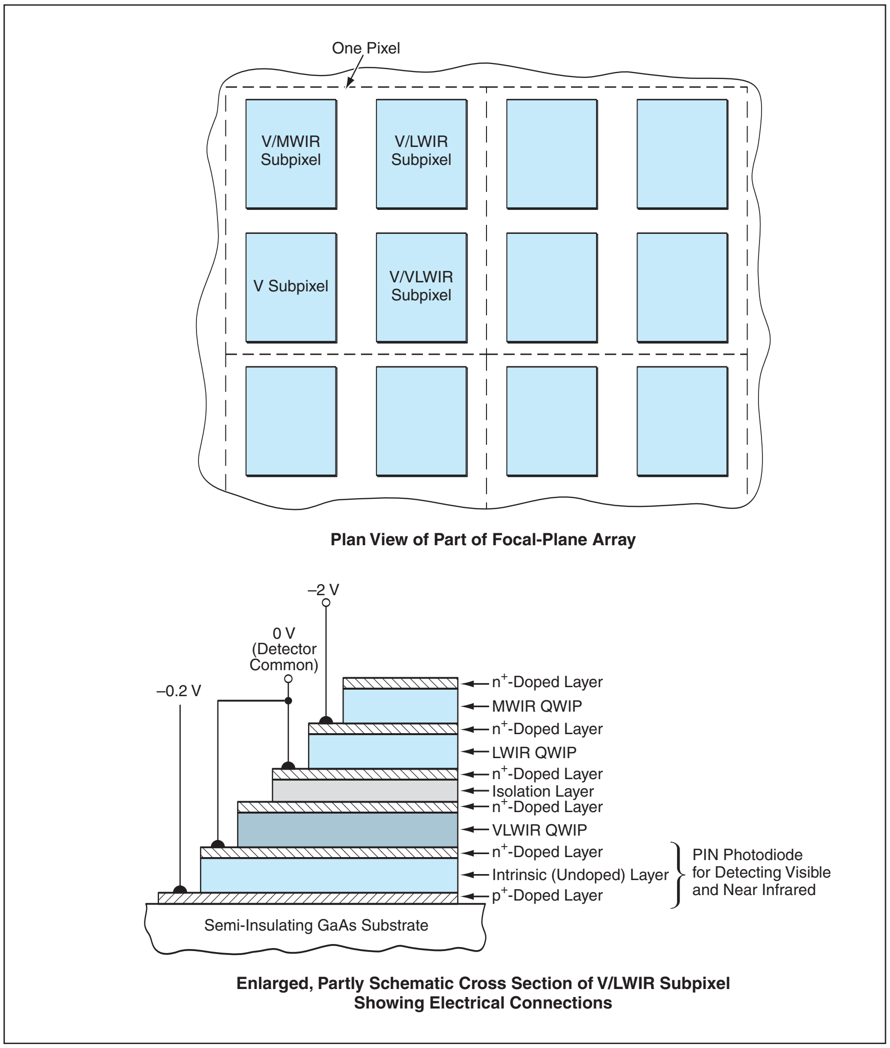
Separate optical trains would not be needed for different wavelength bands.

NASA's Jet Propulsion Laboratory, Pasadena, California

Monolithic focal-plane arrays of photodetectors capable of imaging the same scenes simultaneously in multiple wavelength bands in the visible and infrared spectral regions have been proposed. In prior visible/infrared imaging systems, it has been standard practice to use separate optical trains to form images in visible and infrared wavelength bands on separate visible- and infrared-photodetector arrays. Because the proposal would enable the detection of images in multiple wavelength bands on the same focal plane, the proposal would make it unnecessary to use multiple optical trains. Hence, multispectral imaging systems could be made more compact and the difficulties of aligning multiple optical trains would be eliminated.

Each pixel in an array according to the proposal would contain stacks of several photodetectors. The proposal is a logical extension of prior concepts of arrays of stacked photodetectors for imaging in two or three wavelength bands. For example, such an array was described in "Three-Color Focal-Plane Array of Infrared QWIPs" (NPO-20683), *NASA Tech Briefs*, Vol. 24, No. 5 (May 2000), page 26a.

In one proposed design, (see figure), each pixel would be divided into four



Each Pixel of a Four-Color Focal-Plane Array would be divided into four subpixels containing stacked photodetectors for four wavelength bands. The pixels would be identical except for the electrical connections for activating the detectors for different wavelength-band combinations.

subpixels, one being dedicated to a visible-and-near-infrared (V) band, one to a combination of the V band and a very-long-wavelength infrared (VLWIR) band, one to a combination of the V band and a long-wavelength infrared (LWIR) band, and one to a combination of the V band and a medium-wavelength infrared (MWIR) band. For this purpose, each subpixel would include a GaAs-based positive/intrinsic/negative (PIN) photodiode for detection in the V band stacked with three quantum-well infrared photodetectors (QWIPs), each optimized for one of the aforementioned infrared bands. The stacks of photodetectors in all the subpixels would be identical except for the electrical connections, which would be configured to activate the various wavelength-band combinations.

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

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to:

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Refer to NPO-30541, volume and number of this NASA Tech Briefs *issue, and the page number.*

Semiconductor Bolometers Give Background-Limited Performance

These devices can be fabricated inexpensively by use of established silicon-processing techniques.

Ames Research Center, Moffett Field, California

Semiconductor bolometers that are capable of detecting electromagnetic radiation over most or all of the infrared spectrum and that give background-limited performance at operating temperatures from 20 to 300 K have been invented. The term "background-limited performance" as applied to a bolometer, thermopile, or other infrared detector signifies that the ability to detect infrared signals that originate outside the detector is limited primarily by thermal noise attributable to the background radiation generated external to the bolometer. The signal-to-noise ratios and detectivities of the bolometers and thermopiles available prior to this invention have been lower than those needed for background-limited performance by factors of about 100 and 10, respectively.

Like other electrically resistive bolometers, a device according to the invention exhibits an increase in electrical resistance when heated by infrared radiation. Depending on whether the device is operated under the customary constant-current or constant-voltage bias, the increase in electrical resistance can be measured in terms of an increase in voltage across the device or a decrease in current through the device, respectively. In the case of a semiconductor bolometer, it is necessary to filter out visible and shorter-wavelength light that could induce photoconductivity and thereby counteract all or part of the desired infrared-induced increase in resistance.

The basic semiconductor material of a bolometer according to the invention is preferably silicon doped with one or more of a number of elements, each of which confers a different variable temperature coefficient of resistance. Suitable dopants include In, Ga, S, Se, Te, B, Al, As, P, and Sb. The concentration of dopant preferably lies in the range between 0.1 and 1,000 parts per billion.