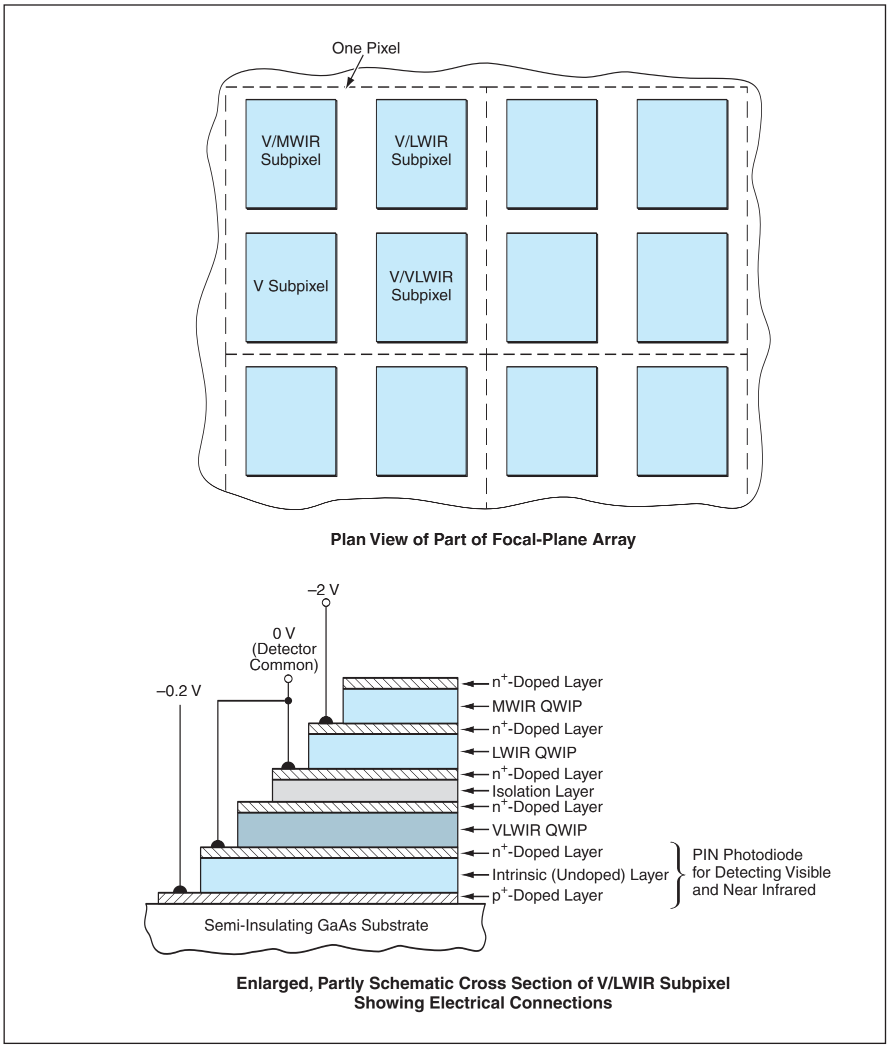

Each Pixel of a Four-Color Focal-Plane Array would be divided into four subpixels containing stacked photodetectors for four wavelength bands. The pixels would be identical except for the electrical connections for activating the detectors for different wavelength-band combinations.

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.

The dopant and its concentration are chosen to optimize the performance of the bolometer, taking account of the bolometer operating temperature, the temperature of the source of infrared radiation to be detected, and other relevant environmental factors.

An important practical advantage of the use of silicon, in contradistinction to other semiconductors, is that the art of fabrication of electronic devices from silicon is mature, enabling mass production at low cost per device. An additional advantage accrues when indium is used as the dopant: Indium can be incorporated into silicon over a wide range of concentrations with little consequent change in the basic structure of the silicon matrix. Hence, with impunity, the concentration of indium dopant can be set at almost any desired value in an effort to obtain the desired electrical impedance.

This work was done by John Goebel and Robert McMurray of **Ames Research Center**. *Further information is contained in a TSP (see page 1).*

This invention has been patented by NASA (U.S. Patent No. 6,838,669). Inquiries concerning rights for the commercial use of this invention should be addressed to the Ames Technology Partnerships Division at (650) 604-2954. Refer to ARC-14577.

Multichannel X-Band Dielectric-Resonator Oscillator

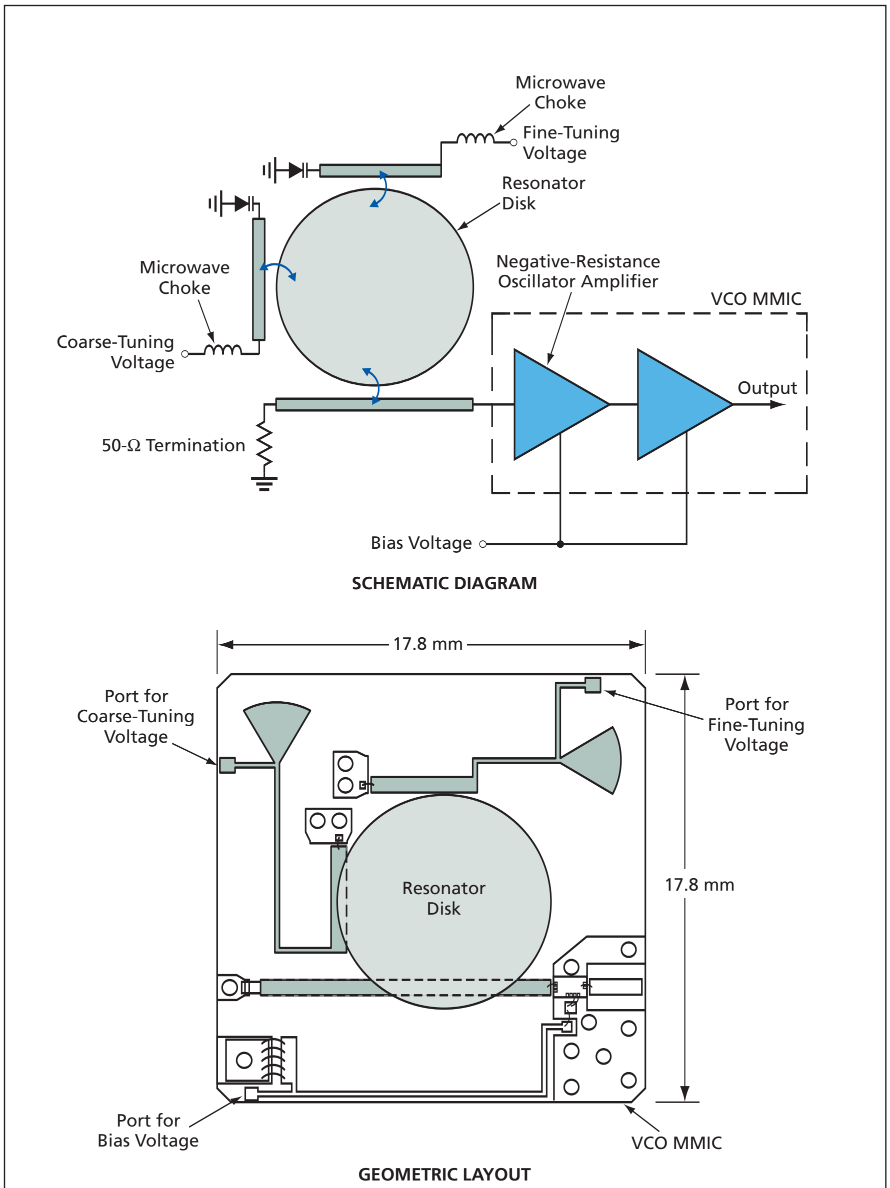
Unlike other DROs, this one is electrically tunable.

NASA's Jet Propulsion Laboratory, Pasadena, California

A multichannel dielectric-resonator oscillator (DRO), built as a prototype of a local oscillator for an X-band transmitter or receiver, is capable of being electrically tuned among and within 26 adjacent frequency channels, each 1.16 MHz wide, in a band ranging from ≈7,040 to ≈7,070 GHz. The tunability of this oscillator is what sets it apart from other DROs, making it possible to use mass-produced oscillator units of identical design in diverse X-band applications in which there are requirements to use different fixed frequencies or to switch among frequency channels.

The oscillator (see figure) includes a custom-designed voltage-controlled-oscillator (VCO) monolithic microwave integrated circuit (MMIC), a dielectric resonator disk ("puck"), and two varactor-coupling circuits, all laid out on a 25-mil (0.635-mm)-thick alumina substrate having a length and width of 17.8 mm. The resonator disk has a diameter of 8.89 mm and a thickness of 4.01 mm. The oscillator is mounted in an 8.9-mm-deep cavity in a metal housing.

The VCO MMIC incorporates a negative-resistance oscillator amplifier along with a buffer amplifier. The resonator disk is coupled to a microstrip transmission line connected to the negative-resistance port of the VCO MMIC. The two varactor-coupling circuits include microstrip lines, laid out orthogonally to each other, for coupling with the resonator disk. Each varactor microstrip line is DC-coupled to an external port via a microwave choke. One varactor is used for coarse tuning to select a channel; the other varactor is used (1) for fine tuning across the 1.16-MHz width of each channel and (2) as a feedback port for a phase-lock loop. The resonator disk is positioned to obtain (1) the most desir-



Microstrip Lines provide coupling among the resonator disk, the tuning varactors, and the VCO MMIC.