

the shapes of which would mimic the electron-beam density profile. Then by use of a transfer etching process that etches the substrate faster than it etches the resist, either the pattern of holes or a pattern comprising the narrow, lowest portions of the dimples would be imparted to the substrate. Having been

thus patterned, the substrate would be cleaned. The resulting holes or dimples in the substrate would serve as nucleation sites for the growth of quantum dots of controlled size in the following steps. The substrate would be cleaned, then placed in a molecular-beam-epitaxy (MBE) chamber, where native

oxide would be thermally desorbed and the quantum dots would be grown.

This work was done by Sarath Gunapala, Daniel Wilson, Cory Hill, John Liu, Sumith Bandara, and David Ting of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-41236

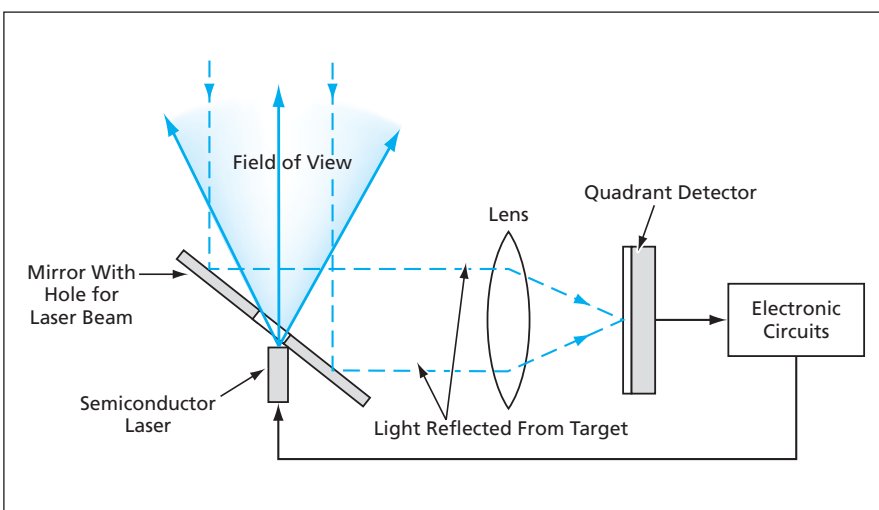
Laser Range and Bearing Finder With No Moving Parts

This instrument would locate a nearby target, without scanning.

Marshall Space Flight Center, Alabama

A proposed laser-based instrument would quickly measure the approximate distance and approximate direction to the closest target within its field of view. The instrument would not contain any moving parts and its mode of operation would not entail scanning over of its field of view. Typically, the instrument would be used to locate a target at a distance on the order of meters to kilometers. The instrument would be best suited for use in an uncluttered setting in which the target is the only or, at worst, the closest object in the vicinity; for example, it could be used aboard an aircraft to detect and track another aircraft flying nearby.

The proposed instrument would include a conventional time-of-flight or echo-phase-shift laser range finder, but unlike most other range finders, this one would not generate a narrow cylindrical laser beam; instead, it would generate a conical laser beam spanning the field of view (see figure). The instrument would also include a quadrant detector, optics to focus the light returning from the target onto the quadrant detector, and circuitry to synchronize the acquisition of the quadrant-detector output with the arrival of laser light returning from the



An Unusually Wide-Beam Laser Range Finder would be combined with a quadrant detector so that the distance and direction to a target could be measured simultaneously.

nearest target. A quadrant detector constantly gathers information from the entire field of view, without scanning; its output is a direct measure of the position of the target-return light spot on the focal plane and is thus a measure of the direction to the target.

The instrument should be able to operate at a repetition rate high enough to enable it to track a rapidly moving tar-

get. Of course, a target that is not sufficiently reflective could not be located by this instrument. Preferably, retroreflectors should be attached to the target to make it sufficiently reflective.

This work was done by Thomas C. Bryan, Richard T. Howard, and Michael L. Book of Marshall Space Flight Center. Further information is contained in a TSP (see page 1). MFS-31705

Microrectenna: A Terahertz Antenna and Rectifier on a Chip

Microscopic rectennas would supply DC power to microdevices.

NASA's Jet Propulsion Laboratory, Pasadena, California

A microrectenna that would operate at a frequency of 2.5 THz has been designed and partially fabricated. The circuit is intended to be a prototype of an extremely compact device that could be used to convert radio-beamed power to DC to drive microdevices (see Figure 1).

The microrectenna (see Figure 2) circuit consists of an antenna, a diode rectifier and a DC output port. The antenna consists of a twin slot array in a conducting ground plane (denoted the antenna ground plane) over an enclosed quarter-wavelength-thick resonant cavity (de-

noted the reflecting ground plane). The circuit also contains a planar high-frequency low-parasitic Schottky-barrier diode, a low-impedance microstrip transmission line, capacitors, and contact beam leads. The entire 3-D circuit is fabricated monolithically from a single



Figure 1. A Synthetic Image of the Microrectenna described in the text is here superimposed, to scale, on a real scanning electron micrograph of an insectlike microrobot. The underlying idea is to use the microrectenna to convert power from an incident 2.5-GHz radio beam to drive the robot and/or to charge its microbattery.

GaAs wafer. The resonant cavity renders the slot radiation pattern unidirectional with a half-power beam width of about 65° . A unique metal mesh on the rear of the wafer forms the backplate for the cavity but allows the GaAs to be wet etched from the rear surface of the twin slot antennas and ground plane. The beam leads protrude past the edge of the chip and are used both to mount the microrectenna and to make the DC electrical connection with external circuitry. The antenna ground plane and the components on top of it are formed on a $2\text{-}\mu\text{m}$ thick GaAs membrane that is grown in the initial wafer MBE (molecular beam epitaxy) process. The side walls of the antenna cavity are not metal coated and, hence, would cause some loss of power; however, the relatively high permittivity ($\epsilon=13$) of the GaAs keeps the cavity modes well confined, without the usual surface-wave losses associated with thick dielectric substrates.

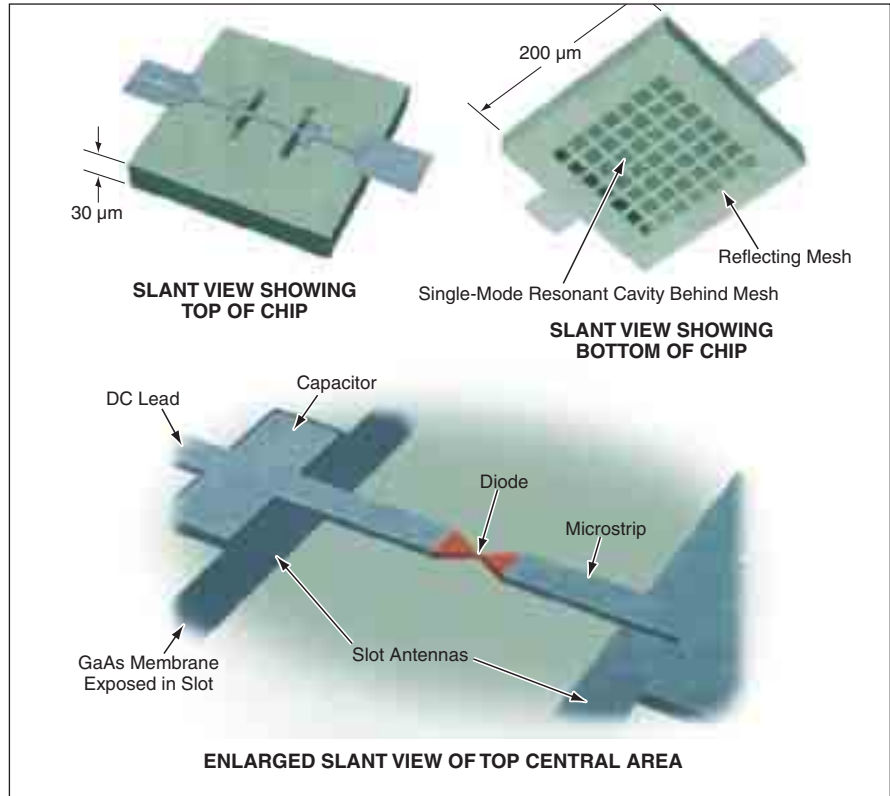


Figure 2. All RF and DC Components of the microrectenna would be fabricated together on a single GaAs chip.

The Schottky-barrier diode has the usual submicron dimensions associated with THz operation and is formed in a mesa process above the antenna ground plane. The diode is connected at the midpoint of a microstrip transmission line, which is formed on $1\text{-}\mu\text{m}$ -thick SiO (permittivity of 5) laid down on top of the GaAs membrane. The twin slots are fed in phase by this structure. To prevent radio-frequency (RF) leakage past the slot antennas, low-loss capacitors are integrated into the microstrip transmission line at the edges of the slots. The DC current-carrying lines extend from the outer

edges of the capacitors, widen approaching the edges of the chip, and continue past the edges of the chip to become the beam leads used in tacking down the devices. The structure provides a self-contained RF to DC converter that works in the THz range.

This work was done by Peter Siegel of Caltech for NASA's Jet Propulsion Laboratory.

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, NASA Management Office-JPL. Refer to NPO-30478.

Miniature L-Band Radar Transceiver

Numerous interdependent considerations are reflected in a compact, low-power, radiation-hard design.

NASA's Jet Propulsion Laboratory, Pasadena, California

A miniature L-band transceiver that operates at a carrier frequency of 1.25 GHz has been developed as part of a generic radar electronics module (REM) that would constitute one unit in an array of many identical units in a very-large-aperture phased-array antenna. NASA and the Department of Defense are considering the deploy-

ment of such antennas in outer space; the underlying principles of operation, and some of those of design, also are applicable on Earth. The large dimensions of the antennas make it advantageous to distribute radio-frequency electronic circuitry into elements of the arrays. The design of the REM is intended to implement the distribution.

The design also reflects a requirement to minimize the size and weight of the circuitry in order to minimize the weight of any such antenna. Other requirements include making the transceiver robust and radiation-hard and minimizing power demand.

Figure 1 depicts the functional blocks of the REM, including the L-band trans-