filament-based ionizer. In tests of various versions of this ionizer in the TOF-MS, electron currents up to 100 nA were registered. Currents of microamperes or more — great enough to satisfy requirements in most TOF-MS applications — could be obtained by use of MCPs different from those used in the tests, albeit at the cost of greater bulk. One drawback of this ionizer is that the gain of the MCP decreases as a function of the charge extracted thus far; the total charge that can be extracted over the operational lifetime is about 1 coulomb. An MCP in the ion-detector portion of the TOF-MS is subject to the same limitation.

This work was done by J. Albert Schultz of Ionwerks Inc. for **Kennedy Space Center**.

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 KSC-12607, volume and number of this NASA Tech Briefs *issue, and the page number.*

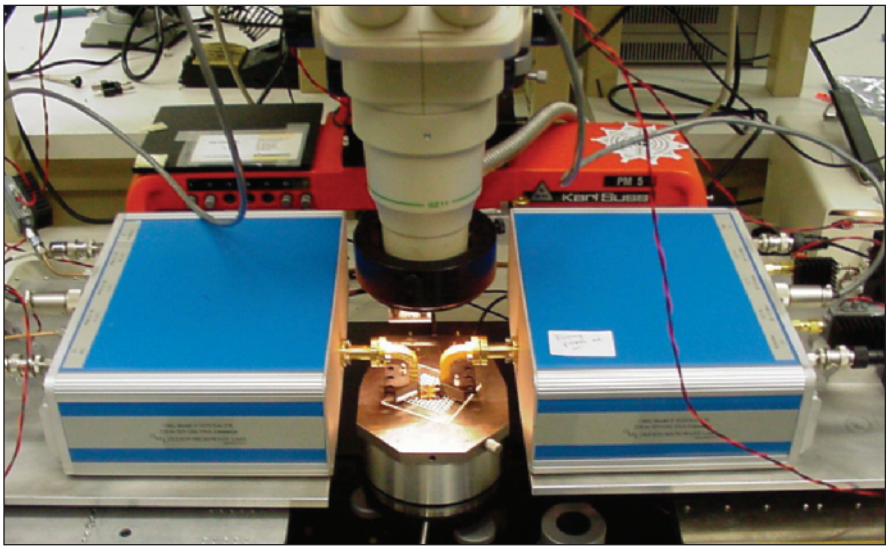
Equipment for On-Wafer Testing From 220 to 325 GHz

On-wafer vector network analysis of semiconductors is extended to higher frequencies.

NASA's Jet Propulsion Laboratory, Pasadena, California

A system of electronic instrumentation, constituting the equivalent of a two-port vector network analyzer, has been developed for use in on-wafer measurement of key electrical characteristics of semiconductor devices at frequencies from 220 to 325 GHz. A prior system designed according to similar principles was reported in "Equipment for On-Wafer Testing at Frequencies Up to 220 GHz" (NPO-20760), *NASA Tech Briefs*, Vol. 25, No. 11 (November 2001), page 42. As one would expect, a major source of difficulty in progressing to the present higher-frequency-range system was the need for greater mechanical precision as wavelengths shorten into the millimeter range, approaching the scale of mechanical tolerances of prior systems.

The system (see figure) includes both commercial off-the-shelf and custom equipment. As in the system of the cited prior article, the equipment includes test sets that are extended versions of commercial network analyzers that function in a lower frequency range. The extension to the higher frequency range is accomplished by use of custom frequency-extension modules that contain frequency multipliers and harmonic mixers. On-wafer measurement is made possible by waveguide wafer probes that were custom designed and built for this wavelength range, plus an on-wafer calibration substrate designed for use with these probes. In this case, the calibration substrate was specially fabricated by laser milling. The system was used to make the first on-wafer measurements of a semiconductor device in the frequency range from 220 to 320 GHz. Some of the measurement results showed that the device had gain.



A **Probe Station and Test Sets** assembled from commercial-off-the-shelf and custom components enable on-wafer measurement of electrical characteristics of devices in the previously inaccessible frequency range of 220 to 325 GHz.

This work was done by Lorene Samoska, Alejandro Peralta, Douglas Dawson, and Karen Lee of Caltech; Greg Boll of GGB Industries; and Chuck Oleson of Oleson Microwave Labs for **NASA's Jet Propulsion Laboratory**. *Further information is contained in a TSP (see page 1).*

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