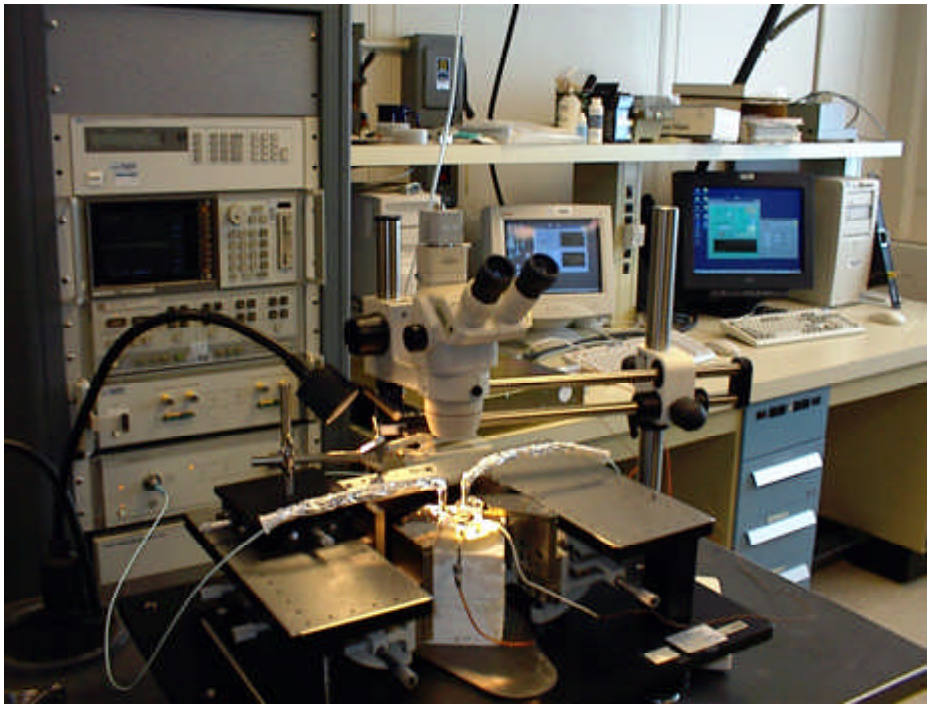
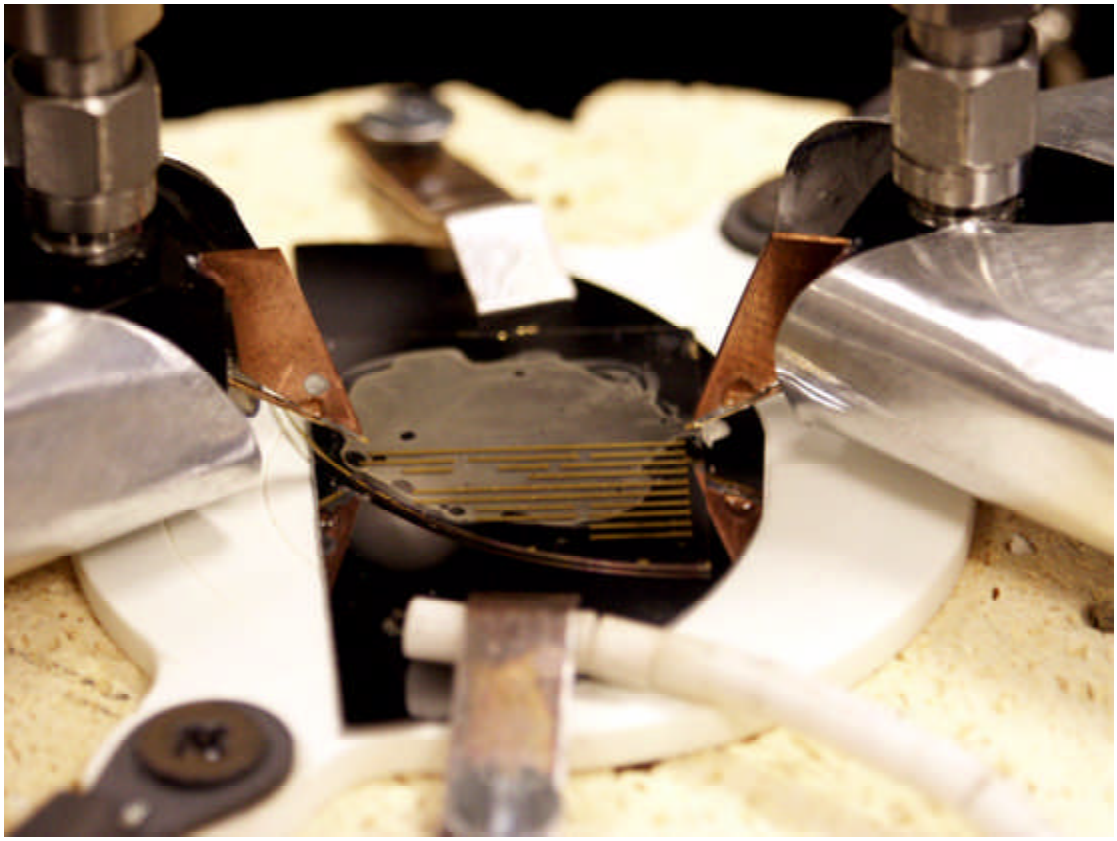
High-Temperature Probe Station Developed to Characterize Microwave Devices Through 500 °C



Photograph of high-temperature probe station and instrumentation.
A photograph and a block diagram of the high-temperature probe station are shown. The system consists of the ceramic heater mounted on a NASA shuttle tile insulator, a direct-current power supply, a personal-computer-based data acquisition and temperature controller, microwave probes, a microscope, and a network analyzer.

The ability to perform microwave tests at high temperatures is becoming necessary. There is now a need for sensors and communication circuits that can operate at 500 °C and above for aircraft engine development and monitoring during flight. To address this need, researchers have fabricated devices using wide bandgap semiconductors such as SiC with targeted operating temperatures of 500 to 600 °C. However, the microwave properties of these devices often change drastically with temperature, so any designs that are intended to be used in such an environment must be characterized at high temperatures. For some reliability, lifetime, and direct-current testing, the device under test can be packaged and characterized in an oven. However, for RF and microwave measurements, it is usually not possible to establish a calibrated reference plane at the device terminals within a package. In addition, the characteristics of the package would vary over a 500 °C temperature range, and this would have to be accounted for when the data were analyzed. A high-temperature probe station allows circuits and devices to be characterized through on-wafer measurements across a broad temperature range with known reference plane.

The conventional, commercially available thermal wafer-probe stations that are used to evaluate microwave devices across a controlled temperature range have a typical upper limit of 200 °C. Standalone thermal heating chucks are available with an extended upper temperature range of 300 to 400 °C. To effectively characterize devices at temperatures up to and surpassing 500 °C, Glenn researchers developed a custom probe station. In the past, custom probe stations have been developed to test devices under other extreme environments, such as cryogenic temperatures as low as 37 K. Similarly, this custom probe station was specifically modified for high-temperature use. It allows devices to be measured quickly and flexibly, without the use of wire bonds and test fixtures.



Microwave probes and test circuit on heater.

The probe station is shown making scattering parameter measurements from 1 to 50 GHz with a Hewlett-Packard 8510C Network Analyzer. There is a half-wafer of silicon directly on top of the heater to provide a uniform heated platform for our sample. A quarter wafer of silicon carbide forms the substrate for our test circuit of several transmission lines.

Glenn contact: Alan N. Downey, 216-433-3508, Alan.N.Downey@nasa.gov
Authors: Alan N. Downey and Zachary D. Schwartz
Headquarters program office: OAT
Programs/Projects: UEET, Intelligent Propulsion Controls