

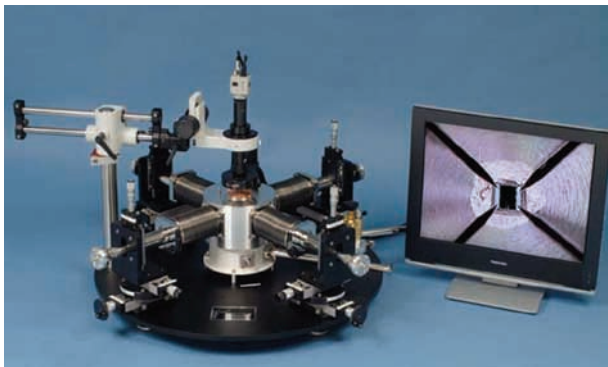
Thermal and Transport Measurements

Facilities

MSEL researchers have established a custom, state-of-the-art Thermal and Transport Measurements (TTM) Facility designed to determine the thermal and electrical properties of thin films and nanomaterials for electronic and thermal applications. The facility is integrated with the MSEL Nanocalorimetry Measurements Facility, permitting determination of thermal and thermodynamic properties of materials, as well as calibration of nanocalorimeter chips fabricated at NIST or obtained from commercial sources.

The facility includes a high vacuum probe station capable of making electrical measurements on materials and nanocalorimeter chips from 10 K (with liquid helium as a cryogen) to 650 K (with a heated stage); the use of an on-chip heater in the nanocalorimeter chips extends the measurement range to over 1000 K. Measurements can be performed in various atmospheres ranging from high vacuum to controlled gas pressure. The temperature is feedback controlled at either a fixed temperature, or follows a programmed temperature ramp.

The high vacuum probe station can be electrically operated between DC mode and 1 GHz AC. The system is turbo-pumped with an oil free backing pump to protect samples from contamination while still enabling cryogenic measurements. Samples up to 50 mm in size can be measured with combinations of cooled conventional probes, Kelvin triax probes, and a fiber optic emissivity corrected pyrometer. Vibration is minimized by placing the system on an air table, optimizing the cryostat design and isolating the pumping lines. A high-resolution imaging system provides megapixel digital still micrographs and 1080 video with 3 μm resolution during experimental measurements. The system is designed for rapid sample changes so multiple samples can be tested in a single day without extended cool down or pump down delays.



High Vacuum Probe Station, photo courtesy of Janis Research Corporation, Inc

Significance

Accurate and precise measurements of thermal and electrical properties of novel materials are essential to the successful implementation of such materials in myriad applications. The MSEL TTM facility enables measurements of key thermal, thermodynamic, electrical, and transport properties of various materials over a wide range of temperatures and environments. The facility is also critical to the development of nanocalorimetry measurement methods and standards: microelectromechanical systems (MEMS) chip design optimization, calibration, and testing are performed in the facility. Finally, the facility is used to measure the thermal and thermodynamic properties of thin films and nanomaterials using MEMS-based test structures.

Feng Yi
Parasuraman Swaminathan

David LaVan (Ceramics Division)
(301) 975-6121
david.lavan@nist.gov

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