This innovation provides a calibration system where the imaging properties in calibration can be made comparable to the test configuration. Thus, if the test is designed to have good imaging properties, then middle and high spatial frequency errors in the test system can be well calibrated. The improved imaging properties are provided by a rudimentary auxiliary optic as part of the calibration system. The auxiliary optic is simple to characterize and align to the CGH. Use of the auxiliary optic also reduces the size of the CGH required for calibration and the density of the lines required for the CGH. The resulting CGH is less expensive than the existing technology and has reduced write error and alignment error sensitivities.

This CGH system is suitable for any kind of calibration using an interferometer when high spatial resolution is required. It is especially well suited for tests that include segmented optical components or large apertures.

This work was done by Gene Olczak of ITT Geospatial Systems for Goddard Space Flight Center. For further information, contact the Goddard Innovative Partnerships Office at (301) 286-5810. GSC-15676-1

Non-Contact Thermal Properties Measurement With Low-Power Laser and IR Camera System

Photons both excite and are used to measure the thermal response of any surface material.

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As shown by the Phoenix Mars Lander's Thermal and Electrical Conductivity Probe (TECP), contact measurements of thermal conductivity and diffusivity (using a modified flux-plate or line-source heat-pulse method) are constrained by a number of factors. Robotic resources must be used to place the probe, making them unavailable for other operations for the duration of the measurement. The range of placement is also limited by mobility, particularly in the case of a lander. Placement is also subject to irregularities in contact quality, resulting in non-repeatable heat transfer to the material under test. Most important from a scientific perspective, the varieties of materials which can be measured are limited to unconsolidated or weakly-cohesive regolith materials, rocks, and ices being too hard for nominal insertion strengths.

Accurately measuring thermal properties in the laboratory requires significant experimental finesse, involving sample preparation, controlled and repeatable procedures, and, practically, instrumentation much more voluminous than the sample being tested (heater plates, insulation, temperature sensors). Remote measurements (infrared images from orbiting spacecraft) can reveal composite properties like thermal inertia, but suffer both from a large footprint (low spatial resolution) and convolution of the thermal properties of a potentially layered medium. *In situ* measurement techniques (the Phoenix TECP is the only robotic measurement of thermal properties to date) suffer from problems of placement range, placement quality, occupation of robotic resources, and the ability to only measure materials of low mechanical strength.

A spacecraft needs the ability to perform a non-contact thermal properties measurement *in situ*. Essential components include low power consumption, leveraging of existing or highly-developed flight technologies, and mechanical simplicity.

This new *in situ* method, by virtue of its being non-contact, bypasses all of these problems. The use of photons to both excite and measure the thermal response of any surface material to a high resolution (estimated footprint ≈ 10 cm^2) is a generational leap in physical properties measurements.

The proposed method consists of spot-heating the surface of a material with a low (<1 W) power laser. This produces a moderate (5-10 K) temperature increase in the material. As the heat propagates in a hemisphere from the point of heating, it raises the temperature of the surrounding surface. The temperature of the heating spot itself, and that of the surrounding material, is monitored remotely with an infrared camera system. Monitoring is done during both the heating and cooling (after the laser is turned off) phases. Temperature evolution as a function of distance from the heating point contains information about the material's thermal properties, and can be extracted through curve-fitting to analytical models of heat transport.

In situ measurement of thermal properties of planetary surface materials provides ground-truth for remote sensing observations and high-resolution, site-specific data for any landed spacecraft environment. Thermal properties are necessary parameters for modeling and understanding thermal evolution of the surface and subsurface, climate state and history, and predicting the presence of subsurface water/ice. The applications extend to all solid bodies in the solar system, but with greatest applicability to bodies with thin or tenuous atmospheres where conduction and radiation are the dominant heat-transport properties.

This work was done by Troy L. Hudson and Michael H. Hecht of Caltech for NASA's Jet Propulsion Laboratory. **F***urther information is contained in a TSP (see page 1)***.** *NPO-47390*