



(A) Manipulation of a **Solid Sample On-Chip**, and (B) mixing of fluid and solid sample on-chip. Each photograph is approximately 4x1 cm in size.

extract organic material. Subsequent chemical analysis is performed using portable microchip capillary electrophoresis systems (CE). These instruments have been used for ultra-highly sensitive (parts-per-trillion, ppt) analysis of organic compounds including amines, amino acids, aldehydes, ketones, carboxylic acids, and thiols. Fully autonomous amino acid analyses in liquids were demonstrated; however, to date there have been no reports of completely automated analysis of solid samples on chip.

This approach utilizes an existing portable instrument that houses optics, high-voltage power supplies, and sole-

noids for fully autonomous microfluidic sample processing and CE analysis with laser-induced fluorescence (LIF) detection. Furthermore, the entire system can be sterilized and placed in a cleanroom environment for analyzing samples returned from extraterrestrial targets, if desired.

This is an entirely new capability never demonstrated before. The ability to manipulate solid samples, coupled with lab-on-a-chip analysis technology, will enable ultraclean and ultrasensitive end-to-end analysis of samples that is orders of magnitude more sensitive than the ppb goal given in the Science Instruments, Obser-

vatories, and Sensor Systems Roadmap. This technology has potential applications for highly sensitive analyses of organic compounds elsewhere in the solar system, including Mars, Europa, Titan, and small bodies. It will also enable contamination-free analysis of returned samples. Finally, this could also be employed for a wide range of terrestrial applications including environmental, biomedical, or forensic analyses.

This work was done by Maria F. Mora, Amanda M. Stockton, and Peter A. Willis of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-48603

Measuring and Estimating Normalized Contrast in Infrared Flash Thermography

Combining temperature contrast analysis with pixel intensity contrast analysis yields better results in characterizing void-like anomalies.

Lyndon B. Johnson Space Center, Houston, Texas

Infrared flash thermography (IRFT) is used to detect void-like flaws in a test object. The IRFT technique involves heating up the part surface using a flash of flash lamps. The post-flash evolution of the part surface temperature is sensed by an IR camera in terms of pixel intensity of image pixels. The IR technique involves recording of the IR video image data and analysis of the data using the normalized pixel intensity and temperature contrast analysis method for characterization of void-like flaws for depth and width.

This work introduces a new definition of the normalized IR pixel intensity con-

trast and normalized surface temperature contrast. A procedure is provided to compute the pixel intensity contrast from the camera pixel intensity evolution data. The pixel intensity contrast and the corresponding surface temperature contrast differ but are related. This work provides a method to estimate the temperature evolution and the normalized temperature contrast from the measured pixel intensity evolution data and some additional measurements during data acquisition.

Thermal simulation software, such as Thermo-Calc, provides simulation of surface temperature evolution on void-

like flaws. A comparison of the experimentally estimated temperature contrast and simulation estimated temperature contrast is required to validate the simulation model and its input parameters. Conversely, if the simulation temperature contrast data is available, then a method provided here can be used to estimate the pixel intensity and the pixel intensity contrast based on known values of parameters of the data acquisition setup.

The normalized pixel intensity contrast and the normalized temperature contrast differ for objects with emissivity other than 1. Therefore, for better con-

trast analysis the two quantities should not be treated as the same. To compare the simulation temperature contrast with the measured pixel contrast, it is necessary to estimate the reflection temperature evolution. It is also necessary to estimate the incident heat flux. Ideally, the simulation should model the compound heat source flux evolution, which also includes the post-flash thermal afterglow. The effect of reflection temperature in the pixel intensity also should be accounted for to seek a better estimation of the temperature contrast evolution from the pixel intensity evolution data.

Using formulas given here, the reflection temperature evolution and the

temperature contrast evolution can be estimated from the IRFT data. An emissivity factor, defined here, relates the temperature contrast to the pixel intensity contrast.

Reflection temperature evolution can be used to model the afterglow flux of the flash source in the simulation to estimate the temperature contrast evolutions and the pixel intensity contrast evolution on simulated voids.

An emissivity estimation technique was developed using the IR camera. If the IR camera is programmed with the reflection temperature formulas derived here, the camera can provide the object surface temperature directly even during the IRFT data acquisition. The IR

camera can be programmed to estimate the object emissivity in real time using the technique provided here. Due to improvement in the contrast analysis, including the modeling of source in thermal simulation, void-like anomalies are characterized more precisely.

This work was done by Ajay M. Koshti of Johnson Space Center. Further information is contained in a TSP (see page 1).

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, Johnson Space Center, (281) 483-1003. Refer to MSC-24506-1.

Spectrally and Radiometrically Stable, Wideband, Onboard Calibration Source

NASA's Jet Propulsion Laboratory, Pasadena, California

The Onboard Calibration (OBC) source incorporates a medical/scientific-grade halogen source with a precisely designed fiber coupling system, and a fiber-based intensity-monitoring feedback loop that results in radiometric and spectral stabilities to within <0.3 percent over a 15-hour period. The airborne imaging spectrometer systems de-

veloped at the Jet Propulsion Laboratory incorporate OBC sources to provide auxiliary in-use system calibration data. The use of the OBC source will provide a significant increase in the quantitative accuracy, reliability, and resulting utility of the spectral data collected from current and future imaging spectrometer instruments.

This work was done by James B. Coles, Brandon S. Richardson, Michael L. Eastwood, Charles M. Sarture, Gregory R. Quetin, Michael D. Porter, Robert O. Green, Scott H. Nolte, Marco A. Hernandez, and Linley A. Kroll of Caltech for NASA's Jet Propulsion Laboratory. For more information, contact iaoffice@jpl.nasa.gov. NPO-47697