Physical Sciences

Cryogenic Caging for Science Instrumentation

NASA's Jet Propulsion Laboratory, Pasadena, California

A method has been developed for caging science instrumentation to protect from pyro-shock and EDL (entry, descent, and landing) acceleration damage. Caging can be achieved by immersing the instrument (or its critical parts) in a liquid and solidifying the liquid by cooling. After the launch shock and/or after the payload has landed, the solid is heated up and evaporated.

In the example of a sensitive *x–y* seismometer, the volume is filled with CO_2 (at an elevated pressure), or other compatible liquid. Then the liquid is frozen and maintained at a temperature below –80 °C for the duration of the flight. The solid is then allowed to sublime through a valved port. Other uses include caging of drag-free elements of LISA (laser interferometer space antenna) spacecraft and their progeny, caging instrumentation and avionics for penetrator missions, and caging of electronics to survive launch shock.

This work was done by Konstantin Penanen and Talso C. Chui of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-46930

Wide-Range Neutron Detector for Space Nuclear Applications

John H. Glenn Research Center, Cleveland, Ohio

A digital, wide-range, neutron detection (WRND) system in a compact, VME form factor monitors neutron activity within the core of a nuclear reactor across the reactor's entire operating range, from 1.0 $n/cm^2/s$ up to 10^{10} $n/cm^2/s$. This allows for a reduction in the complexity of space-based nuclear instrumentation systems, as a single instrument can be used instead of requiring different instrumentation for each of the operation ranges of the reactor (start-up, ramp-up, and nominal power).

This instrument consists of one or more fission chamber detectors, an integrated electronics module, and interconnected cabling, all of which are adapted for the space environment from proven, terrestrial-based technology. WRND delivers logarithmic output signals to a host system, proportional to neutron flux and rate across the entire operating range of the reactor. The electronics module hardware and firmware are the basis of the innovation.

WRND is broadly compatible with many potential future applications (nuclear power, nuclear propulsion, etc.). Nothing in the initial design assumes a particular type of reactor, or whether it will be vehicle- or land-based. This innovation's ability to function over a wide range of neutron fluxes ensures its development is not necessarily linked with any particular reactor type, and in no way limits future nuclear power implementation options, while still providing NASA with the needed functionality.

This work was done by John F. Merk of Aurora Flight Sciences and Alberto Busto of Black River Technology for Glenn Research Center.

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Innovative Partnerships Office, Attn: Steve Fedor, Mail Stop 4–8, 21000 Brookpark Road, Cleveland, Ohio 44135. LEW-18469-1

In Situ Guided Wave Structural Health Monitoring System

John H. Glenn Research Center, Cleveland, Ohio

Aircraft engine rotating equipment operates at high temperatures and stresses. Noninvasive inspection of microcracks in those components poses a challenge for nondestructive evaluation. A low-cost, low-profile, high-temperature ultrasonic guided wave sensor was developed that detects cracks *in situ*. The transducer design provides nondestructive evaluation of structures and materials.

A key feature of the sensor is that it withstands high temperatures and excites strong surface wave energy to inspect surface and subsurface cracks. The sol-gel bismuth titanate-based surface acoustic wave (SAW) sensor can generate efficient SAWs for crack inspection. The sensor is very thin (submillimeter) and can generate surface waves up to 540 °C. Finite element analysis of the SAW transducer design was performed to predict the sensor behavior, and experimental studies confirmed the results.

The sensor can be implemented on structures of various shapes. With a spray-coating process, the sensor can be applied to the surface of large curvatures. It has minimal effect on airflow or rotating equipment imbalance, and provides good sensitivity.

This work was done by George Zhao of Intelligent Automation, Inc. and Bernhard R. Tittmann of The Pennsylvania State University for Glenn Research Center.

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Innovative Partnerships Office, Attn: Steve Fedor, Mail Stop 4–8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-18447-1.