Technology Focus: Sensors

Laser Truss Sensor for Segmented Telescope Phasing

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A paper describes the laser truss sensor (LTS) for detecting piston motion between two adjacent telescope segment edges. LTS is formed by two point-to-point laser metrology gauges in a crossed geometry.

A high-resolution (<30 nm) LTS can be implemented with existing laser metrology gauges. The distance change between the reference plane and the target plane is measured as a function of the phase change between the reference and target beams. To ease the bandwidth requirements for phase detection electronics (or phase meter), homodyne or heterodyne detection techniques have been used.

The phase of the target beam also changes with the refractive index of air, which changes with the air pressure, temperature, and humidity. This error can be minimized by enclosing the metrology beams in baffles. For longer-term (weeks) tracking at the micron level accuracy, the same gauge can be operated in the absolute metrology mode with an accuracy of microns; to implement absolute metrology, two laser frequencies will be used on the same gauge. Absolute metrology using heterodyne laser gauges is a demonstrated technology. Complexity of laser source fiber distribution can be optimized using the range-gated metrology (RGM) approach.

This work was done by Duncan T. Liu, Oliver P. Lay, Alireza Azizi, Hernan Erlig, Leonard I. Dorsky, Cheryl G. Asbury, and Feng Zhao of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-47753

Qualifications of Bonding Process of Temperature Sensors to Deep-Space Missions

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A process has been examined for bonding a platinum resistance thermometer (PRT) onto potential aerospace materials such as flat aluminum surfaces and a flexible copper tube to simulate coaxial cables for flight applications. Primarily, PRTs were inserted into a silver-plated copper braid to avoid stresses on the sensor while the sensor was attached with the braid to the base material for long-duration, deep-space missions.

A1-1145/graphite composite (planar substrate) and copper tube have been used in this study to assess the reliability of PRT bonding materials. A flexible copper tube was chosen to simulate the coaxial cable to attach PRTs. The substrate materials were cleaned with acetone wipes to remove oils and contaminants. Later, the surface was also cleaned with ethyl alcohol and was air-dried. The materials were gently abraded and then were cleaned again the same way as previously mentioned.

Initially, shielded (silver plated copper braid) PRT (type X) test articles were fabricated and cleaned. The base antenna material was pretreated and shielded, and CV-2566 NuSil silicone was used to attach the shielded PRT to the base material. The test articles were cured at room temperature and humidity for seven days. The resistance of the PRTs was continuously monitored during the thermal cycling, and the test articles were inspected prior to, at various intermediate steps during, and at the end of the thermal cycling as well. All of the PRTs survived three times the expected mission life for the JUNO project. No adhesion problems were observed in the PRT sensor area, or under the shielded PRT. Furthermore, the PRT resistance accurately tracked the thermal cycling of the chamber.

This work was done by Rajeshuni Ramesham, Amarit Kitiyakara, Richard W. Redick III, and Eric T. Sunada of Caltech for NASA's Jet Propulsion Laboratory. For more information, contact iaoffice@jpl.nasa.gov. NPO-47682

Optical Sensors for Monitoring Gamma and Neutron Radiation

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For safety and efficiency, nuclear reactors must be carefully monitored to provide feedback that enables the fission rate to be held at a constant target level via adjustments in the position of neutron-absorbing rods and moderating coolant flow rates. For automated reactor control, the monitoring system should provide calibrated analog or digital output. The sensors must survive and produce reliable output with minimal drift for at least one to two years, for replacement only during refueling. Small sensor size is preferred to enable more sensors to be placed in the core for more detailed characterization of the local fission rate and fuel consumption, since local deviations from the norm tend to amplify themselves. Currently, reactors are monitored by local power range meters (LPRMs) based on the neutron flux or gamma thermometers based on the gamma flux. LPRMs tend to be bulky, while gamma ther-