Titanium Alloy Strong Back for IXO Mirror Segments

Potential applications include glancing-incidence mirrors and optics.

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A titanium-alloy mirror-holding fixture called a strong back allows the temporary and permanent bonding of a 50° D263 glass x-ray mirror (IXO here stands for International X-ray Observatory). The strong back is used to hold and position a mirror segment so that mounting tabs may be bonded to the mirror with ultra-low distortion of the optical surface. Ti-15%Mo alloy was the material of choice for the strong back and tabs because the coefficient of thermal expansion closely matches that of the D263 glass and the material is relatively easy to machine.

This invention has the ability to transfer bonded mounting points from a temporary location on the strong back to a permanent location on the strong back with minimal distortion. Secondly, it converts a single mirror segment into a rigid body with an acceptable amount of distortion of the mirror, and then maneuvers that rigid body into optical alignment such that the mirror segment can be bonded into a housing simulator or mirror module. Key problems are that the mirrors are 0.4-mm thick and have a very low coefficient of thermal expansion (CTE). Because the mirrors are so thin, they are very flexible and are easily distorted. When permanently bonding the mirror, the goal is to achieve a less than 1-micron distortion. Temperature deviations in the lab, which have been measured to be around 1 °C, have caused significant distortions in the mirror segment.

The Ti-15%Mo is with a CTE of 7.2 microinches/in./°C (7.2 mm/m/°C). It is 200 mm in height, 15 mm thick, has an azimuthal span of 51.5° and an internal radius of 242.50 mm. Mounting of the x-ray mirror consists of suspending the mirror segment in mid-air using two parallel strings and positioning a strong back to a location behind the mirror such that the mirror can be aligned and temporarily bonded to the strong back. Once this is accomplished, the surface map of the mirror is re-measured. Tabs, which are used to support the mirror at the edges, are then located precisely to the edge of the mirror and then fastened to the edge of the strong back with fasteners. Epoxy is then injected through portals in the mirror tabs and allowed to cure. Once curing of the epoxy is complete, the temporary bonds at the back of the mirror are disconnected. The mirror surface is then re-measured with an interferometer and the results are compared to prior measurements.

Novel features include the near match between the D263 glass and the Ti-15%Mo. The mirror tabs allow epoxy to be injected in front of the mirror or behind the mirror. The strong back acts not only as a mirror segment transfer mechanism but also as the medium to mount the mirror into a permanent housing.

This work was done by Glenn P. Byron and Chan Kai-Wing of Goddard Space Flight Center. Further information is contained in a TSP (see page 1). **GSC-15850-1**

Improved Ambient Pressure Pyroelectric Ion Source

This instrument enables ultra-sensitive detection of chemical and biological warfare agents.

NASA's Jet Propulsion Laboratory, Pasadena, California

The detection of volatile vapors of unknown species in a complex field environment is required in many different applications. Mass spectroscopic techniques require subsystems including an ionization unit and sample transport mechanism. All of these subsystems must have low mass, small volume, low power, and be rugged. A volatile molecular detector, an ambient pressure pyroelectric ion source (APPIS) that met these requirements, was recently reported by Caltech researchers to be used in *in situ* environments.

APPIS creates ions through temperature changes of the crystal. A change in temperature of the pyroelectric crystal creates a potential difference between the +z and –z surface. With a sufficient voltage buildup, electrical discharge occurs at the surface of the crystal and either positive or negative ions are produced depending on the crystal face. This discharge ionizes compounds on and near the surface of the crystal. If thermal cycling is applied to the pyroelectric crystal (i.e., heated and cooled repeatedly), one can obtain negative and positive ions through a thermal cycle. This process, however, creates ions at random times throughout operations and makes the source difficult to use with several detection techniques.

The improved APPIS system employs an active cooling system equipped with a feedback capability using a Peltier module to achieve better temperature control, and a heat rejection system to force-cool the crystal in order to increase the ionization efficiency of the pyroelectric crystal, on which the original APPIS source is based. In addition, the APPIS crystal housing system was completely redesigned to take advantage of the full ionization capability of the crystal source. The temperature is monitored using a thermocouple, and a custom LabVIEW program is used to control the temperature gradient of the crystal.

A Peltier module utilizes the thermoelectric-Seebeck effect to create a temperature difference between the front and back sides of the module. If the temperature of one side of the Peltier module is heated, the other side can be cooled, depending on the polarity of the applied voltage. The system is able to provide a thermal cycling improvement compared to a conventional system by a factor of three, and can produce more uniform cooling of the crystal.

To apply thermal cycling to the crystal, two Peltier modules, one for heating and the other for cooling, are thermally bonded to the pyroelectric crystal. A chilled water pipe serves as a heat sink to prevent heating of the APPIS system. The crystal temperature is monitored with a thermocouple. The polarity of the