Manufacturing & Prototyping

Cryogenic-Compatible Winchester Connector Mount and Retaining System for Composite Tubes

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A connector retainer and mounting system has been designed to replace screw-mounting of Winchester connectors. Countersunk screws are normally used to secure connectors to structures, and to keep them from coming apart. These screws are normally put into threaded or through-holes in metallic structures. This unique retainer is designed such that integral posts keep the connector halves retained, and a groove permits a cable tie to be fastened around the retainer and composite tube, thus securing the connector to the structure.

The system is compatible for use on cryogenic (and conventional) bonded composite tube assemblies. Screws and tapped/through-holes needed to retain and mount Winchester connectors cannot be used on blind-access composite tubes. This system allows for rapid installation, removal, low-molecular-outgassing materials, and particulate-free installation and removal. Installation and/or changes late in the integration, and test flow with limited access in a cleanroom environment are possible. No sanding or bonding is needed.

This work was done by James Pontius and Douglas McGuffey of Goddard Space Flight Center. Further information is contained in a TSP (see page 1). GSC-16028-1

Development of Position-Sensitive Magnetic Calorimeters for X-Ray Astronomy

These calorimeters can be used in x-ray metrology, materials microanalysis, and medical applications.

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Metallic magnetic calorimeters (MMC) are one of the most promising devices to provide very high energy resolution needed for future astronomical x-ray spectroscopy. MMC detectors can be built to large detector arrays having thousands of pixels. Position-sensitive magnetic (PoSM) microcalorimeters consist of multiple absorbers thermally coupled to one magnetic microcalorimeter. Each absorber element has a different thermal coupling to the MMC, resulting in a distribution of different pulse shapes and enabling position discrimination between the absorber elements. PoSMs therefore achieve the large focal plane area with fewer number of readout channels without compromising spatial sampling.

Excellent performance of PoSMs was achieved by optimizing the designs of key parameters such as the thermal conductance among the absorbers, magnetic sensor, and heat sink, as well as the absorber heat capacities. Microfabrication techniques were developed to construct four-absorber PoSMs, in which each absorber consists of a two-layer composite of bismuth and gold. The energy resolution (FWHM — full width at half maximum) was measured to be better than 5 eV at 6 keV x-rays for all four absorbers. Position determination was demonstrated with pulse-shape discrimination, as well as with pulse rise time.

X-ray microcalorimeters are usually designed to thermalize as quickly as possible to avoid degradation in energy resolution from position dependence to the pulse shapes. Each pixel consists of an absorber and a temperature sensor, both decoupled from the cold bath through a weak thermal link. Each pixel requires a separate readout channel; for instance, with a SQUID (superconducting quantum interference device). For future astronomy missions where thousands to millions of resolution elements are required, having an individual SQUID readout channel for each pixel becomes difficult. One route to attaining these goals is a position-sensitive detector in which a large continuous or pixilated array of x-ray absorbers shares fewer numbers of temperature sensors.

A means of discriminating the signals from different absorber positions, however, needs to be built into the device for each sensor. The design concept for the device is such that the shape of the temperature pulse with time depends on the location of the absorber. This inherent position sensitivity of the signal is then analyzed to determine the location of the event precisely, effectively yielding one device with many sub-pixels. With such devices, the total number of electronic channels required to read out a given number of pixels is significantly reduced.

PoSMs were developed that consist of four discrete absorbers connected to a single magnetic sensor. The design concept can be extended to more than four absorbers per sensor. The thermal conductance between the sensor and each absorber is different by design and consequently, the pulse shapes are different depending upon which absorber the x-rays are received, allowing position discrimination. A magnetic sensor was used in which a paramagnetic Au:Er temperature-sensitive material is located in a weak magnetic field.

Deposition of energy from an x-ray photon causes an increase in temperature, which leads to a change of magnetization of the paramagnetic sensor, which is subsequently read out using a low noise dc-SQUID. The PoSM microcalorimeters are fully microfabricated: the Au:Er sensor is located above the meander, with a thin insulation gap in between. For this position-sensitive device, four electroplated absorbers are thermally linked to the sensor via heat links of different thermal conductance. One pixel is identical to that of a single-pixel design, consisting of an overhanging absorber fabricated directly on top of the sensor. It is therefore very strongly thermally coupled to it. The three other absorbers are supported directly on a silicon-nitride membrane. These absorbers are thermally coupled to the sensor via Ti (5 nm)/Au (250 nm) metal links. The strength of the links is parameterized by the number of gold squares making up the link.

For detector performance, experimentally different pulse-shapes were demonstrated with 6 keV x-rays, which clearly show different rise times for different absorber positions. For energy resolution measurement, the PoSM was operated at 32 mK with an applied field that was generated using a persistent current of 50 mA. Over the four pixels, energy resolution ranges from 4.4 to 4.7 eV were demonstrated.

This work was done by Simon Bandler, Thomas Stevenson, and Wen-Ting Hsieh of Goddard Space Flight Center. Further information is contained in a TSP (see page 1).
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