Mount Protects Thin-Walled Glass or Ceramic Tubes From Large Thermal and Vibration Loads

Low-stress, low-profile mounts were developed for photomultiplier tubes for imaging systems, biological sensing, and atmospheric sensing.

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The design allows for the low-stress mounting of fragile objects, like thin walled glass, by using particular ways of compensating, isolating, or releasing the coefficient of thermal expansion (CTE) differences between the mounted object and the mount itself. This mount profile is lower than true full kinematic mounting. Also, this approach enables accurate positioning of the component for electrical and optical interfaces. It avoids the higher and unpredictable stress issues that often result from "potting" the object. The mount has been built and tested to space-flight specifications, and has been used for fiber-optic, optical, and electrical interfaces for a space-flight mission.

This mount design is often metal and is slightly larger than the object to be mounted. The objects are optical or optical/electrical, and optical and/or electrical interfaces are required from the top and bottom. This requires the mount to be open at both ends, and for the object's position to be controlled. Thin inside inserts at the top and bottom contact the housing at defined lips, or edges, and hold the fragile object in the mount. The inserts can be customized to mimic the outer surface of the object, which further reduces stress. The inserts have the opposite CTE of the housing material, partially compensating for the CTE difference that causes thermal stress. A spring washer is inserted at one end to compensate for more CTE difference and to hold the object against the location edge of the mount for any optical position requirements. The spring also ensures that any fiber-optic or optic interface, which often requires some pressure to ensure a good interface, does not overstress the fragile object. The insert thickness, material, and spring washer size can be traded against each other to optimize the mount and stresses for various thermal and vibration load ranges and other mounting requirements.

The alternate design uses two separate, unique features to reduce stress and hold the object. A release agent is applied to the inside surface of the mount just before the binding potting material is injected in the mount. This prevents the potting material from bonding to the mount, and thus prevents stress from being applied, at very low temperatures, to the fragile object being mounted. The potting material mixing and curing is temperature- and humidity-controlled. The mount has radial grooves cut in it that the potting material fills, thus controlling the vertical position of the mounted object. The design can easily be used for long and thin objects, short and wide objects, and any shape in between. The design's advantages are amplified for long and thin fragile objects. The general testing range was –45 to +45 °C, but multiple mounts were successfully tested down to –60 and up to 50 °C and the design can be adjusted for larger ranges.

This work was done by Michael Amato, Stephen Schmidt, and James Marsh of Goddard Space Flight Center and Kevin Dahya of ATK. Further information is contained in a TSP (see page 1). GSC-15546-1

Carbon Nanotube-Based Structural Health Monitoring Sensors

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Carbon nanotube (CNT)-based sensors for structural health monitoring (SHM) can be embedded in structures of all geometries to monitor conditions both inside and at the surface of the structure to continuously sense changes. These CNTs can be manipulated into specific orientations to create small, powerful, and flexible sensors. One of the sensors is a highly flexible sensor for crack growth detection and strain field mapping that features a very dense and highly ordered array of single-walled CNTs.

CNT structural health sensors can be mass-produced, are inexpensive, can be packaged in small sizes (0.5 micron^2), require less power than electronic or piezoelectric transducers, and produce less waste heat per square centimeter than electronic or piezoelectric transducers.

Chemically functionalized lithographic patterns are used to deposit and align the CNTs onto metallic electrodes. This method consistently produces aligned CNTs in the defined locations. Using photo- and electron-beam lithography, simple Cr/Au thin-film circuits are patterned onto oxidized silicon substrates. The samples are then re-patterned with a CNT-attracting, self-assembled monolayer of 3-aminopropyltriethoxysilane (APTES) to delineate the desired CNT locations between electrodes. During the deposition of the solution-suspended single-wall CNTs, the application of an electric field to the metallic contacts causes alignment of the CNTs along the field direction. This innovation is a prime candidate for smart skin technologies with applications ranging from military, to aerospace, to private industry.

This work was done by Russell Wincheski and Jeffrey Jordan of Langley Research Center; Donald Oglesby, Anthony Watkins, and JoAnne Patry of Swales Aerospace; Jan Smits of Lockheed Martin; and Phillip Williams of National Research Council. Further information is contained in a TSP (see page 1). LAR-16475-1