

tance between the nozzle and wafer surface as well as allowing for longer cleaning time. The 3- to 5-mm critical distance is important for the ability to remove particles by megasonic cavitations. The in-

creased UPW sonication time and exposure to heated UPW improve the removal of 1- to 5-micron-sized particles.

This work was done by Judith H. Allton and Eileen K. Stansbery of Johnson Space

Center, Michael J. Calaway of Jacobs Technology, and Melissa C. Rodriguez of Geocontrol Systems Inc. Further information is contained in a TSP (see page 1). MSC 24499-1

⚙️ Piezoelectrically Initiated Pyrotechnic Igniter

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This innovation consists of a pyrotechnic initiator and piezoelectric initiation system. The device will be capable of being initiated mechanically; resisting initiation by EMF, RF, and EMI (electromagnetic field, radio frequency, and electromagnetic interference, respectively); and initiating in water environments and space environments.

Current devices of this nature are initiated by the mechanical action of a firing pin against a primer. Primers historically are prone to failure. These failures are commonly known as misfires or hang-fires. In many cases, the primer shows the dent where the firing pin struck the primer, but the primer failed to fire. In devices such as “T” handles, which are commonly used to initiate the blowout of canopies, loss of function of the device may result in loss of crew. In devices such as flares or smoke genera-

tors, failure can result in failure to spot a downed pilot.

The piezoelectrically initiated ignition system consists of a pyrotechnic device that plugs into a mechanical system (activator), which on activation, generates a high-voltage spark. The activator, when released, will strike a stack of electrically linked piezo crystals, generating a high-voltage, low-amperage current that is then conducted to the pyro-initiator. Within the initiator, an electrode releases a spark that passes through a pyrotechnic first-fire mixture, causing it to combust. The combustion of the first-fire initiates a primary pyrotechnic or explosive powder. If used in a “T” handle, the primary would ramp the speed of burn up to the speed of sound, generating a shock wave that would cause a high explosive to go “high order.” In a flare or smoke generator, the secondary

would produce the heat necessary to ignite the pyrotechnic mixture.

The piezo activator subsystem is redundant in that a second stack of crystals would be struck at the same time with the same activation force, doubling the probability of a first strike spark generation. If the first activation fails to ignite, the device is capable of multiple attempts.

Another unique aspect is in the design of the pyrotechnic device. There is an electrode that aids the generation of a directed spark and the use of a conductive matrix to support the first-fire material so that the spark will penetrate to the second electrode.

This work was done by Asia Quince, Maureen Dutton, Robert Hicks, and Karen Burnham of Johnson Space Center. Further information is contained in a TSP (see page 1). MSC-24841-1

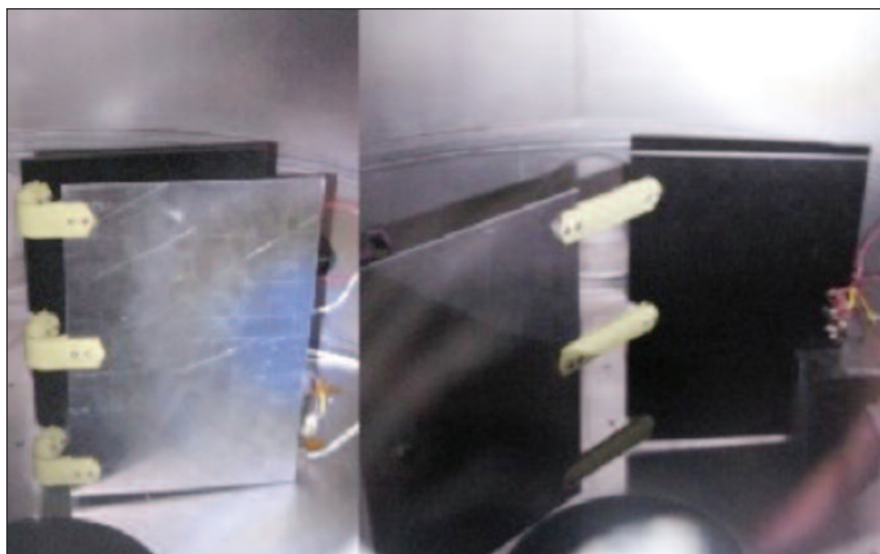
⚙️ Folding Elastic Thermal Surface — FETS

By using tape-spring hinges, the FETS avoids the need for lubricants.

NASA's Jet Propulsion Laboratory, Pasadena, California

The FETS is a light and compact thermal surface (sun shade, IR thermal shield, cover, and/or deployable radiator) that is mounted on a set of offset tape-spring hinges. The thermal surface is constrained during launch and activated in space by a thermomechanical latch such as a wax actuator.

An application-specific embodiment of this technology developed for the MATMOS (Mars Atmospheric Trace Molecule Occultation Spectrometer) project serves as a deployable cover and thermal shield for its passive cooler. The FETS fits compactly against the instrument within the constrained launch envelope, and then unfolds into a larger area once in space. In this application, the FETS protects the passive cooler from thermal damage and contamination during ground operations, launch,



The figure depicts the FETS in its stowed and deployed states during high vacuum testing at JPL.

and during orbit insertion. Once unfolded or deployed, the FETS serves as a heat shield, intercepting parasitic heat loads by blocking the passive cooler's view of the warm spacecraft.

The technology significantly enhances the capabilities of instruments requiring either active or passive cooling of optical detectors. This can be particularly important for instruments where performance is limited by the available radiator area. Examples would be IR optical instruments on CubeSATS or those launched as hosted payloads because radiator area is limited and views are often undesirable. As a deployable radiator, the panels making up the FETS are linked thermally by thermal straps and heat pipes; the structural support and deployment energy is provided using tape-spring hinges.

The FETS is a novel combination of existing technologies. Prior art for deployable heat shields uses rotating hinges that typically must be lubricated to avoid cold welding or static friction. By using tape-spring hinges, the FETS avoids the need for lubricants by avoiding friction altogether. This also eliminates the potential for contamination of nearby cooled optics by outgassing lubricants. Furthermore, the tape-spring design of the FETS is also self-locking so the panels stay in a rigid and extended configuration after deployment. This unexpected benefit makes the tape-spring hinge design of the FETS a light, simple, reliable, compact, non-outgassing hinge, spring, and latch.

While tape-spring hinges are not novel, they have never been used to deploy passive unfolding thermal surfaces

(radiator panels, covers, sun shades, or IR thermal shields). Furthermore, because this technology is compact, it has minimal impact on the launch envelope and mass specifications. FETS enhances the performance of hosted payload instruments where the science data is limited by dark noise.

Incorporating FETS into a thermal control system increases radiator area, which lowers the optical detector temperature. This results in higher SNR (signal-to-noise ratio) and improved science data.

This work was done by Eugenio Urquiza, Burt X. Zhang, Michael P. Thelen, Jose I. Rodriguez, and Sergio Pellegrino of Caltech for NASA's Jet Propulsion Laboratory. For more information, contact iaoffice@jpl.nasa.gov. NPO-48759