



## Books & Reports

### Dual-Compartment Inflatable Suitlock

A paper discusses a dual-compartment inflatable suitlock (DCIS) for Extravehicular Activity (EVA) that will allow for dust control, suit maintenance, and efficient EVA egress/ingress. The expandable (inflatable technologies) aspect of the design will allow the unit to stow in a compact package for transport.

The DCIS consists of three hard, inline bulkheads, separating two cylindrical membrane-walled compartments. The inner bulkhead can be fitted with a variety of hatch types, docking flanges, and mating hardware, such as the common berthing mechanism (CBM), for the purpose of mating with vehicles, habitats, and other pressurized modules. The inner bulkhead and center bulkhead function as the end walls of the inner compartment, which, during operations, would stay pressurized, either matching the pressure of the habitat or acting as a lower-pressure transitional volume. The suited crewmember can quickly don a suit, and egress the suitlock without waiting for the compartment to depressurize. The outer compartment can be pressurized infrequently, when a long dwell time is expected prior to the next EVA, or during off-nominal suit maintenance tasks, allowing “shirtsleeve” inspections and maintenance of the space suits. The outer bulkhead has a pressure-assisted hatch door that stays open and stowed routinely, but can be closed for suit maintenance and pressurization as needed.

*This work was done by A. Scott Howe of Caltech, and Kriss J. Kennedy, Peggy L. Guirgis, and Robert M. Boyle of Johnson Space Center for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-47786*

### Large-Strain Transparent Magnetoactive Polymer Nanocomposites

A document discusses polymer nanocomposite superparamagnetic actuators that were prepared by the addition of organically modified superparamagnetic nanoparticles to the polymer matrix. The nanocomposite films exhibited large deformations under a magnetostatic field with a low loading level of 0.1 wt% in a thermoplastic

polyurethane elastomer (TPU) matrix. The maximum actuation deformation of the nanocomposite films increased exponentially with increasing nanoparticle concentration.

The cyclic deformation actuation of a high-loading magnetic nanocomposite film was examined in a low magnetic field, and it exhibited excellent reproducibility and controllability. Low-loading TPU nanocomposite films (0.1–2 wt%) were transparent to semi-transparent in the visible wavelength range, owing to good dispersion of the magnetic nanoparticles. Magnetoactuation phenomena were also demonstrated in a high-modulus, high-temperature polyimide resin with less mechanical deformation.

*This work was done by Michael A. Meador of Glenn Research Center and Mitra Yoonessi of the Ohio Aerospace Institute. Further information is contained in a TSP (see page 1).*

*Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Innovative Partnerships Office, Attn: Steven Fedor, Mail Stop 4–8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-18752-1.*

### Thermodynamic Vent System for an On-Orbit Cryogenic Reaction Control Engine

A report discusses a cryogenic reaction control system (RCS) that integrates a Joule-Thompson (JT) device (expansion valve) and thermodynamic vent system (TVS) with a cryogenic distribution system to allow fine control of the propellant quality (subcooled liquid) during operation of the device. It enables zero-venting when coupled with an RCS engine. The proper attachment locations and sizing of the orifice are required with the propellant distribution line to facilitate line conditioning. During operations, system instrumentation was strategically installed along the distribution/TVS line assembly, and temperature control bands were identified.

A sub-scale run tank, full-scale distribution line, open-loop TVS, and a combination of procured and custom-fabricated cryogenic components were used in the cryogenic RCS build-up. Simulated on-orbit activation and thruster

firing profiles were performed to quantify system heat gain and evaluate the TVS's capability to maintain the required propellant conditions at the inlet to the engine valves. Test data determined that a small control valve, such as a piezoelectric, is optimal to provide continuously the required thermal control. The data obtained from testing has also assisted with the development of fluid and thermal models of an RCS to refine integrated cryogenic propulsion system designs.

This system allows a liquid oxygen-based main propulsion and reaction control system for a spacecraft, which improves performance, safety, and cost over conventional hypergolic systems due to higher performance, use of non-toxic propellants, potential for integration with life support and power subsystems, and compatibility with *in-situ* produced propellants.

*This work was done by Eric A. Hurlbert, Kris A. Romig, Rafael Jimenez, and Sam Flores of Johnson Space Center. Further information is contained in a TSP (see page 1). MSC-24543-1*

### Time Distribution Using SpaceWire in the SCaN Testbed on ISS

A paper describes an approach for timekeeping and time transfer among the devices on the CoNNeCT project's SCaN Testbed. It also describes how the clocks may be synchronized with an external time reference; e.g., time tags from the International Space Station (ISS) or RF signals received by a radio (TDRSS time service or GPS).

All the units have some sort of counter that is fed by an oscillator at some convenient frequency. The basic problem in timekeeping is relating the counter value to some external time standard such as UTC.

With SpaceWire, there are two approaches possible: one is to just use SpaceWire to send a message, and use an external wire for the sync signal. This is much the same as with the RS-232 messages and 1 pps line from a GPS receiver. However, SpaceWire has an additional capability that was added to make it easier — it can insert and receive a special “timecode” word in the data stream.

Another method is to use the SpaceWire time code features. A standard SpaceWire interface provides four signals: Tick In, Time In, Time Out, and Tick Out. When one end of the SpaceWire link asserts "Tick In," some small amount of time later (a few micro-seconds), Tick Out at the other end of the link is asserted. So there is a "virtual" wire connection over the SpaceWire link that can do synchronization (with an uncertainty and latency on the order of a few microseconds). The Time In signal provides an interface to send a 6-bit time code that is transparently inserted in the stream of data and control tokens being carried across the link, and recovered and presented on the Time Out at the destination without needing to create a special "time message."

*This work was done by James P. Lux of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-47437*

## **Techniques for Solution-Assisted Optical Contacting**

A document discusses a "solution-assisted contacting" technique for optical contacting. An optic of surface flatness  $\Lambda/20$  was successfully contacted with one of "moderate" surface quality, or  $\Lambda/4$ . Optics used were both ultra-low expansion (ULE) glass ( $\Lambda/4$  and  $\Lambda/20$ ) and fused silica ( $\Lambda/20$ ).

A stainless steel template of the intended interferometer layout was designed and constructed with three contact points per optic. The contact points were all on a common side of the template. The entire contacting jig was tilted at about  $30^\circ$ . Thus, when the isopropanol was applied, each optic slid due to gravity, resting on the contact points.

All of the contacting was performed in a relatively dusty laboratory. A number of successful contacts were achieved

where up to two or three visible pieces of dust could be seen. These were clearly visible due to refraction patterns between the optic and bench. On a number of optics, the final step of dropping isopropyl between the surfaces was repeated until a successful contact was achieved.

The new procedures realized in this work represent a simplification for optical contacting in the laboratory. They will both save time and money spent during the contacting process, and research and development phases. The techniques outlined are suitable for laboratory experiments, research, and initial development stages.

*This work was done by Glenn De Vine, Brent Ware, Danielle M. Wuchenich, Robert E. Spero, William M. Klipstein, and Kirk McKenzie of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-47963*