quent crystal growth. The increase (relative to the prior art) in interfacial surface area occasioned by the transition from planar membranes to spherical microcapsules makes it possible to change conditions more rapidly throughout the mother liquor surrounding the crystal(s), thereby promoting the formation of more ordered and more nearly perfect crystals.

This work was done by Dennis R. Morrison of **Johnson Space Center** *and Benjamin Mosier of the Institute for Research, Inc. Further information is contained in a TSP [see page 1].*

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, Johnson Space Center, (281) 483-0837. Refer to MSC-22936.

Lightweight, Self-Deployable Wheels

Compacted, frozen wheels are deployed by heating above T_g.

NASA's Jet Propulsion Laboratory, Pasadena, California

Ultra-lightweight, self-deployable wheels made of polymer foams have been demonstrated. These wheels are an addition to the roster of cold hibernated elastic memory (CHEM) structural applications. Intended originally for use on nanorovers (very small planetary-exploration robotic vehicles), CHEM wheels could also be used for many commercial applications, such as in toys.

The CHEM concept was reported in "Cold Hibernated Elastic Memory (CHEM) Expandable Structures" (NPO-20394), *NASA Tech Briefs*, Vol. 23, No. 2 (February 1999), page 56. To recapitulate: A CHEM structure is fabricated from a shape-memory polymer (SMP) foam. The structure is compressed to a very small volume while in its rubbery state above its glass-transition temperature (T_g). Once compressed, the structure can be cooled below T_g to its glassy state. As long as the temperature remains $<T_g$ the structure remains compacted (in a cold hibernated state), even when the external compressive forces are removed. When the structure is subsequently heated above T_g, it returns to the rubbery state, in which a combination of elasticity and the SMP effect cause it to expand (deploy) to its original size and shape. Once thus deployed, the CHEM structure can be rigidified by cooling below T_g to the glassy state. The structure could be subsequently reheated above T_g and recompacted. The compaction/deployment/rigidification cycle could be repeated as many times as needed.

SMPs with T_gs ranging from −100 to almost +100 °C are available. Hence, it should be possible to select SMPs with T_gs suitable for CHEM structures for a variety of potential terrestrial and outer-space applications. During an investigation directed toward extending the CHEM concept to wheels, several wheel designs for a prototype nanorover were evaluated. CHEM models of the designs were fabricated and assessed by subjecting the models to a CHEM processing cycle. All wheels recovered completely after the cycle, and a wheel design with the fastest deployment was selected for the nanorover. Full-scale wheels were fabricated and assembled on two-wheeled prototype nanorover. Finally, the compacted wheels were successfully deployed at 80 °C and subsequently rigidified, both at room temperature in the terrestrial atmosphere and at a lower temperature and pressure chosen to simulate the Mars atmosphere.

This work was done by Artur Chmielewski, Witold Sokolowski, and Peter Rand of Caltech for **NASA's Jet Propulsion Laboratory**. *Further information is contained in a TSP [see page 1].*
NPO-21225

Grease-Resistant O Rings for Joints in Solid Rocket Motors

There is a continuing effort to develop improved O rings for sealing joints in solid-fuel rocket motors. Following an approach based on the lessons learned in the explosion of the space shuttle *Challenger*, investigators have been seeking O-ring materials that exhibit adequate resilience for effective sealing over a broad temperature range: What are desired are O rings that expand far and fast enough to maintain seals, even when metal sealing surfaces at a joint move slightly away from each other shortly after ignition and the motor was exposed to cold weather before ignition. Other qualities desired of the improved O rings include adequate resistance to ablation by hot rocket gases and resistance to swelling when exposed to hydrocarbon-based greases used to protect some motor components against corrosion. Five rubber formulations — two based on a fluorosilicone polymer and three based on copolymers of epichlorohydrin with ethylene oxide — were tested as candidate O-ring materials. Of these, one of the epichlorohydrin/ethylene oxide formulations was found to offer the closest to the desired combination of properties and was selected for further evaluation.

This work was done by Albert R. Harvey and Harold Feldman (deceased) of Thiokol Propulsion for **Marshall Space Flight Center**. *To obtain a copy of the report, "Resilient, Hydrocarbon Base Grease Resistant O-ring Seals for Solid Rocket Motor Applications," please contact the company at (435) 863-4123.*
MFS-31643