

reflector without introducing significant amounts of mass or stiffness to the reflector. They can be rolled up or folded to accommodate the packaging needed for launch.

An analytical model of the system, which includes the membrane reflector, actuator, and controller has been devel-

oped to investigate the functionality of this control system on a 35-meter-diameter membrane reflector. The performance of this system under external disturbances such as in space thermal loads and W-error due to inflation has been investigated. A subscale breadboard has been developed, and the functionality of

this control concept has been demonstrated by this breadboard.

This work was done by Houfei Fang and Eastwood Im of Caltech, and Kon-Well Wang and Qiming Zhang of Penn State University for NASA's Jet Propulsion Laboratory. For more information, contact iaoffice@jpl.nasa.gov. NPO-44913

⚙️ Rapid Active Sampling Package

A field-deployable, battery-operated tool enables rock sampling in the field.

NASA's Jet Propulsion Laboratory, Pasadena, California

A field-deployable, battery-powered Rapid Active Sampling Package (RASP), originally designed for sampling strong materials during lunar and planetary missions, shows strong utility for terrestrial geological use. The technology is proving to be simple and effective for sampling and processing materials of strength. Although this originally was intended for planetary and lunar applications, the RASP is very useful as a powered hand tool for geologists and the mining industry to quickly sample and process rocks in the field on Earth.

The RASP allows geologists to surgically acquire samples of rock for later laboratory analysis. This tool, roughly the size of a wrench, allows the user to cut away swaths of weathering rinds, revealing pristine rock surfaces for observation and subsequent sampling with the same tool. RASping deeper ($\approx 3\text{--}5$ cm) exposes single rock strata *in-situ*.

Where a geologist's hammer can only expose unweathered layers of rock, the RASP can do the same, and then has the added ability to capture and process samples into powder with particle sizes less than 150 microns, making it easier for XRD/XRF (x-ray diffraction/x-ray fluorescence). The tool uses a rotating rasp bit (or two counter-rotating bits) that resides inside or above the catch container. The container has an open slot to allow the bit to extend outside the container and to allow cuttings to enter and be caught. When the slot and rasp bit are in contact with a substrate, the bit is plunged into it in a matter of seconds to reach pristine rock.

A user in the field may sample a rock multiple times at multiple depths in minutes, instead of having to cut out huge, heavy rock samples for transport back to a lab for analysis. Because of the speed and accuracy of the RASP, hundreds of samples can be taken in one

day. RASP-acquired samples are small and easily carried. A user can characterize more area in less time than by using conventional methods. The field-deployable RASP used a Ni/Cad rechargeable battery. Power usage was less than 1 Wh/cm³ even when sampling strong basalts, so many samples could be taken on a single battery charge.

The prototype field RASP was equipped with a load tube in which sealable sample containers were inserted. Positioning the tool upside-down conveniently loaded the sample containers with powdered rock samples. This technology could be adapted to existing battery-operated rotary tools, or could be used as a stand-alone sampling tool.

This work was done by Gregory Peters of Caltech for NASA's Jet Propulsion Laboratory. For more information, contact iaoffice@jpl.nasa.gov. NPO-44946

⚙️ Miniature Lightweight Ion Pump

This lightweight pump with no moving parts eliminates the need for a backup pump.

NASA's Jet Propulsion Laboratory, Pasadena, California

This design offers a larger surface area for pumping of active gases and reduces the mass of the pump by eliminating the additional vacuum enclosure. There are three main components to this ion pump: the cathode and anode pumping elements assembly, the vacuum enclosure (made completely of titanium and used as the cathode and maintained at ground potential) containing the assembly, and the external magnet. These components are generally put in a noble diode (or differential) configuration of the ion pump technology. In the

present state of the art, there are two cathodes, one made of titanium and the other of tantalum. The anodes are made up of an array of stainless steel cylinders positioned between the two cathodes.

All the elements of the pump are in a vacuum enclosure. After the reduction of pressure in this enclosure to a few microns, a voltage is applied between the cathode and the anode elements. Electrons generated by the ionization are accelerated toward the anodes that are confined in the anode space by the axial magnetic field. For the generation of the

axial field along the anode elements, the magnet is designed in a C-configuration and is fabricated from rare earth magnetic materials (Nd-B-Fe or Sm-Co) possessing high energy product values, and the yoke is fabricated from the high permeability material (Hiperco-50A composed of Fe-Co-V). The electrons in this region collide with the gas molecules and generate their positive ions. These ions are accelerated into the cathode and eject cathode material (Ti). The neutral atoms deposit on the anode surfaces. Because of the chemical activity of

Ti, the atoms combine with chemically active gas molecules (e.g. N₂, O₂, etc.) and remove them. New layers of Ti are continually deposited, and the pumping of active gases is thus accomplished.

Pumping of the inert gases is accomplished by their burial several atomic layers deep into the cathode. However, they tend to re-emit if the entrapping lattice atoms are sputtered away. For stable pumping of inert gases, one side of the cathode is made of Ta. Impaction on Ta produces energetic, neutral atoms that pump the inert gases on the anode structure at the peripheral areas of the cath-

odes (between anode rings). For inert gases stability, a post design has been implemented. Here, posts of cathode material (Ti) are mounted on the cathode. These protrude into the initial part of the anode elements. Materials sputtered from the posts condense on the anode assembly and on the cathode plane at higher rates than in the normal diodes due to enhanced sputtering at glancing angles from geometrical considerations. This increases pumping by burial. This post design has enhanced pumping rates for both active and inert gases, compared with conventional designs.

This work was done by Mahadeva P. Sinha of Caltech for NASA's Jet Propulsion Laboratory.

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to:

*Innovative Technology Assets Management
JPL*

Mail Stop 202-233

4800 Oak Grove Drive

Pasadena, CA 91109-8099

E-mail: iaoffice@jpl.nasa.gov

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