

achieve maximum van der Waals forces. By maximizing the real area of contact that these fibers make and minimizing the bending energy necessary to achieve that contact, the net amount of adhesion has been improved dramatically.

The suspension structure consists of millimeter-scale fibers that are bonded to the contacting level through a wet assembly step. These millimeter-sized fibers serve as a discretized way of both conforming to roughness on the surface and distributing the overall climbing loads down to the individual contacts. These structures have been tested on an experimental testbed meant to determine the contact forces very exactly, and have also been demonstrated by hanging weights off of a patch adhering to a variety of walls (glass, metal, wood, plastic, drywall, etc).

This material is fabricated via a molding process. A new process has been de-

veloped at JPL to make this process simpler, more reliable, and to allow new geometries not previously possible. These new geometries will make the adhesive and the reliability significantly better, and will drive down cost and development time.

The process involves using optical lithography to make a master pattern, and from this master pattern, making a reusable master mold that is used to cast the adhesive strips. To create the master photoresist pattern that will be used to make the master mold, a self-aligned double exposure technique was used. Two different angled UV exposures are performed using a single opaque pattern on a transparent wafer. This simplifies fabrication considerably.

A second advantage of this technique is the ability to achieve right-angle wedge-shaped structures with both sides

of the wedge leaning to the same side, i.e., an actual overhang of the fibers, which is more like the arrangement of a gecko foot's fibers. A third critical difference is the use of a standard positive Novalac photoresist, which has a wide process latitude.

The new microfabrication process has allowed the shape of the wedge-like fibers to be controlled. Prior to these process improvements, only right-angle wedges had been fabricated. Now, the process not only allows for increased control over the angle of these fibers, but is also much more reliable, manufacturable, and cost-effective.

This work was done by Aaron Parness and Victor E. White of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-48156

Using Pre-Melted Phase Change Material to Keep Payloads in Space Warm for Hours Without Power

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Adding phase change material (PCM) to a mission payload can maintain its temperature above the cold survival limit, without power, for several hours in space. For the International Space Station, PCM is melted by heaters just prior to the payload translation to the worksite when power is available. When power is cut off during the six-hour translation, the PCM releases its latent heat to make up the heat loss

from the radiator(s) to space. For the interplanetary Probe, PCM is melted by heaters just prior to separation from the orbiter when power is available from the orbiter power system. After the Probe separates from the orbiter, the PCM releases its latent heat to make up the heat loss from the Probe exterior to space.

Paraffin wax is a good PCM candidate. It has a high solid-to-liquid enthalpy,

which is about 225 kJ/kg, and a range of melting points. For example, C₁₈H₃₈ has a melting point of 28 °C, which is well within the payload temperature limits. At the time of this reporting, paraffin wax PCM had a TRL (technology readiness level) of 7.

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