architectures is possible for this application. Thickness of load-bearing devices can be achieved by using either a 3D woven structure, or a layered, 2D structure. For the prototype device, a belt approximately 0.10 in. (0.25 cm) thick, and 3.0 in. (7.6 cm) wide was formed by layering and stitching a 2D aluminosilicate fiber weave. The circumferential length of the 2D, layered belt was approximately 36 in. (91 cm).

To demonstrate the resistance to abrasion while under load, the ceramic fiber belt was installed on two aluminum spools that were mounted in an Instron load frame. Both spools were completely enclosed in a Lexan box within the load frame. Bearings were used at each end of the spool shafts to allow the spools to spin freely while a load was applied. The lower spool, which was secured to the stationary head of the load frame, was also attached to a small motor to drive the rollers. The upper spool was attached to the movable crosshead of the Instron frame to apply a load to the belt while it was rolling. JSC1a, a highly abrasive lunar regolith simulant, was added to the Lexan box. Enough JSC1a was placed in the bottom of the box to allow the belt to contact and pick up the dust as it traveled around the lower spool. The track was exposed to the dust while rolling under load for several hours to simulate relevant rover mission duration. After 12.5 hours of exposure to the lunar simulant, under loads varying between 50 and 100 N, no elongation or mechanical creep of the belt was measured. Under these loads, which were estimated to be comparable to those required for tracks on the lunar rover, there was no deformation or loss of load carrying ability.

To demonstrate flexibility under cryogenic conditions, individual fibers and fiber tows were exposed to cryogenic temperatures by being submerged in liquid nitrogen for 4 minutes, and then were flexure tested. Immediately upon removal from the liquid nitrogen, the fibers and tows were wrapped around mandrels of progressively smaller diameters. Both the fibers and the tows were successfully wrapped around wire mandrels with a diameter of approximately 0.02 in. (0.5 mm) without any breakage. The continuous ceramic belt that is envisioned for the lunar rover would be a closed-edge, multilayer weave with through thickness holes woven in place. The holes in the weave would engage the sprockets on the drive mechanism of the track device.

This work was done by Martha H. Jaskowiak and Andrew J. Eckel of Glenn Research Center. 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: Steve Fedor, Mail Stop 4–8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW- 18364-1.

Elastomer Reinforced With Carbon Nanotubes

Lyndon B. Johnson Space Center, Houston, Texas

Elastomers are reinforced with functionalized, single-walled carbon nanotubes (SWNTs) giving them high-breaking strain levels and low densities. Cross-linked elastomers are prepared using amine-terminated, poly(dimethylsiloxane) (PDMS), with an average molecular weight of 5,000 daltons, and a functionalized SWNT.

Cross-link densities, estimated on the basis of swelling data in toluene (a dispersing solvent) indicated that the polymer underwent cross-linking at the ends of the chains. This thermally initiated cross-linking was found to occur only in the presence of the aryl alcohol functionalized SWNTs. The cross-link could have been via a hydrogen-bonding mechanism between the amine and the free hydroxyl group, or via attack of the amine on the ester linage to form an amide.

Tensile properties examined at room temperature indicate a three-fold increase in the tensile modulus of the elastomer, with rupture and failure of the elastomer occurring at a strain of 6.5.

This work was done by James M. Tour and Jared L. Hudson of Rice University and Ramanan Krishnamoorti of University of Houston for Johnson Space Center. For further information, contact the JSC Innovation Partnerships Office at (281) 483-3809.

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:

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Refer to MSC-24071-1, volume and number of this NASA Tech Briefs *issue, and the page number.*

Biologically Inspired Purification and Dispersion of SWCNTs

Lyndon B. Johnson Space Center, Houston, Texas

A biologically inspired method has been developed for (1) separating single-wall carbon nanotubes (SWCNTs) from other materials (principally, amorphous carbon and metal catalysts) in raw production batches and (2) dispersing the SWCNTs as individual particles (in contradistinction to ropes and bundles) in suspension, as required for a number of applications. Prior methods of purification and dispersal of SWCNTs involve, variously, harsh physical processes (e.g., sonication) or harsh chemical processes (e.g., acid reflux). These processes do not completely remove the undesired materials and do not disperse bundles and ropes into individual suspended SWCNTs. Moreover, these processes cut long SWCNTs into shorter pieces, yielding typical nanotube lengths between 150 and 250 nm.

In contrast, the present method does not involve harsh physical or chemical processes. The method involves the use of biologically derived dispersal agents (BDDAs) in an aqueous solution that is mechanically homogenized (but not sonicated) and centrifuged. The dense solid material remaining after centrifugation is resuspended by vortexing in distilled water, yielding an aqueous suspension of individual, separated SWCNTs having lengths from about 10 to about 15 µm.

This work was done by Daniel L. Feeback of Johnson Space Center, Mark S. F. Clarke of University Space Research Association, and Pavel Nikolaev of GB Tech Inc. Further information is contained in a TSP (see page 1).

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:

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