Radiation-Shielding Polymer/Soil Composites

Radiation shields could be fabricated *in situ* at relatively low cost.

Marshall Space Flight Center, Alabama

It has been proposed to fabricate polymer/soil composites primarily from extraterrestrial resources, using relatively low-energy processes, with the original intended application being that habitat structures constructed from such composites would have sufficient structural integrity and also provide adequate radiation shielding for humans and sensitive electronic equipment against the radiation environment on the Moon and Mars. The proposal is a response to the fact that it would be much less expensive to fabricate such structures *in situ* as opposed to transporting them from Earth.

Prototype polymer/soil composite bricks have been fabricated on Earth. Transport calculations have shown that the addition of polymeric materials to soil significantly improves the radiation-shielding properties of the resulting composites due to the high hydrogen content of the polymeric constituent. Mechanical testing and hypervelocity-ballistic testing of the proposed composites have demonstrated that structural properties can be improved by a factor of 10 when compared to bricks consisting of only the planetary soil.

A typical composite of this type consists of 5-to 95-weight percent polymeric material and 95-to-5-weight percent of the local planetary soil. The polymeric and soil constituents are thoroughly mixed, heated to slightly over the melting point of the polymeric constituent and pressure is applied to ensure complete infiltration of the polymeric material within the pores of the soil particles. Through suitable choice of pressure and temperature, the resulting polymer/soil composite can be made nearly free of voids.

This work was done by Subhayu Sen of BAE Systems for Marshall Space Flight Center. 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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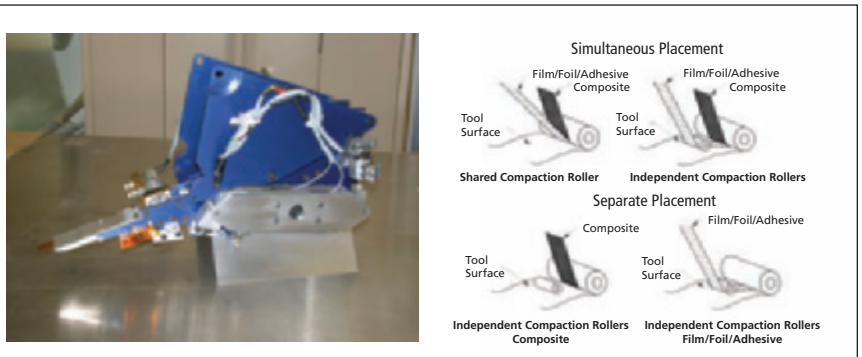
Refer to MFS-32340-1, volume and number of this NASA Tech Briefs *issue, and the page number.*

Film/Adhesive Processing Module for Fiber-Placement Processing of Composites

Films, foils, or adhesives may be interleaved while fiber-placing composite material structures.

Marshall Space Flight Center, Alabama

An automated apparatus has been designed and constructed that enables the automated lay-up of composite structures incorporating films, foils, and adhesives during the automated fiber-placement process. This apparatus, denoted a film module, could be used to deposit materials in film or thin sheet form either simultaneously when laying down the fiber composite article or in an independent step. Examples of materials that may be processed with this device include structural core and joining adhesives, permeation barrier films/foils, surfacing films, lightning-strike materials and IVHM (Integral Vehicle Health Monitoring) arrays. The use of this technology will reduce composite fabrication time and will allow for new concepts/designs to be considered for fiber-placed composite structures.



The **Prototype Film Module** is shown on the left. Materials, as shown on the right, may be placed either simultaneously with to the composite tow/tape, or in an independent step such as in the application of external structural core adhesives.

The film module may be easily designed to fit existing fiber-placement machinery or may be integrally designed into new machines. The film materials may be placed either simultaneously with the fiber composite material as with the case of embedded materials, or in an independent operation as with application of exterior structural core adhesives, as shown in the figure. The device is designed such that it may be made to operate by use of existing fiber-placement lay-up program files. This eliminates the need for additional computer