ily by conventional machining of high-aspect-ratio structures like those of scroll-pump components. In addition, the vibrations of conventional motors and ball bearings exceed these tight tolerances by an order of magnitude. Therefore, the proposed pumps would be fabricated by the microfabrication method known by the German acronym LIGA ("lithographie, galvanoformung, abformung," which means lithography, electroforming, molding) because LIGA has been shown to be capable of providing the required tolerances at large aspect ratios.

This work was done by Dean Wiberg, Kirill Shcheglov, Victor White, and Sam Bae of Caltech for NASA's Jet Propulsion Laboratory. 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 NPO-21161, volume and number of this NASA Tech Briefs *issue, and the page number.*

Self-Assembling, Flexible, Pre-Ceramic Composite Preforms

Pliable, unfired preforms deploy *in-situ* to save fuel and weight costs.

John H. Glenn Research Center, Cleveland, Ohio

In this innovation, light weight, high temperature, compact aerospace structures with increased design options are made possible by using self-assembling, flexible, pre-ceramic composite materials. These materials are comprised of either ceramic or carbon fiber performs, which are infiltrated with polymer precursors that convert to ceramics upon thermal exposure. The preform architecture can vary from chopped fibers formed into blankets or felt, to continuous fibers formed into a variety of 2D or 3D weaves or braids. The matrix material can also vary considerably. For demonstration purposes, a 2D carbon weave was infiltrated with a SiC polymer precursor. The green or unfired material is fabricated into its final shape while it is still pliable. It is then folded or rolled into a much more compact shape, which will occupy a smaller space. With this approach, the part remains as one continuous piece, rather than being fabricated as multiple sections, which would require numerous seals for eventual component use. The infiltrated preform can then be deployed *in-situ*. The component can be assembled into its final shape by taking advantage of the elasticity of the material, which permits the structure to unfold and spring into its final form under its own stored energy. The pre-ceramic composites are converted to ceramics and rigidized immediately after deployment.

The final ceramic composite yields a high-temperature, high-strength material suitable for a variety of aerospace structures. The flexibility of the material, combined with its high-temperature structural capacity after rigidization, leads to a less complex component design with an increased temperature range. The collapsibility of these structures allows for larger components to be designed and used, and also offers the potential for increased vehicle performance. For the case of collapsible nozzle extensions, a larger nozzle, and thus a larger nozzle exit plane, is possible because interference with surrounding structures can be avoided in the collapsed state. The larger exit plane leads to an increase in expansion area ratio, which has the potential to increase thrust and overall rocket performance. In general, the use of advanced ceramic materials can lead to improved engine and vehicle performance. The ceramics can run hotter, so less cooling is required. Fuel to coolant ratios can be balanced more readily to reduce weight. Engine efficiency can also be increased with hotter combustion and exhaust temperatures. In addition, the ceramic composites themselves can reduce the component weight by as much as 50 percent, which can translate into greater payload for the vehicle.

This work was done by Martha H. Jaskowiak and Andrew J. Eckel of Glenn Research Center and Daniel Gorican of Arctic Slope Regional Corp. 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-18421-1.