Inflatable Tubular Structures Rigidized With Foams

Lightweight booms could be deployed from compact stowage and rigidized in place.

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Inflatable tubular structures that have annular cross sections rigidized with foams, and the means of erecting such structures in the field, are undergoing development. Although the development effort has focused on lightweight structural booms to be transported in compact form and deployed in outer space, the principles of design and fabrication are also potentially applicable to terrestrial structures, including components of ultralightweight aircraft, lightweight storage buildings and shelters, lightweight insulation, and sales displays.

The use of foams to deploy and harden inflatable structures was first proposed as early as the 1960s, and has been investigated in recent years by NASA, the U.S. Air Force Research Laboratory, industry, and academia. In cases of deployable booms, most of the investigation in recent years has focused on solid cross sections, because they can be constructed relatively easily. However, solid-section foam-filled booms can be much too heavy for some applications.

In contrast, booms with annular cross sections according to the present innovation can be tailored to obtain desired combinations of stiffness and weight through choice of diameters, wall thicknesses, and foam densities. By far the most compelling advantage afforded by this innovation is the possibility of drastically reducing weights while retaining or increasing the stiffnesses, relative to comparable booms that have solid foam-filled cross sections.

A typical boom according to this innovation includes inner and outer polyimide film sleeves to contain foam that is injected between them during deployment. The cavity inside the inner polyimide sleeve is pressurized for deployment (see figure). The internal pressure provides out-of-plane stiffness for the inner sleeve, preventing its collapse and thereby creating the barrier needed to maintain the radially innermost surface of the injected foam in the desired cylindrical shape during expansion and curing of the foam.

Lightweight end plugs seal the ends of the boom. The plugs contain inlets for compressed air and the foam; they also contain escape ports for gas generated during expansion of the foam. Lightweight flexible hoses are used to inflate the interior of the boom and to inject the foam.

In preparation for a typical application, an assembly of sleeves and end plugs destined to be deployed and rigidized into a boom would be packaged compactly, the inner and outer sleeves being accordion-folded into a storage canister. For deployment, compressed air would be admitted to the cavity enclosed by the inner sleeve. While this cavity remained pressurized, the foam would be injected into the space between the inner and outer sleeves. Once the injected foam had cured, the internal pressure would be released and the boom would be ready for service.

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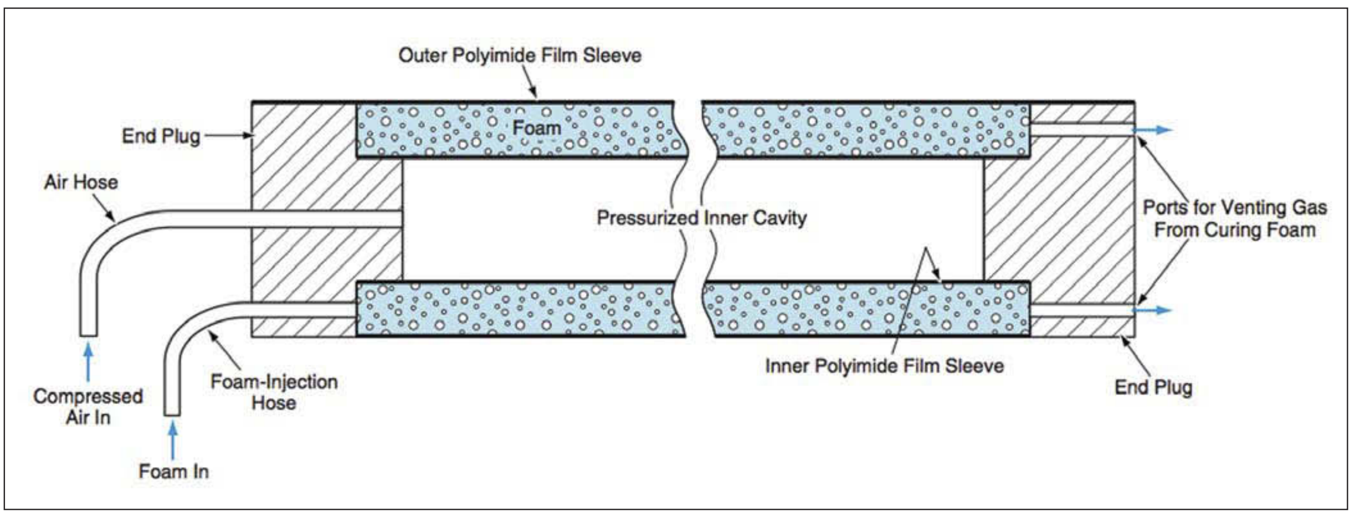

Foam Is Injected into the annular space between the inner and outer polyimide film sleeves while the inner cavity remains pressurized. After curing of the injected foam to a state of rigidity, the pressure is released, and the boom holds its shape.