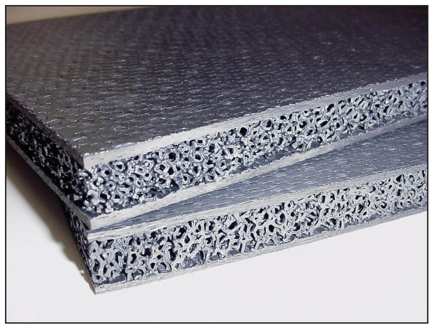
Improved Fabrication of Ceramic Matrix Composite/Foam Core Integrated Structures

CMC face sheets bonded to ceramic foam cores are delamination-resistant and reduce cost, weight, and maintenance.

John H. Glenn Research Center, Cleveland, Ohio

The use of hybridized carbon/silicon carbide (C/SiC) fabric to reinforce ceramic matrix composite face sheets and the integration of such face sheets with a foam core creates a sandwich structure capable of withstanding high-heat-flux environments (150 W/cm^2) in which the core provides a temperature drop of 1,000 °C between the surface and the back face without cracking or delamination of the structure. The composite face sheet exhibits a bilinear response, which results from the SiC matrix not being cracked on fabrication. In addition, the structure exhibits damage tolerance under impact with projectiles, showing no penetration to the back face sheet. These attributes make the composite ideal for leading-edge structures and control surfaces in aerospace vehicles, as well as for acreage thermal protection systems and in high-temperature, lightweight stiffened structures.

By tailoring the coefficient of thermal expansion (CTE) of a carbon fiber-containing ceramic matrix composite (CMC) face sheet to match that of a ceramic foam core, the face sheet and the core can be integrally fabricated without any delamination. Carbon and SiC are woven together in the reinforcing fabric. Integral densification of the CMC and the foam core is accomplished with chemical vapor deposition, eliminating the need for bond-line adhesive. This means there is no need to separately fabricate the core and the face sheet, or to bond the two elements together, risking edge delamination during use.



The **Foam Core Ceramic Matrix Composite** is a weave SiC and carbon fiber, which allows heat dissipation in-plane. Face sheet thickness is nominally 2.4 mm, and core thickness is 1.26 cm.

Fibers of two or more types are woven together on a loom. The carbon and ceramic fibers are pulled into the same "pick" location during the weaving process. Tow spacing may be varied to accommodate the increased volume of the combined fiber tows while maintaining a target fiber volume fraction in the composite. Foam pore size, strut thickness, and ratio of face sheet to core thickness can be used to tailor thermal and mechanical properties. The anticipated CTE for the hybridized composite is managed by the choice of constituents, varying fiber tow sizes and constituent part ratios.

This structural concept provides high strength and stiffness at low density — 1.06 g/cm^3 in panels tested. Varieties of face sheet constructions are possible, including variations in fiber type and weave geometry. The integrated structures possible with this composite could eliminate the need for non-load-bearing thermal protection systems on top of a structural component. The back sheet can readily be integrated to substructures through the incorporation of ribs. This would eliminate weight and cost for aerospace missions.

This work was done by Frances I. Hurwitz 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-18126-1.

Inert Welding/Brazing Gas Filters and Dryers

This system can be used in any process requiring reduction of inert-gas moisture level.

John F. Kennedy Space Center, Florida

A system has been designed to reduce the hydrogen molecule content in inert gases that are used for shielding the welding arc and molten weld area during the manual fusion, automated welding, and induction brazing process. Two desiccant pipeline dryer cartridges are connected together using either aircraft or KC .250 fittings, and are installed in-line between the inert-gas facility source (argon and helium) and the welding machine. This process helps maintain alloy grain structure and integrity to engineering specifications during the welding and brazing processes. Also, this method enhances weldability when joining similar and dissimilar alloys. It is easy to restore the system to original drying capabilities by using a nitrogen purge or by oven drying. This design has low schedule impact or down time when being installed on machines or in systems. There is also a sight glass to indicate when servicing is needed.

Reducing the moisture level in ultra-high-purity gasses also lowers costs. The