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# NASA TECH BRIEF

*Lyndon B. Johnson Space Center*



## Lightweight Graphite/Polyimide Panels

Composite construction materials are made from a polymeric resin incorporating fibers of a material such as graphite or boron to improve their strength. By aligning the fibers in the same direction, the materials can be made with strength-to-weight ratios greater than metals. Because of their great strength, these lightweight composites promise to become one of the most important construction materials.

Graphite composite technology has expanded into the area of honeycomb-cored sandwich panels. The panels are constructed of a honeycombed polyimide/graphite core covered with a thin face sheet of the same material. The fabrication is based on an extension of thin-gage graphite technology and a modification of glass filament polyimide honeycomb techniques.

The honeycomb is prepared from two cross-plied sheets of prepreg. The prepregs are fabricated by spraying a light film of polyimide resin on a drum. Ribbons of tow-type graphite fiber are then spread to a three-inch (7.6 cm) width and wound onto the drum to produce 7000 filaments per inch (2750/cm). A second light coat of resin is applied, and the prepreg is removed from the drum. After a second prepreg is prepared, the two are crossplied and pressed together.

TABLE I

HONEYCOMB PANEL STRUCTURAL PERFORMANCE SUMMARY

| Design Property | Value | |
|---|---|---|
| | 25° C PSI | 260° C PSI |
| Facing strength | | |
| Parallel to ribbon | 42,000 | 31,320 |
| Perpendicular to ribbon | >16,750 | 17,390 |
| Facing modulus (psi x $10^6$) | | |
| Parallel to ribbon | 18 x $10^6$ | 17.9 x $10^6$ |
| Perpendicular to ribbon | 5.1 x $10^6$ | 5 x $10^6$ |
| Flatwise sheer strength | | |
| Parallel to ribbon | 140 | 110 |
| Perpendicular to ribbon | 80 | 66 |
| Flatwise compressive strength | | |
| With foam | > 1,000 | 600 |
| Without foam | 194 | 150 |
| Total panel weight | 0.42, lb/ft$^2$ | |

(continued overleaf)

TABLE II

HONEYCOMB TEST RESULTS
3/8-IN. (0.98 CM) CELL SIZE

| Property | Temperature (° C) | Graphite/Polyimide | Aluminum | Glass/Polyimide |
|---|---|---|---|---|
| "L" Shear Modulus (psi) | 25 | 32,400 | 27,000 | 14,000 |
| | 232 | 27,830 | 17,010 | 11,500 |
| "W" Shear Modulus (psi) | 25 | 12,500 | 13,000 | 6,000 |
| | 232 | 13,470 | 8,190 | 4,900 |
| Compression Modulus (psi) | 25 | 19,600 | 45,000 | 20,000 |
| | 232 | 19,650 | 28,350 | 16,400 |
| Density ($lb/ft^3$) | | 1.9 | 2.0 | 2.5 |

This two-ply sheet is then dried, corrugated, and cured. The honeycomb is constructed with simultaneous curing of the node bonds and cell webs, an improvement over past techniques that results in a reduced core weight.

The face sheets are made from nine plies of a prepreg fabricated on a drum in the same manner as the honeycomb prepregs. They are pressed together, but this time without the cross-plying.

Finally, the honeycomb and the face sheets are bonded to each other to form the sandwich panel. A polyimide foam is used for edge closure. Bonding by dipping the core into a film of high-temperature adhesive further reduces the panel weight in comparison to fabrication by more usual techniques.

These panels are lightweight, stiff, and are relatively unaffected by temperatures up to 260° C, as shown by the list of properties in Table I. The panels have many properties superior to those of fiberglas or other polymer structures, and at higher temperatures, are better than aluminum, as shown in Table II.

**Note:**

1. The following documentation may be obtained from:
   National Technical Information Service
   Springfield, Virginia 22151

Development of Lightweight Graphite/Polyimide Honeycomb
Phase I – Materials Selection
Reference: NASA CR-115637 (N72-24533)
Single document price $4.75
(or microfiche $0.95)

Development of Lightweight Graphite/Polyimide Sandwich Panels
Phase II – Thin Gage Material Manufacture
Reference: NASA CR-115421 (N72-18577)
Single document price $4.75
(or microfiche $0.95)

Development of Lightweight Graphite/Polyimide Sandwich Panels
Phases III, IV, and V
Reference: NASA CR-12810 (N73-10503)
Single document price $7.75
(or microfiche $0.95)

**Patent status:**

NASA has decided not to apply for a patent.

Source: J. G. Poesch and
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