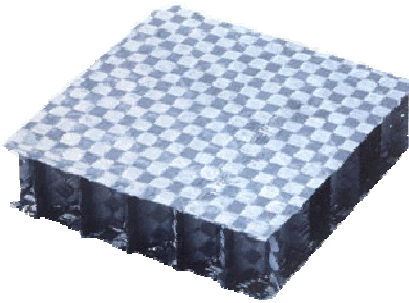


CARBON CARBON HONEYCOMB SANDWICH

(rev. 091301)

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Thermal Management on satellites has become an increasingly important part of spacecraft design. New satellites are becoming larger and more powerful, generating up to 20 kilowatts and carrying electronics payloads of up to 1,000 kilograms. To dissipate the heat from such a high-power system, innovative strategies are needed to both handle this heat and to keep weight down. Carbon-Carbon (C-C) honeycomb sandwich used as radiator panels to dissipate heat is one of these innovative approaches.

Presently, radiator panels are constructed from a composite sandwich using high thermal conductivity graphite facesheets with aluminum honeycomb core (H/C) or panels with aluminum facesheets and aluminum H/C.

CARBON-CARBON H/C SANDWICH PANEL

Ultracor Inc. now offers a Carbon-Carbon H/C sandwich panel. This sandwich is constructed from a low density, low modulus, Carbon/Epoxy H/C and thin low modulus Carbon/Epoxy facesheets. The entire structure is then processed into a high thermal conductivity, high modulus structure that has exceptionally good through the thickness ("Z-direction") thermal conductivity, low CTE (-0.15 ppm/°C), and low density. It is intended that the sandwich will be used as spacecraft radiator panels and in other thermal management applications. The C-C panels are priced competitively to current radiator panels.

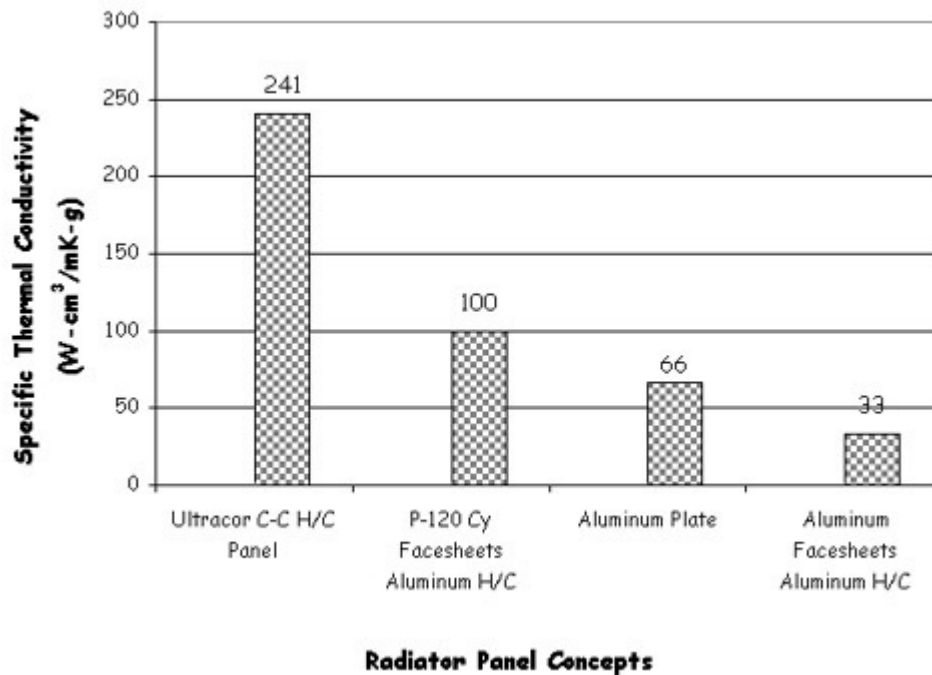
THERMAL PROPERTIES

The table below lists the thermal conductivities and density of existing passive radiator concepts and Ultracor C-C radiator panels.

	Ultracor C-C H/C Panel	P-120 Facesheets Al. H/C	Aluminum Facesheets Al. H/C	Aluminum Plate
Thermal Conductivity (in plane) (W/mK)	350	275	180	180

Density (g/cc)	0.27	0.2	0.3	2.7
Specific Thermal Conductivity (W-cm ³ /mK-g)	1296	1375	600	66
Thermal Conductivity in Z-direction (W/mK)	65	20	10	180
Specific Thermal Conductivity (W-cm ³ /mK-g)	241	100	33	66

The figure below compares the specific thermal conductivity of existing passive radiator concepts and Ultracor C-C radiator panels.



MECHANICAL PROPERTIES

The mechanical properties of the C-C honeycomb core were determined using ASTM C365 and C273 for Core Compression and Core Shear, respectively. The table below shows two types of C-C honeycomb core and its mechanical properties. PCC-300 samples are of C-C panels and UCC-2158 samples are of bare C-C honeycomb core.

Type	Density	Flatwise Tension	Comp. Strength	"L" Shear Strength	"L" Shear Modulus
	pcf (g/cc)	psi (KPa)	psi (KPa)	psi (KPa)	ksi (MPa)
PCC-300-3/8-4.0	4 (0.064)	98 (676)	500 (3447)	325 (2241)	194 (1331)
UCC-2158-3/16-10	12 (0.192)	-	1411 (9729)	1025 (7067)	265 (1827)