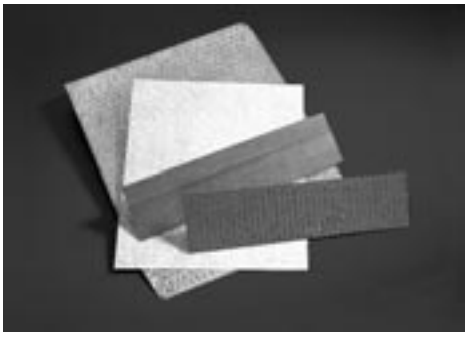
Carbon Base Heat Spreaders

The Cutting Edge in High *k* Materials

6 Uniquely Different Materials Available



INTRODUCTION

Enertron's family of carbon base heat spreaders includes polymer, metal, and carbon matrix composites as well as pyrolytic graphite. These materials are specifically designed for use in electronics thermal management. They are used in a variety of ways as heat pipe replacements, as CTE matching thermal spreaders for chip packaging, and as component level heat spreaders. Each material system is unique, with its own benefits, limitations, and specific applications. Enertron's engineers are available to provide assistance with the carbon base materials.

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Woven Carbon Fiber (WCF):

Sheets of this material can be designed to attach to the inside of an electronics enclosure to spread heat away from the hotter components. The material, when produced as a heat spreader in production quantities, is very cost effective vis-a-vis its performance. It is extremely light weight and is somewhat pliable, although not at sharp angles.

Specifications:

Density:	1.85 g/cm^3 multiplied by the % of fiber volume.
Thermal Conductivity:	1D, up to 350 W/m-°K (x axis) 2D, up to 175 W/m-°K (x/y axis)
Effective Thickness:	0.3 mm to 2 mm

Best Applications:

- High-End Notebook PCs
- Ultra-slim Portables

Carbon Carbon Composite (3C):

The process of creating a 3C plate involves first weaving carbon fibers to the customer's specifications (one or two axes), adding a carbon matrix resin, and then machining the plate to the customer's specifications. The result is a very lightweight plate with very high thermal conductivity. 3C plates are highly customizable. Enertron's engineers will need detailed property (e.g. load bearing, directional, radio frequency) requirement information in order to design the best possible solution. 3C's cost is approximately twenty times that of WCF, but has much better thermal performance.

Specifications:

Density:	1.85 g/cm^3
Thermal Conductivity:	1D, 800 W/m-°K (x axis), 50 W/m-°K (y/z axes) 2D, 350 W/m-°K (x/y axes), 40 W/m-°K (z axis)
Coefficient of Thermal Expansion:	~ -0.05 ppm/°K (x/y axes), 5-7 ppm/°K (z axis)
Effective Thickness:	0.5 mm to 3.5 mm

Best Applications:

- Aerospace Modules
- Avionics Systems

Polymer Matrix Composites

Polymer Matrix composites are sheets of woven fabric or chopped fiber. These sheets can be laminated or injection-molded in production quantities and can be very cost effective.

Specifications:

Density:	1.65 g/cm^3
Thermal Conductivity	1D, up to 600 W/m-°K (x-axis) 2D, up to 300 W/m-°K (x/y axis)
Typical Thickness	0.2 - 5 mm

Best Applications:

- High End Notebook PCs
- Ultra Slim Portables

See page 2 for information on additional Carbon Base Materials.

Enertron... A Powerful Thermal Management Team and a Skilled Production Partner
Enertron is both a powerful thermal management engineering service and a highly-skilled, cost effective production partner. Enertron offers custom thermal solutions at "off-the-shelf" prices and delivery times. Enertron's customers are Fortune 500 companies in the computer, microelectronics, aerospace, and defense industries. Enertron competes on its industrial expertise, timely service, and unerring commitment to excellence for its customers.

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Metal Matrix Composites

Metal Matrix Composites are aluminum and copper-impregnated pseudo-isotropic composites which are used in chip packaging. By adjusting the volume of metal in the composite, the CTE of the material can be modified to match the CTE of Silicon, GaAs, and Alumina (Al_2O_3) while still maintaining good thermal conductivity.

Specifications:

Density:	2.3 g/cm^3 when impregnated with Aluminum, 5.0 g/cm^3 when impregnated with Copper
Thermal Conductivity	150-225 W/m-°K in all three axis
CTE - RT	2-10 ppm/°K
Typical Thickness	1-50 mm

Best Applications:

- High-Power Density Chip Packaging

Carbon Matrix Composites

Carbon matrix composites can be used as thermal spreaders where planar and through thickness conductivity are critical. In addition, SiC can be added to the surface of C-C composites for CTE modification and for achieving smoother contact surface.

Specifications:

Density:	1.8 g/cm^3
Thermal Conductivity	1D, up to 800 W/m-°K (x-axis), 50 W/m-°K (z axis) 2D, up to 550 W/m-°K (x/y axis), 40 W/m-°K (z axis)
CTE - RT	-1.5 ppm/°K (x/y axis), 5-7 ppm/°K (z axis)
Typical Thickness	0.2-5 mm

Best Applications:

- Aerospace and Space Avionics Thermal Planes and Thermal doublers

Pyrolytic Graphite

PG is highly-oriented crystalline graphite. PG has 3 times the thermal conductivity of copper in both x and y directions. PG is very soft and has minimal structural integrity. It is usually sandwiched between two aluminum plates for structure. The material is relatively expensive.

Specifications:

Density:	2.2 g/cm^3
Thermal Conductivity	1200 W/m-°K (x/y axis), 10 W/m-°K, (z axis)
CTE - RT	-1.0 ppm/°K (x/y axis), 20 ppm/°K (z axis)
Typical Thickness	0.5-10 mm

Best Applications:

- Specialized high power applications.

Enertron provides optimal thermal design solutions using the most innovative and cost-effective material systems available. Enertron is also a leading producer of thermal management systems for portable PCs.

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