

GRAPHENOL HS

Ultra-High Heat Spreading Pyrolytic Graphite Film

Type: HS - Dry Film Surface

In-Plane Thermal Conductivity: 1,500 W/m-K

Graphenol HS offers an ultra-high in-plane thermal conductivity packaged with superior handling characteristics over traditional pyrolytic graphite films available on the market today. Graphenol HS's enhanced durability properties prevents breaks and film shattering that can typically occur in other brittle pyrolytic graphite films.

Graphenol HS is a non-metallic lightweight thermal interface material ideal for a range of applications including consumer mobile electronics (mobile phone, tablets, laptops), battery thermal management and medical device electronics assembly.

Graphenol HS's flexible film design allows for bending along a range of angled planes without worry impacting its lateral heat flow. Graphenol HS film can be paired easily with adhesive backings for enhanced ease of assembly as well as barrier film laminations to achieve a variety of properties (polyimide film, PET film, conformal film backings).

Graphenol HS exhibits ultra-low water absorption allowing it to operate reliably within demanding environmental temperature and humidity conditions. Due to its high electromagnetic shielding capability, Graphenol HS is suitable for EMI-shielding applications especially at frequencies of 5GHz and above.



- Flexible—easily navigate angles and bends
- High temperature resistant
- Low water absorption characteristics
- High thermal diffusivity
- Non-metallic TIM solution
- Excellent EMI-Shielding capability
- Electrically conductive film
- Durable film—resistant to breaks and shatters
- Optional adhesive backings
- Optional discrete adhesive placements
- Optional dielectric or insulating film backings
- Optional silicone film or metal foil backings

Typical Device Applications

- Battery Thermal Management
- High Power Density Energy Storage
- Automotive Inverter | Electronics
- Mobile Consumer Electronics
- LED Assembly
- Lighting (consumer or commercial)
- High End Computing
- Medical Electronics
- Robotics | Automation
- Microprocessor | Heat Sink
- Memory Module | Heat Sink
- EMI-Shielding

Graphenol HS Properties

In-Plane (XY) Thermal Conductivity	1,500 W/m-K
Thru-Plane (Z) Thermal Conductivity	5.0 W/m-K
Base Material Chemistry	Pyrolytic Graphite
Density	2.0 g/cm ³
Electrical Conductivity	14,000 S/cm
Water Absorption	< 0.1%
Bending Cycles	> 10,000 cycles
Min / Max Operating Temperature	-100C / 500C
Material Surface	Dry
Material Color	Silver/Gray

Graphenol HS Standard Film Thickness

HS-32 (32 microns 1.26 mils)	HS-40 (40 microns 1.57 mils)
HS-70 (70 microns 2.76 mils)	

Graphenol HS Thermal Impedance (per ASTM D5470)

HS-32 (32 micron | 1.26 mils)

5 PSI	0.299 °C-in ² / W		1.93 °C-cm ² / W
10 PSI	0.290 °C-in ² / W		1.87 °C-cm ² / W
20 PSI	0.193 °C-in ² / W		1.25 °C-cm ² / W
40 PSI	0.074 °C-in ² / W		0.48 °C-cm ² / W
80 PSI	0.028 °C-in ² / W		0.18 °C-cm ² / W
100 PSI	0.025 °C-in ² / W		0.16 °C-cm ² / W

HS-40 (40 micron | 1.57 mils)

5 PSI	0.328 °C-in ² / W		2.12 °C-cm ² / W
10 PSI	0.315 °C-in ² / W		2.03 °C-cm ² / W
20 PSI	0.226 °C-in ² / W		1.46 °C-cm ² / W
40 PSI	0.117 °C-in ² / W		0.75 °C-cm ² / W
80 PSI	0.047 °C-in ² / W		0.30 °C-cm ² / W
100 PSI	0.036 °C-in ² / W		0.23 °C-cm ² / W

HS-70 (70 micron | 2.76 mils)

5 PSI	0.344 °C-in ² / W		2.22 °C-cm ² / W
10 PSI	0.331 °C-in ² / W		2.14 °C-cm ² / W
20 PSI	0.237 °C-in ² / W		1.53 °C-cm ² / W
40 PSI	0.122 °C-in ² / W		0.79 °C-cm ² / W
80 PSI	0.049 °C-in ² / W		0.32 °C-cm ² / W
100 PSI	0.038 °C-in ² / W		0.24 °C-cm ² / W

Standard Graphenol HS Cross Section



Adhesive Backing Options

A	low tack (repositionable)	12.5 microns 0.5 mils
T20	thermally conductive (high adhesion)	50.8 microns 2.0 mils

100% adhesive surface backing or discrete adhesive placement (outside of primary thermal via)

Dielectric Film Lamination Options

MT	Kapton ® MT	1.0 mil to 3.0 mil
MT+	Kapton ® MT+	1.5 mil to 2.0 mil
HN	Kapton ® HN	1.0 mil to 3.0 mil
PET	PET (polyester) Film	1.0 mil to 5.0 mil

Nominal adhesive tie layer utilized between HS and film layers

Non-Dielectric Foil Lamination Options

AL	Aluminum Foil	0.5 mil to 5.0 mil
CU	Copper Foil	1.0 mil to 5.0 mil
SS	Stainless Steel	0.5 mil to 3.0 mil

Nominal adhesive tie layer utilized between HS and foil layers

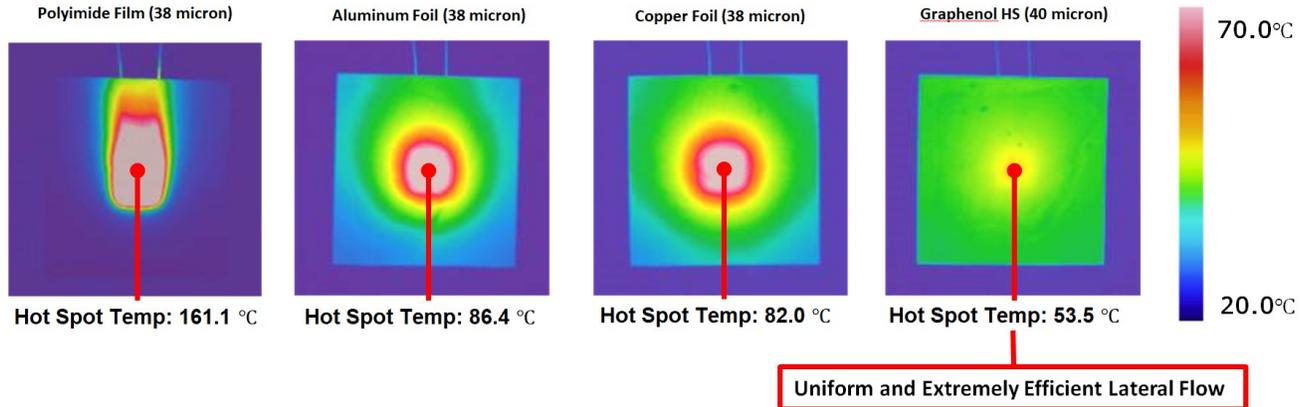
Conformable SILTEL Film & Gap Pad Lamination Options

SF	SILTEL Silicone Films	Several thicknesses and types
SG	SILTEL Silicone Gap Pads	Several thicknesses and types
NSG	SILTEL Silicone-Free Gap Pads	Several thicknesses and types

Visit www.streuter.com to review available SILTEL film and gap pad options
Nominal adhesive tie layer utilized between HS and SILTEL layers

Graphenol HS Lateral Heat Flow Capability

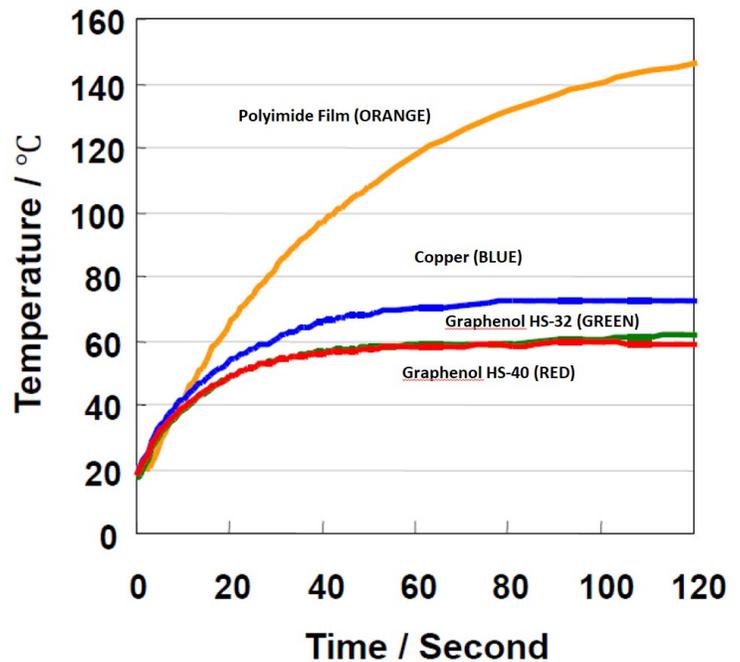
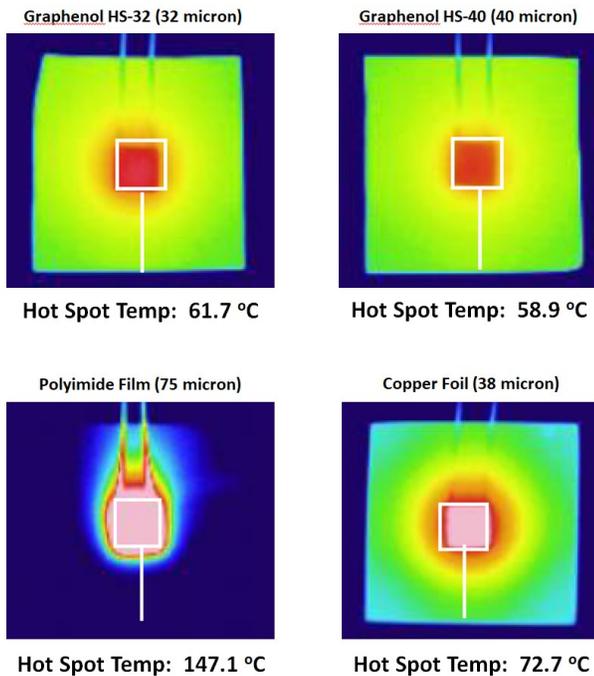
Graphenol HS has significantly higher heat spreading capability than copper, aluminum or polyimide film within the same relative thickness.



Graphenol HS lowers heat source (hot spot) temperatures by 201.1% over thermally conductive polyimide films
 Graphenol HS lowers heat source (hot spot) temperatures by 61.5% over aluminum foil
 Graphenol HS lowers heat source (hot spot) temperatures by 53.5% over copper foil

Graphenol HS Heat Flow Efficiency

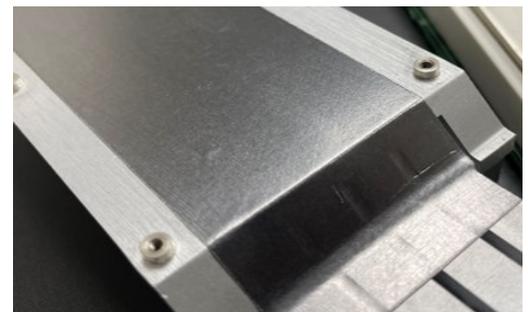
Due to the uniformity of the internal graphite layers within Graphenol HS, it exhibits extremely high heat transfer efficiency. As shown in the graph below, heat dissipation begins to occur much quicker with Graphenol HS when compared to copper and polyimide film allowing for devices to operate at cooler temperatures sooner. This type of heat dissipation capability makes Graphenol HS ideal for both high or low frequency (on/off) applications.



Graphenol HS—Flexibility and Durability

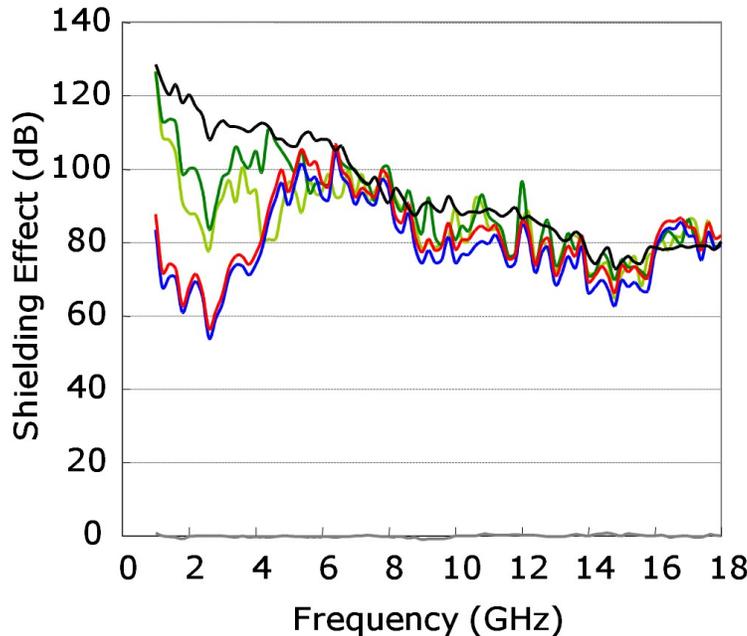
The flexibility and durability of the Graphenol HS film substrate is suitable for applications that require the TIM material to follow various angles and slopes with no change in lateral heat spreading capability. Full 180° ultra-sharp crease scenarios may impact lateral heat flow.

Graphenol HS can be installed without worry of breaks or shattering that is typically found in more traditional pyrolytic graphite films. Graphenol HS has been cycle tested and able to withstand > 10,000 bends without substrate breaks or shattering. Test stopped after 10,000+ bends.



Graphenol HS - EMI-Shielding Capability

Graphenol HS can be considered for applications that require a high performing EMI-shielding solution especially at frequencies at or above 5GHz. Graphenol HS provides the ability to offer EMI-Shielding without the use of a metallic shielding material. Contact us for applications that require a multi-layer insulation/shield/insulation configuration.



Materials Tested

Aluminum Foil (Light Green)

Copper Foil (Dark Green)

Graphenol HS-32 (Blue)

Graphenol HS-40 (Red)

Measurement limit (Black)*

* attributed to measurement system

KEC Method: 1~18GHz

Graphenol HS Other Information

Characteristic	Graphenol HS
Compliance	RoHS REACH Halogen Free
Standard Roll Widths	HS-32, HS70 (6.00" 152.4mm) HS-40 (8.00" 203.2mm)
Standard Sheet Lengths	6" (152mm) 12" (305mm) 18" (457mm)
Typical Die Cut Dimensional Tolerances Confirmed during drawing review	Die cut individual pads: +/- 0.010" (0.25mm) Die cut reels: 0.020" (0.50mm)
Storage Temperature	60°F to 80°F (15.5°C to 26.6°C)
Storage Environment	Store in a cool, dry location until use
Shelf Life	2 years from date of manufacture (HS film) Optional adhesive, film or foil laminations may impact shelf life.
Handling Notes	Avoid touching film surface with hands to avoid contamination As Graphenol HS is more durable and handling friendly than traditional pyrolytic films, HS should still be handled with a degree of care
Phase Change Coating Options	Graphenol PCM—visit www.streuter.com to learn more

Graphenol HS Samples and Prototypes

Thermal material evaluation is always critical when designing in a new material or developing a new product. Bulk sheet samples of Graphenol HS as well as cut prototypes are available for preliminary testing in order to optimize the best Graphenol HS Die Cut Pre-Form within the scope of your application. Contact us for details on how to receive bulk sample sheets as well as cut prototypes for testing.