

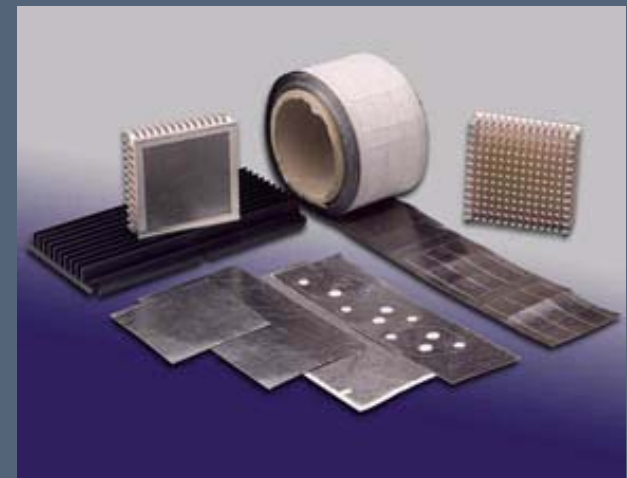
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GrafTech International Ltd.

eGraf™ Thermal Interface Materials



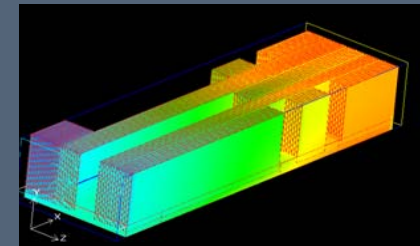
**Features
Advantages
&
Benefits**



New Thermal Interface Materials from a Company with a Long Technical History



- 120 + Years of Carbon & Graphite History
- 120 + Years of High Temperature Processing
- ISO Certified since 1996
- QS-9000 Certified since 2000
- World Class R & D Facility in Parma, Ohio, USA
- Full Thermal Design and Testing Capabilities



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eGraf™ Thermal Interface Material Comparison vs Competitive Materials



- Performance equal to or better than the Best thermal tapes
- With HiTherm, performance close to that of the very best Phase Change Material
- No Reflow & Rework issues
- High Volume / Cost effective manufacturing process allows:
 - Extremely attractive cost / value equation

**Phase Change - like Performance
No reflow & No Rework issues
@ Tape Cost !**



Product Classifications ^{1/2}

Thermal Greases

dispersed thermally conductive ceramic fillers in silicone or hydrocarbon oils to form a paste

Gels

compounds are converted to a cured rubber film after application at the thermal interface. Initially flow as freely as grease.

Elastomers

silicone elastomer paste filled with thermally conductive ceramic particles often re-enforced with woven glass fiber or dielectric film for strength



Product Classifications 2/2

Adhesive Tapes

double sided pressure sensitive adhesive films filled with ceramic powder and supported with either aluminum foil or polyimide film

Phase Change

Thixotropic, paste like product which when heated (crossover temperature) turns to liquid, fills voids and returns to a solid.

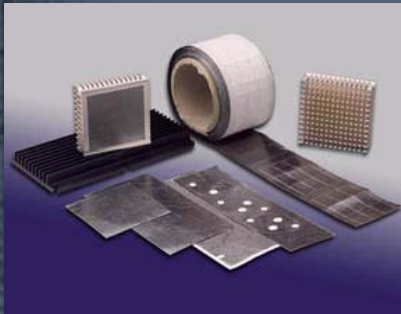
Soft Solders

Solders with low melting points and high thermal conductivity



Product Classification Advantages / Disadvantages

MATERIAL	TYPICAL COMPOUND	ADVANTAGES	DISADVANTAGES
Thermal Grease	AlN, ZnO, Silicon Oil	High bulk thermal conductivity, Conformability, No cure	Pump out, Separation, Migration, Processing/Handability Issues
Gel	Al, Ag, Silicon, olefin	Good bulk thermal conductivity, Conforms before cure, No pump out or Migration	Processing/Cure needed, Moisture issues
Adhesives	Ag filled epoxies	Conforms to surface irregularities, No pump out	Processing /Cure needed, Stress at interfaces, Resin-Filler separation
Elastomers	BN, Alumina, Silicone, Urethane Rubbers	Good handability, High bulk thermal conductivity, No pump out, Gap filling, Film form	Very high contact resistance, Need high clamping pressure
Phase Change	Polyolefins, Epoxies, Polyesters, Acrylics, BN, Alumina	Conforms to surface irregularities, no cure needed, Film Form	Utilized with carriers, Lower thermal conductivity than grease, Technology limitations
Soft Solders	Indium, Tin-Silver	High bulk thermal conductivity	High stress at Interfaces





eGraf™ Thermal Interface Material Features

Heat Transfer Performance

Superior to most commercial materials in conducting heat in-plane and through the thickness

Conformability and Resilience

Exhibits extremely low thermal contact resistance

Thermal Anisotropy

Minimizes temperature variation and dampens hot spots

Consistent Application Performance

Insensitive to service-thermal conditions and assembly process

Highly Customizable and Engineered Materials

Application/customer-driven product development

Proprietary and customized assembly solutions





Graftech Thermal Interface Materials

<u>Features</u>	<u>Advantages</u>	<u>Benefits</u>
Easy Rework	Ability to Rework	Easy Repairs
No Reflow	No Need	Saves Asm'bly cost & time
No Mess vs. Grease & Gel	Cleaner Work Area	Saves Asm'bly cost & time
High Volume Capacity	Quick Turnaround	Lowers Inventory Costs
High Volume Capacity	Lower cost = lower price	Higher Value Equation
700/1200 No Outgassing	Higher Purity levels	Aerospace Compatible
UL-V90	700/1200 = 400C, HT=250C	Safety
Anisotropic	Insulation & Spreading	Custom Heat management
Tailorable Properties	Higher & Lower densities	Custom Heat management
Low pressure = High Perf	Simple clip mechanisms	Lower attachment cost
Edge Seal	No PSA, Easy attachment	Better Perf & Lower Cost
Compressibility	Sink Flatness less critical	Lowers cost of heatsinks
100% Graphite	Therm & Mech Stable	NO Dry Out, won't degrade



3 grades of eGraf™ Thermal Interface Material ^{1/2}

Grades 700, 1200 & HiTherm

HiTherm newly introduced April 2002 with Significant Improvements in Thermal Conductivity and Contact Resistance. Performance reaches the levels of Greases, Gels and PCM without the mess or rework/reflow issues of greases, gels and PCM

All have a thermal conductivity of about 200W/m.k in plane but different thermal conductivity through the thickness

Each can be delivered in various thicknesses depending on Customer needs



3 grades of eGraf™ Thermal Interface Material 2/2

eGraf 700

Thermal conductivity through the thickness ~7W/m.k

Available from 0.05" to 0.060"

Standard thickness : 5,10,15 & 20 mil"

Standard rolls 24" wide x 100 feet

Available in rolls or Die Cut to your drawing (any size or shape up to 600mm x 600mm)

eGraf 1200

Thermal conductivity through the thickness ~12W/m.k

Available from 0.05" to 0.060"

Standard thickness : 5, 10 & 20 mil"

Standard rolls 24" wide x 100 feet

Avail in rolls or Die Cut to your drawing (any size or shape up to 600mm x 600mm)

eGraf HiTherm

Thermal conductivity through the thickness ~16W/m.k

Available from 0.03" to 0.010"

Standard thickness : 3, 5 & 10 mil"

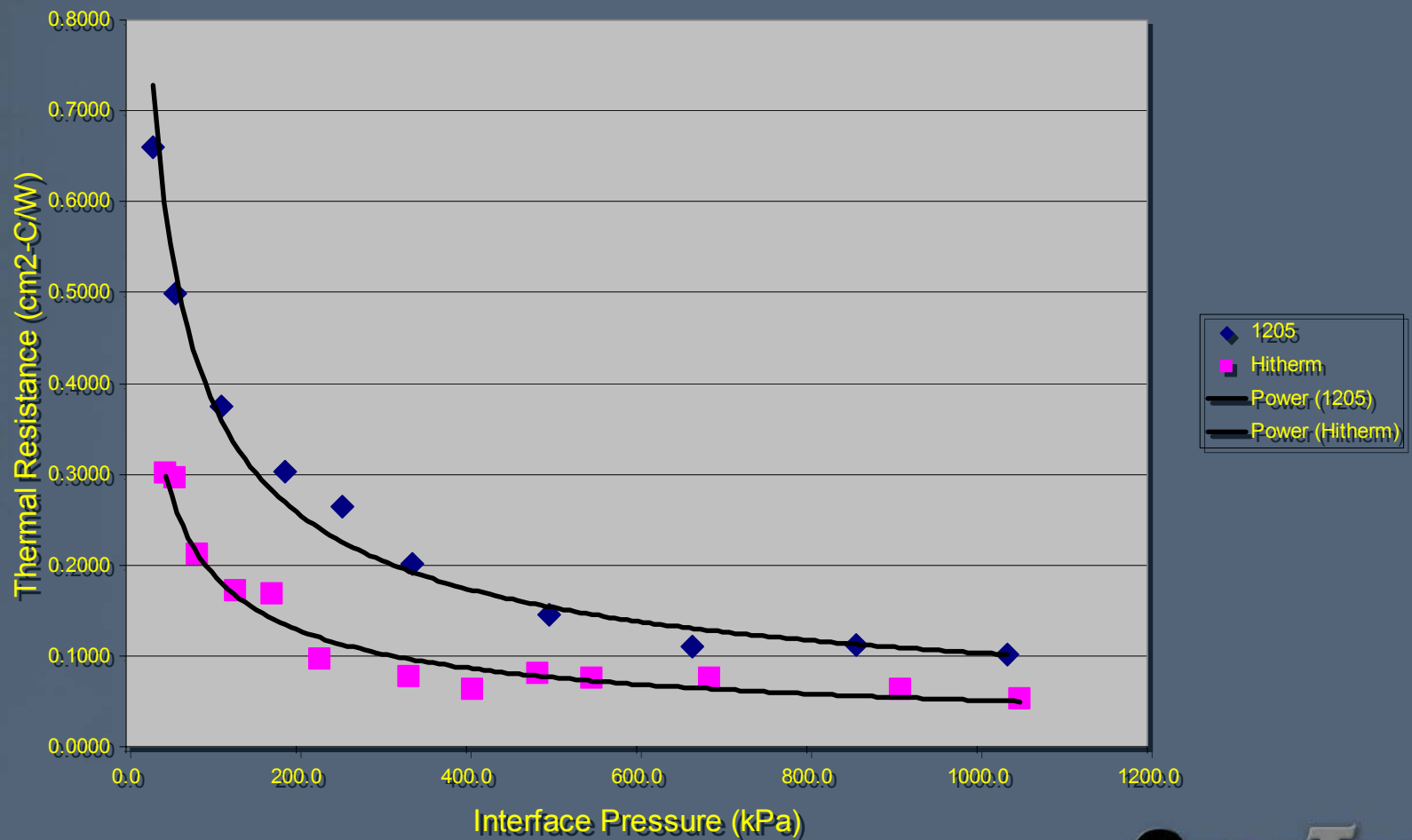
Standard rolls 24" wide x 100 feet

Die Cut to your drawing (any size or shape up to 600mm x 600mm)



eGraf™ 1205 & HT005

Variation of Thermal Resistance with Interface Pressure

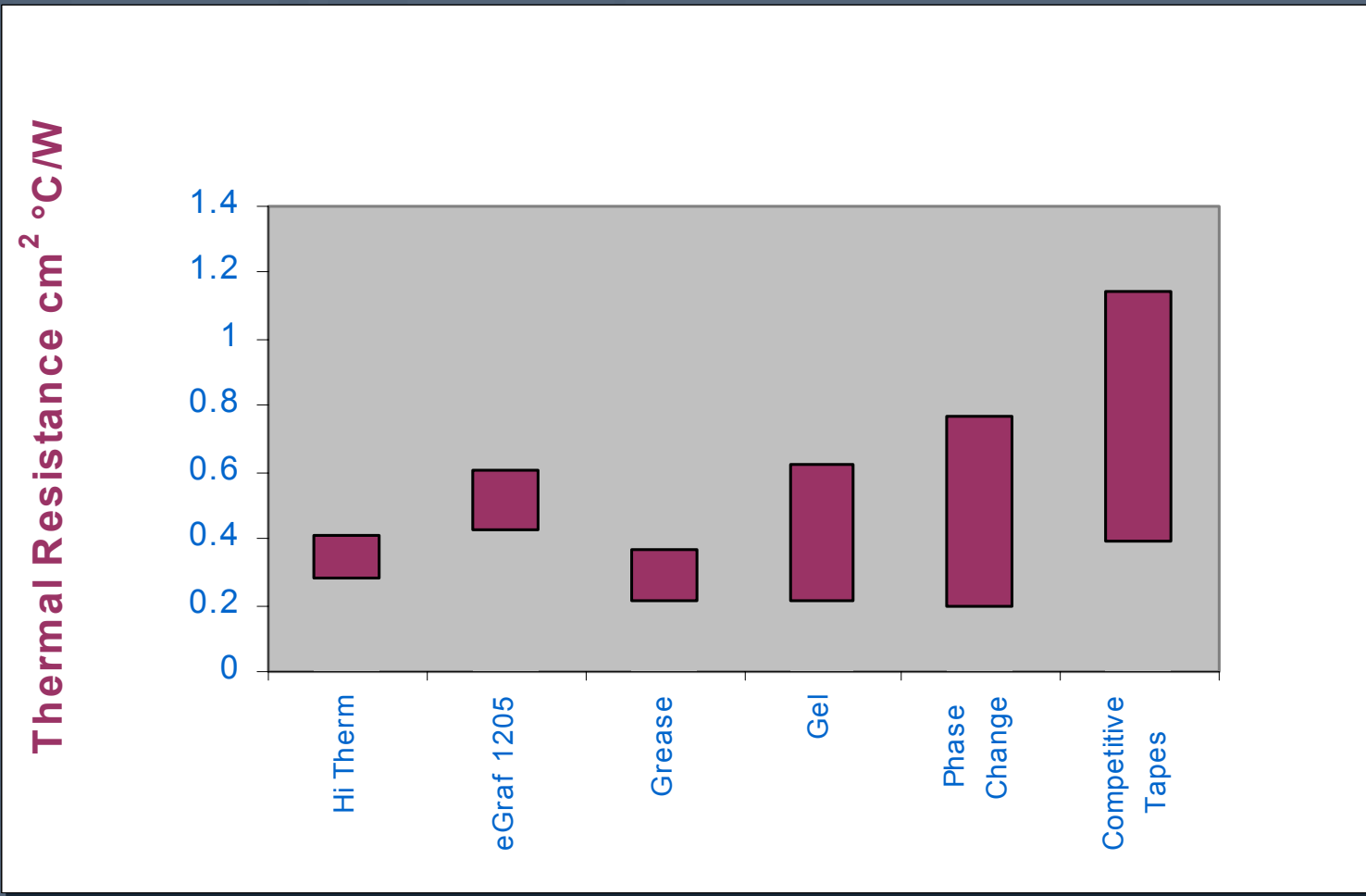


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eGraf™ 1205 & HiTherm vs. Other Material





Ordering Info & Options

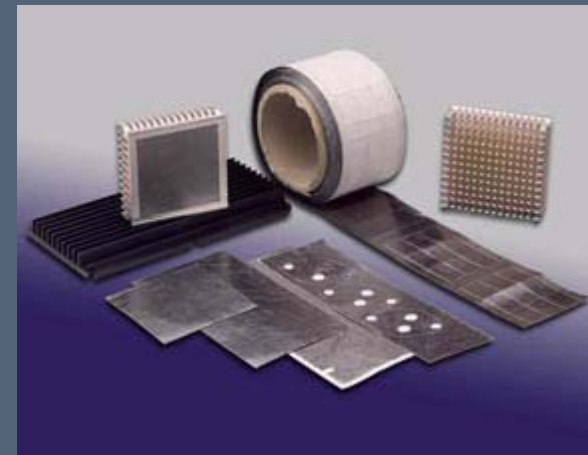
**Last 2 digits of p/n refers to the thickness of the material.
i.e. 1205 is our grade 1200, 0.005" thick.**

Available in Rolls

- slit sizes from 13mm up to 600mm widths
- lengths on non-PSA rolls up to 1,000 feet
- lengths on PSA coated rolls up to 100 feet

Several options are available :

1. PSA 1 side, add A to the p/n. i.e. 1205A
2. PSA 2 sides, add AA to the p/n. i.e. 1205AA
3. Electrical Insulation, add P to the p/n. i.e. 1205P
4. Edge Seal, add Edge Seal to the p/n : i.e 1205 Edge Seal



Contact factory for any Die Cut.

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