Basic Properties and Application Examples of PGS Graphite Sheet

PGS Graphite Sheet

1. Basic properties of PGS Graphite sheet
2. Functions of PGS Graphite sheet
3. Application Examples Presentation

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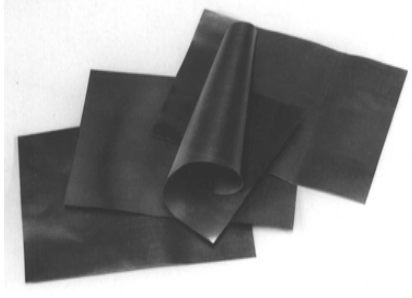
PGS Graphite Sheet

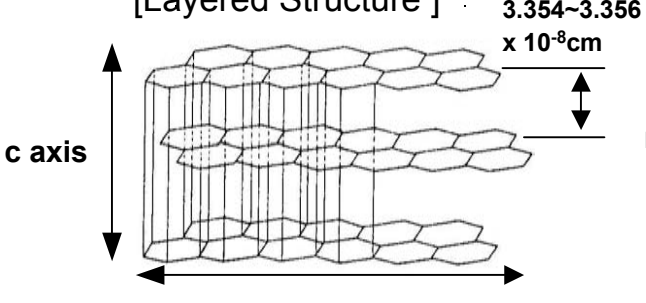
PGS Graphite Sheet

PGS (**P**yrolytic **H**ighly **O**riented **G**raphite **S**heet) is made of graphite with a structure that is close to a single crystal, which is achieved by the heat decomposition of polymeric film. PGS is a competitive conductive sheet with high thermal conductivity and high flexibility.

PGS Graphite Sheet:C99.9% or more

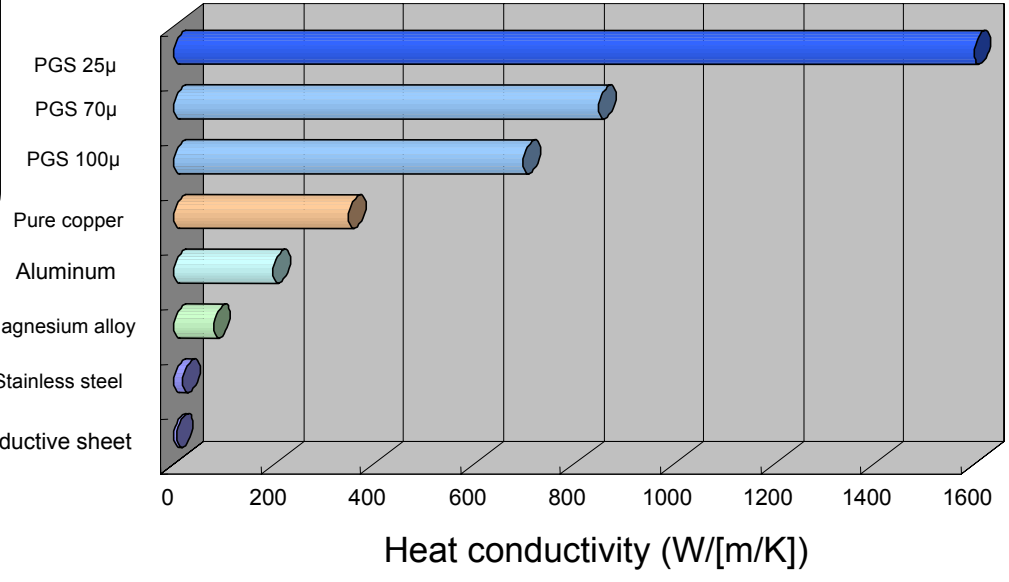


[Layered Structure]



High heat conductivity: Each material has high heat conductivity.

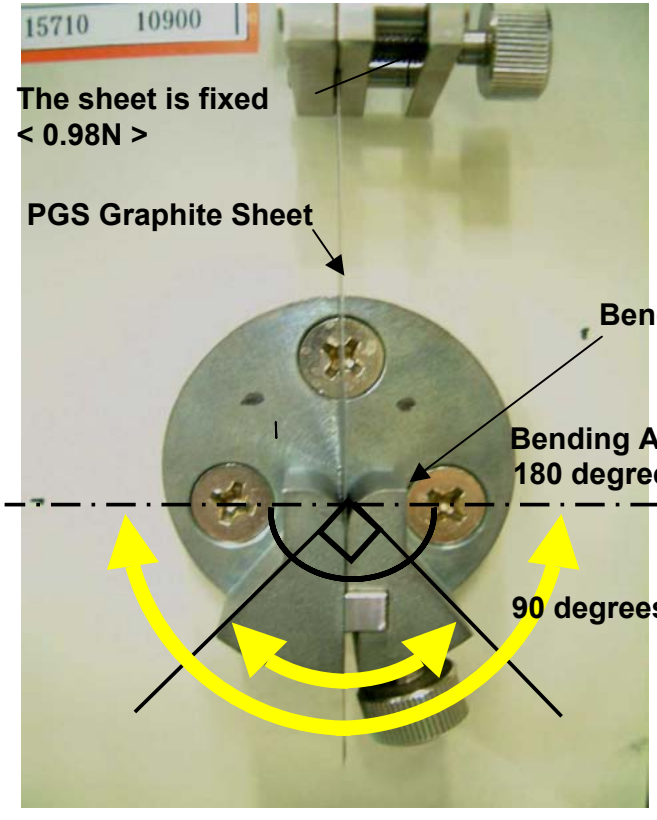
Heat conductivity of each material (a-b plane)



Flexibility of PGS Graphite Sheet

PGS Graphite Sheet

[Bending Test]



[Bending Limitation]

Bending Angle	Bending Radius(R)	
	R =2(mm)	R =5(mm)
90 degrees	10,000 cycls or more	100,000 cycls or more
180 degrees	3,000 cycls or more	30,000 cycls or more

Flexibility: PGS is bending-resistant due to its flexibility. PGS can be used for areas such as curved surfaces and corners because its heat conductivity will remain unchanged in the absence of folds in PGS.

Material Characteristics of Graphite Sheets

PGS Graphite Sheet

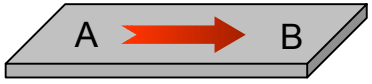
		PGS 100μm (100 +/- 30μm)	PGS 70μm (70 +/- 15μm)	PGS 25μm (25 +/-10μm)
Thermal Conductivity (W/m K)	X,Y direction	600 to 800	750 to 950	1500 to 1700
	Z direction	15	15	15
Thermal diffusivity (cm2/s)		9 to 10	9 to 10	9 to 10
Density (g/cm3)		0.85	1.10	2.10
Specific Heat (50deg.C)(J/gK)		0.85	0.85	0.85
Heat resistance (deg.C)		400	400	400
Extensional strength (MPa)	X,Y direction	19.6	22.0	30.0
	Z direction	0.4	0.4	0.1
Bending test (times) R5 180 deg.C		30000 or more	30000 or more	30000 or more
Electric Conductivity (S/cm)		10000	10000	20000

Applications of PGS Graphite Sheet (two functions)

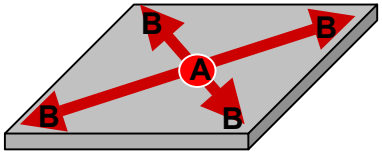
PGS Graphite Sheet

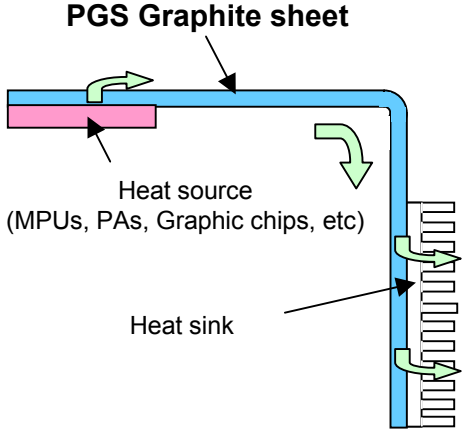
1)Thermal Transfer

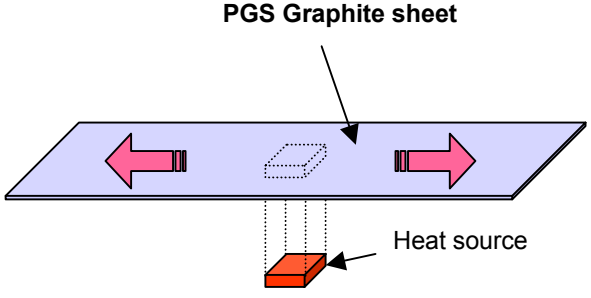
Carrying the heat



Diffusing the heat

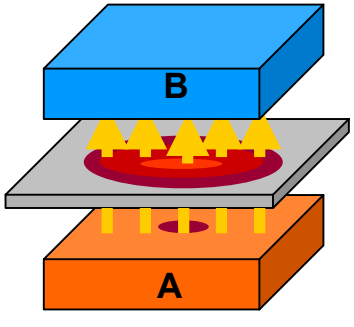


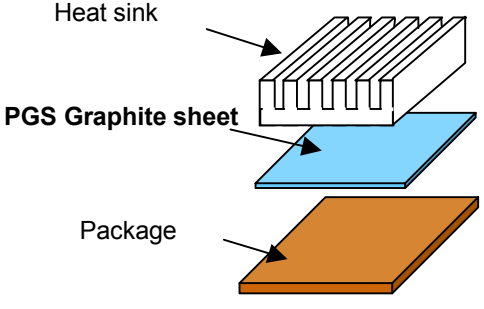


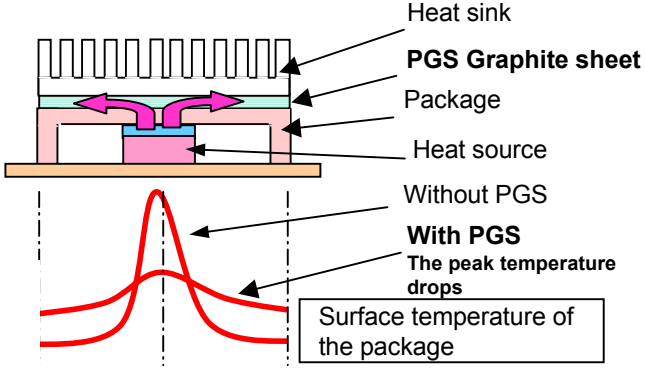


2)Thermal Interface

Decreasing the thermal resistance and diffusing the heat





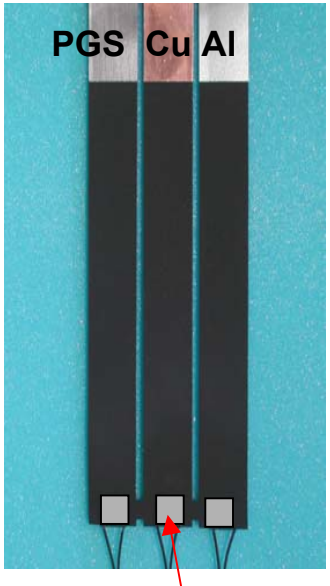


Application Example of PGS Graphite Sheet (Transfer)

PGS Graphite Sheet

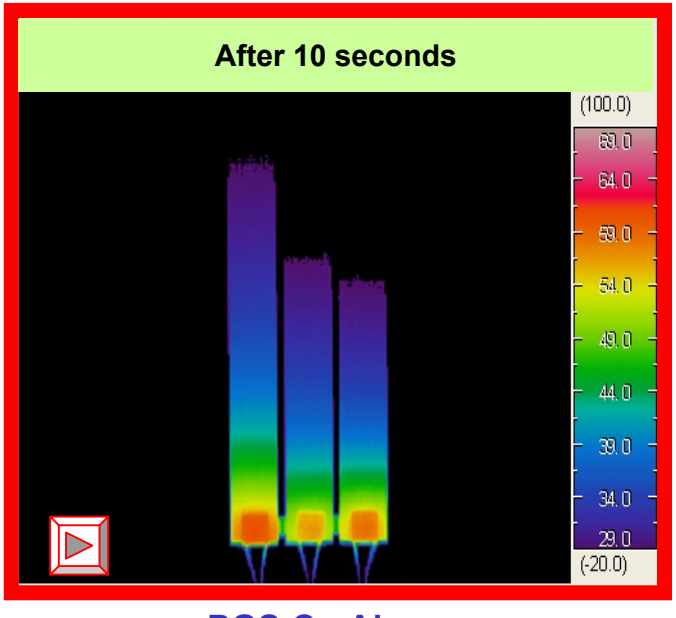
■ **Inspection 1** The heat transfer was monitored with thermograph after the heater was attached to the lower part of PGS, Copper and Aluminum.

Size;18x180x0.1mm



Resistance heater 10x10mm
Applied voltage 8V (appro.12W)

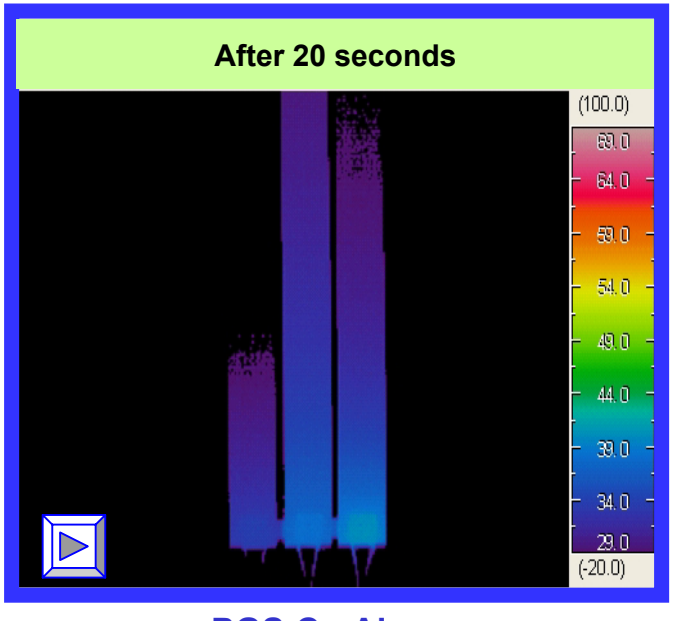
«Heat conductivity when the heater was on.»



PGS Cu Al

·PGS Graphite Sheet carries the heat rapidly due to high heat conductivity

« Cooling state when the heater was turned on during the heat balance state»



PGS Cu Al

·PGS Graphite sheet has high cooling effect .

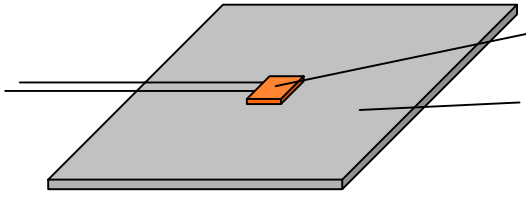
Application of PGS Graphite Sheet (Transfer)

PGS Graphite Sheet

■**Inspection 2** The heat transfer was monitored with thermograph after the heater was attached to the center part of PGS, Copper and Aluminum.

[Measuring method]

Resistance Heater
Electric power 12W



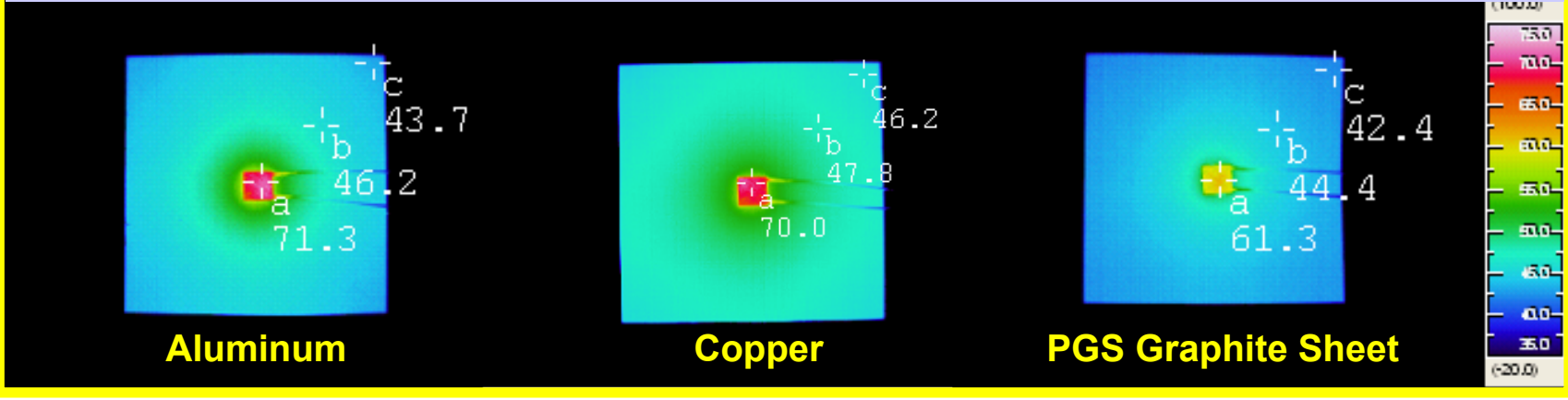
Heater size 10×10mm

Sample size(heat sink)
90×90×0.3mm

Ambient Temperature:25 deg.C

***The surface of the samples and the heater was subjected to black oxide treatment.**

After 30 minutes



Aluminum **Copper** **PGS Graphite Sheet**

・The temperature of the heater reveals that PGS Graphite Sheet carried the heat, keeping the heat temperature lowest among the three materials.
・The low temperature of PGS surface shows that PGS has high heat dissipation.

Thermal Resistance of PGS Graphite Sheet (Interface)

PGS Graphite Sheet

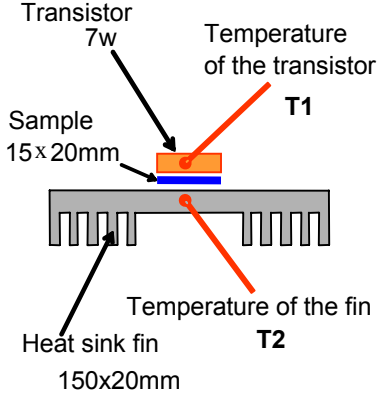
■Thermal resistance property

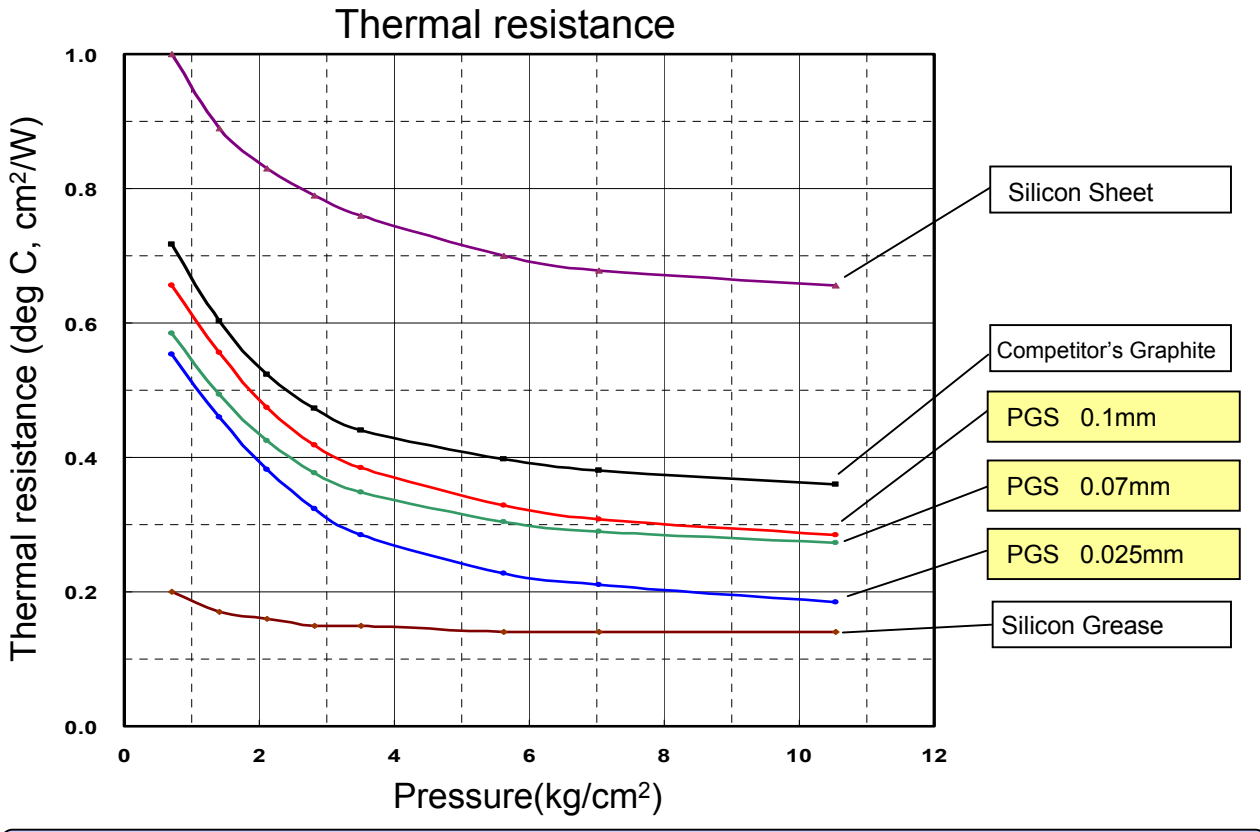
Thermal resistance represents the degree of non-conductivity of the heat. Materials with lower thermal resistance are a more efficient conductor of heat (Thermal resistance depends on hardness of, and surface condition of material as well as heat conductivity.)

[Measuring Method]
The sample is placed and fixed between the transistor and the fin to measure temperature difference, from which the thermal resistance is calculated.

Thermal resistance
Rth = (T1-T2) / W
(deg.C/W)

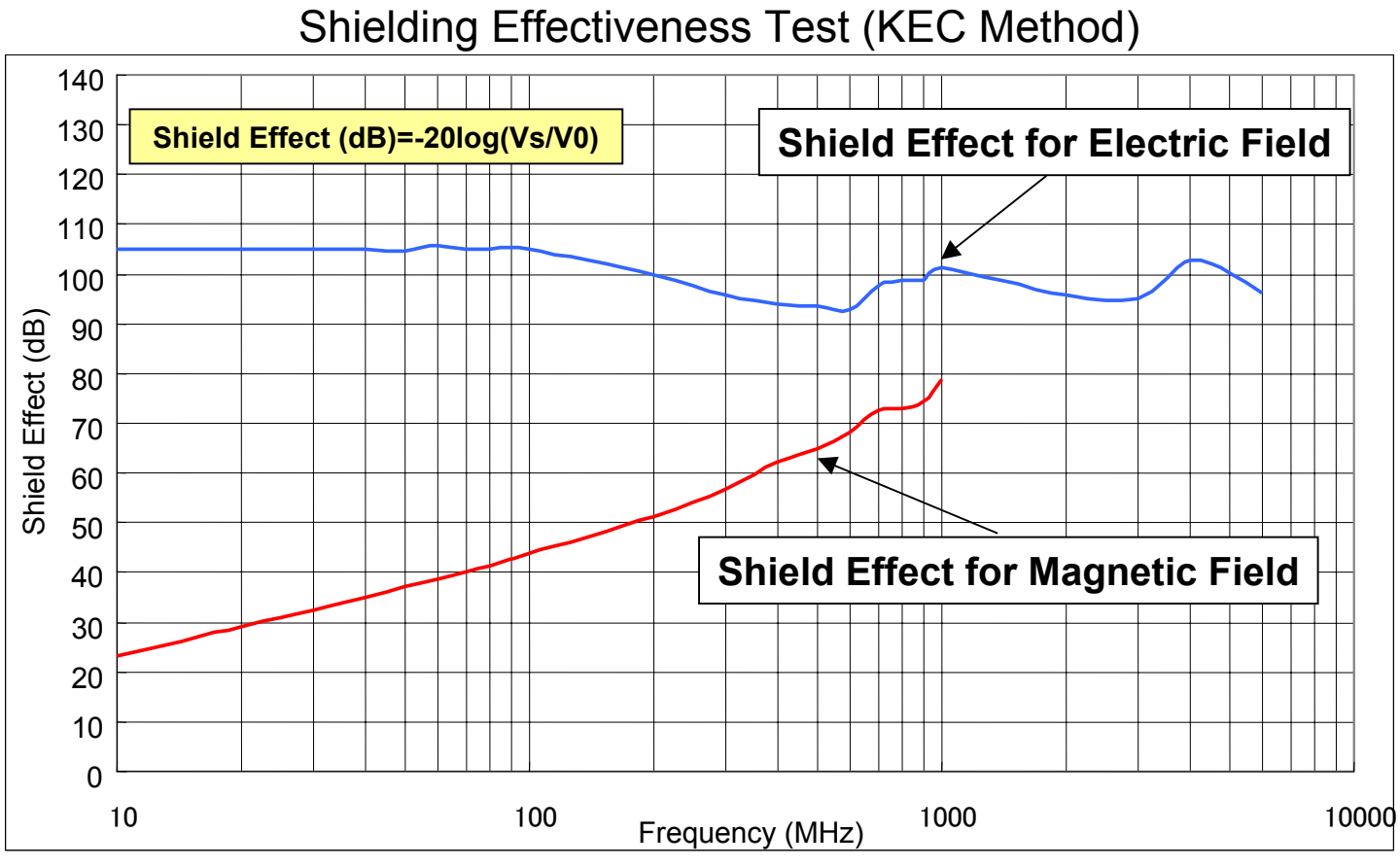
Transistor
1.5x2cm=3cm^2
P =approx. 7W





PGS has low thermal resistance due to its high conductivity and flexibility.

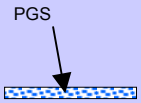
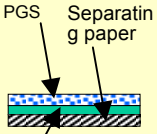
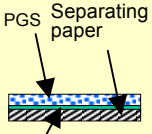
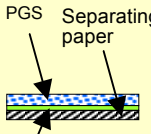
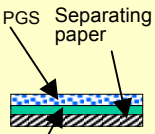
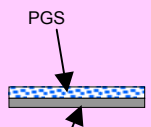
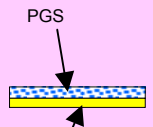
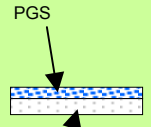
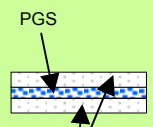
Shield Effect of PGS Graphite Sheet



PGS Graphite Sheet Application Development(PGS100μseries)

PGS Graphite Sheet

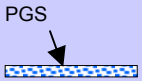
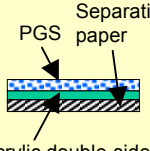
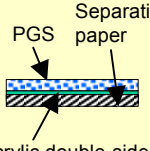
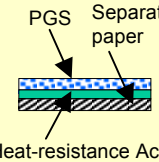
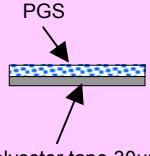
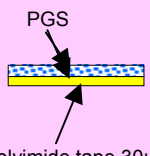
■ PGS100μseries

Type	1. PGS only	Adhesive type				Insulation type		Multilayered type	
		2. Insulative strong adhesion type	3. Insulative thin adhesion type	4. Low thermal resistancetype	5. High heat resistance type	6. Polyester tape type	7. Polyimide tape type	8. One-sided type	9. Double-sided type
Structure									
Features	• Maximizing the heat property and the flexibility of PGS	•Adding one-side adhesion •Employing insulating adhesive tapes	• Adding one-side adhesion • Employing insulating adhesive tapes	• Adding one-side adhesion • Improving thermal conductivity in adhesive layers	• Adding one-side adhesion • Employing high heat resistance double-sided tape	• Ensuring one-side insulation • Employing insulating film	• Ensuring one-side insulation • Employing heat-resistant insulating film	• Improving one-side thermal contact and absorbing roughness of contacted face • Low adhesion • Heat resistance	• Improving one-side thermal contact and absorbing roughness of contacted face • Low adhesion • Heat resistance
Thickness	100μm	130μm	110μm	110μm	130μm	130μm	130μm	200μm	300μm
Thermal conductivity	600 to 800 W/m K	500 to 600 W/m K	550 to 650 W/m K	550 to 650 W/m K	500 to 600 W/ m K	500 to 600 W/ m K	500 to 600 W/m K	250 to 350 W/m K	200 to 300 W/m K
Withstand temperature	400 deg.	100 deg.C	100 deg.C	100 deg.C	150 deg.C	100 deg.C	180 deg.C	180 deg.C	180 deg.C
Part No. Standard size	EYGS182310	EYGA091210A	EYGA091210M	EYGC091210C	EYGA091210T	EYGA091210P	EYGA091210K	EYGM121810SS	EYGM121810SW
	180 x 230mm	90x115mm	90x115mm	90x115mm	90x115mm	90x115m	90x115mm	115x80mm	115x180mm
Maximum size	360x460mm	115x180mm							

PGS Graphite Sheet Application Development (PGS70, 25μseries)

PGS Graphite Sheet

■ PGS70,25μseries

TYPE		1. PGS only	Adhesive Type			Insulation type	
			2. Insulative strong adhesion type	3. Insulating thin adhesion type	4. High heat-resistance type	6. Polyester tape type	7. Polyimide tape type
Structure							
PGS 70μSeries	Thickness	70μm	100μm	80μm	100μm	100μm	100μm
	Thermal conductivity	750 to 950 W/m K	550 to 700 W/m K	650 to 800 W/m K	550 to 700 W/m K	550 to 700 W/m K	550 to 700 W/m K
	Withstand temperature	400 deg.C	100 deg.C	100 deg.C	150 deg.C	100 deg.C	180 deg.C
	Part No.	EYGS182307	EYGA091207A	EYGA091207M	EYGA091207T	EYGA091207P	EYGA091207K
	Standard size	180x230mm	90x115mm	90x115mm	90x115mm	90x115mm	90x115mm
	Maximum size	180x460mm	115x180mm	115x180mm	115x180mm	115x180mm	115x180mm
PGS 25μSeries	Thickness	25μm	55μm	35μm	55μm	55μm	55μm
	Thermal conductivity	1500 to 1700 W/m K	650 to 800 W/m K	1100 to 1250 W/m K	650 to 800 W/m K	650 to 800 W/m K	650 to 800 W/m K
	Withstand temperature	400 deg.C	100 deg.C	100 deg.C	150 deg.C	100 deg.C	180 deg.C
	Part No.	**EYGS121803**	EYGA091203A	EYGA091203M	EYGA091203T	EYGA091203P	EYGA091203K
	Standard size	**115x180mm**	90x115mm	90x115mm	90x115mm	90x115mm	90x115mm
	Maximum size	**115x180mm**	115x180mm	115x180mm	115x180mm	115x180mm	115x180mm

PGS Graphite Sheet Application Method

1.Application Example of PGS through simulation

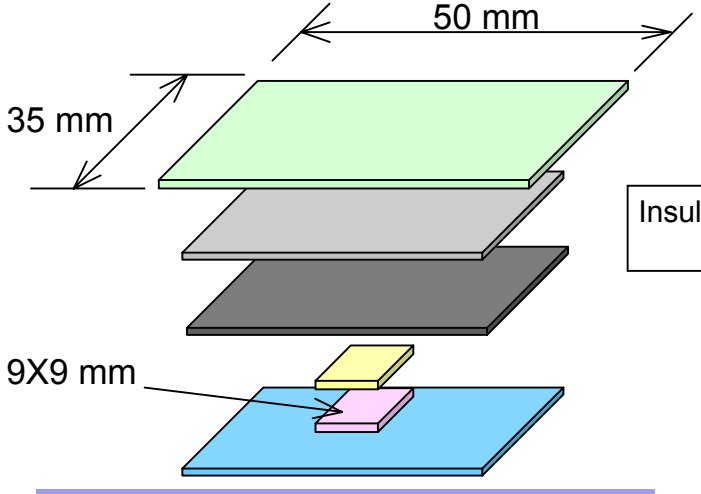
2.General Thermal Design Model

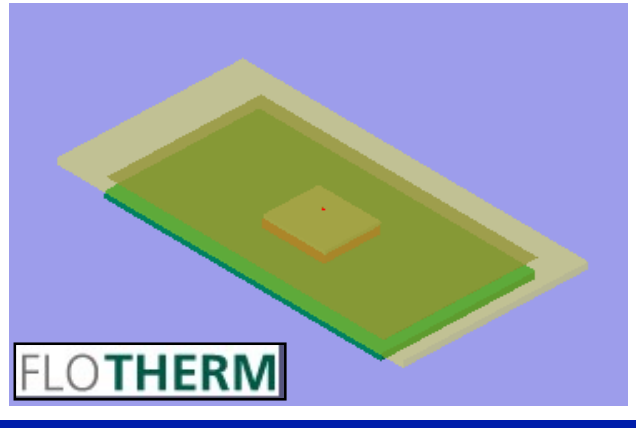
1.Application Example of PGS (Simulation with heat)

PGS Graphite Sheet

◆ **In this simulation test, thermal diffusivity will be measured by analyzing heat spot of a layered sample mainly consisting of PWB, IC (heating element), PGS and a case face (ABS Resin).**

[Model]





ABS Resin 35x50x1mm
K=0.18 W/m K

Graphite Sheet 25x40mm
Thickness : 0.025mm , 0.07mm

Measurement point

Insulated film 25x40x0.03mm
K=0.25 W/m K

at 35 deg.C

at 1atm

Silicon 9x9x0.5mm
K=1 W/m K

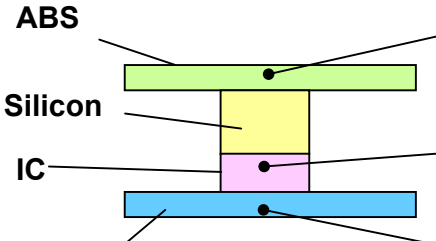
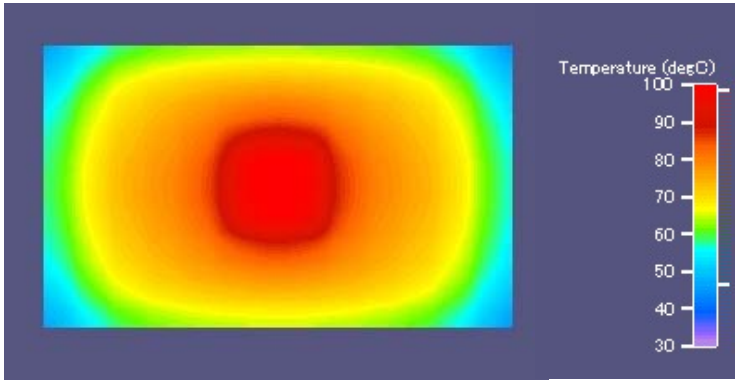
IC 9x9x1.2mm
P=1W

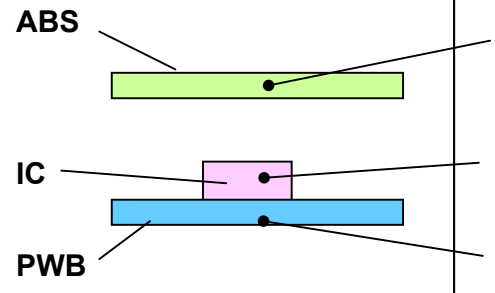
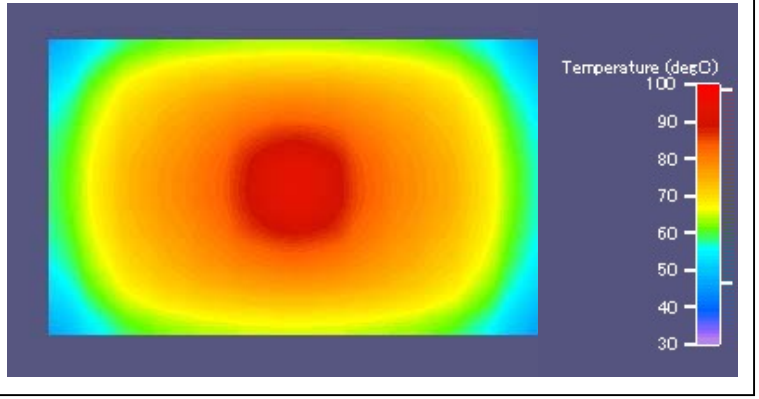
PWB 25x40x1mm
K (xy)=60W/mK,K(Z)=1W/mK

1. Application Example of PGS (Simulation with heat)

PGS Graphite Sheet

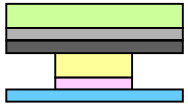
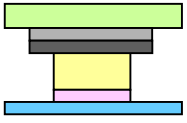
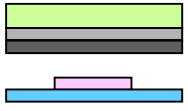
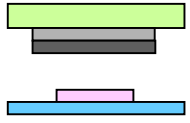
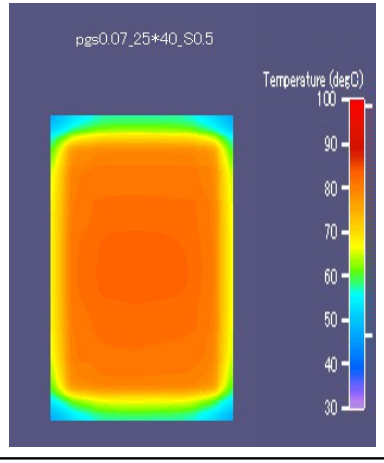
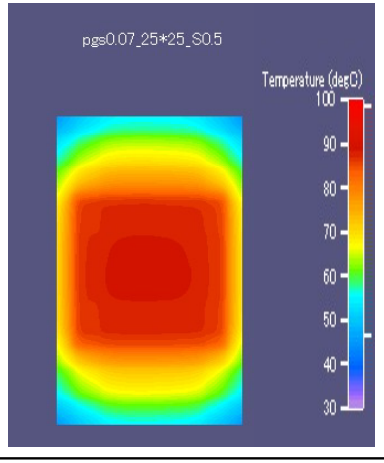
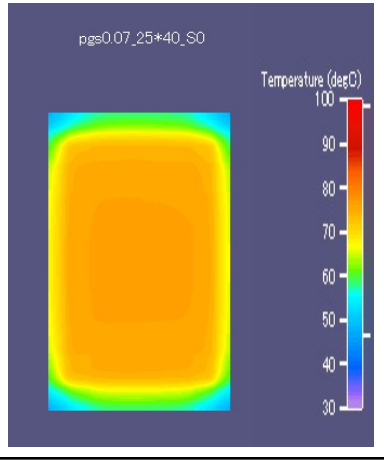
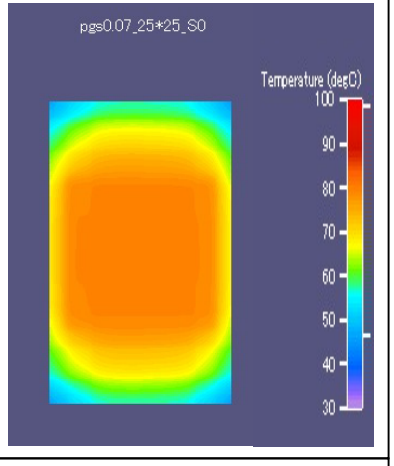
◆ Temperature distribution of ABS surface without PGS: The heater (IC) temperature appeared on ABS surface as a heat spot.

Model A	Result
	99.85 deg.C 101.9 deg.C 96.25 deg.C 

Model B	Result
	93.65 deg.C 103.2 deg.C 97.26 deg.C 

1.Application Examination of PGS (Simulation with heat)

◆**Heat distribution of the ABS surface with PGS70μ: Diffused the heat and broke the heat spot.**

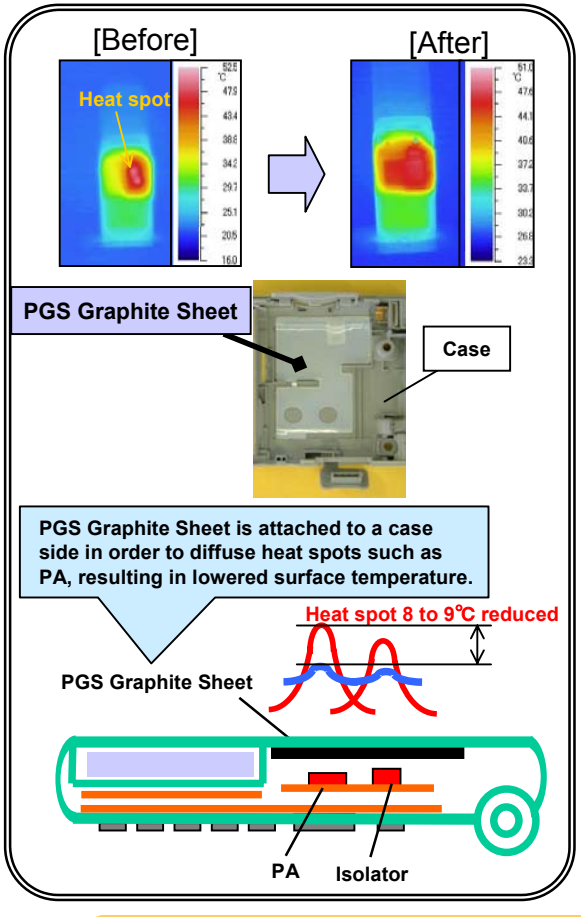
	Model A-1-70	Model A-2-70	Model B-1-70	Model B-2-70
TYPE				
PGS size	25x40x0.07 mm	25x25x0.07 mm	25x40x0.07 mm	25x25x0.07 mm
Silicon	with	with	without	without
Result				
Surface Temp	**83.84 deg.C**	**89.08 deg.C**	**77.17 deg.C**	**80.86 deg.C**
IC Temp	**88.89 deg.C**	**93.26 deg.C**	**99.76 deg.C**	**100.96 deg.C**
PWB Temp	**85.31 deg.C**	**89.06 deg.C**	**94.19 deg.C**	**95.31 deg.C**

You can choose whichever application you think is suitable for your purposes-whether to lower the temperature of heat source or to lower the surface temperature.

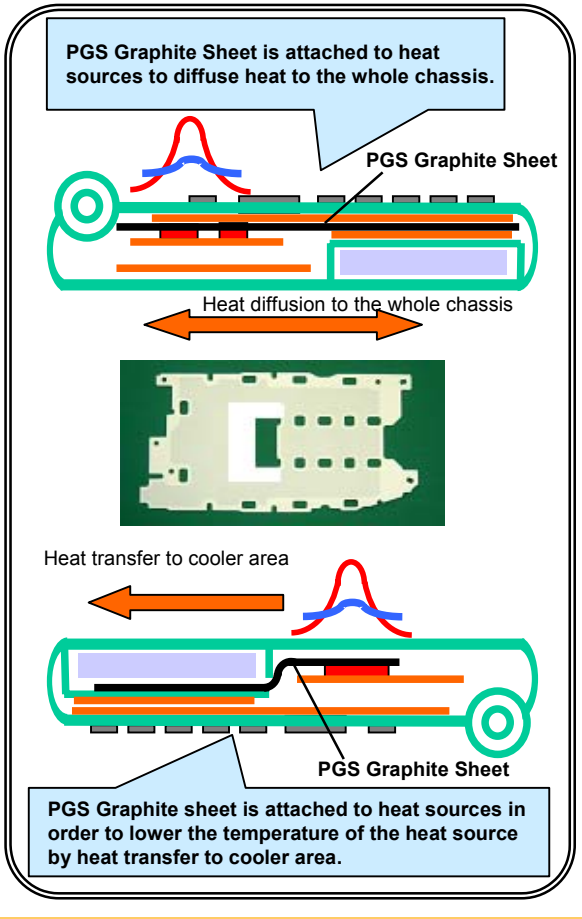
2. Typical Thermal Design with PGS Graphite Sheet

PGS Graphite Sheet

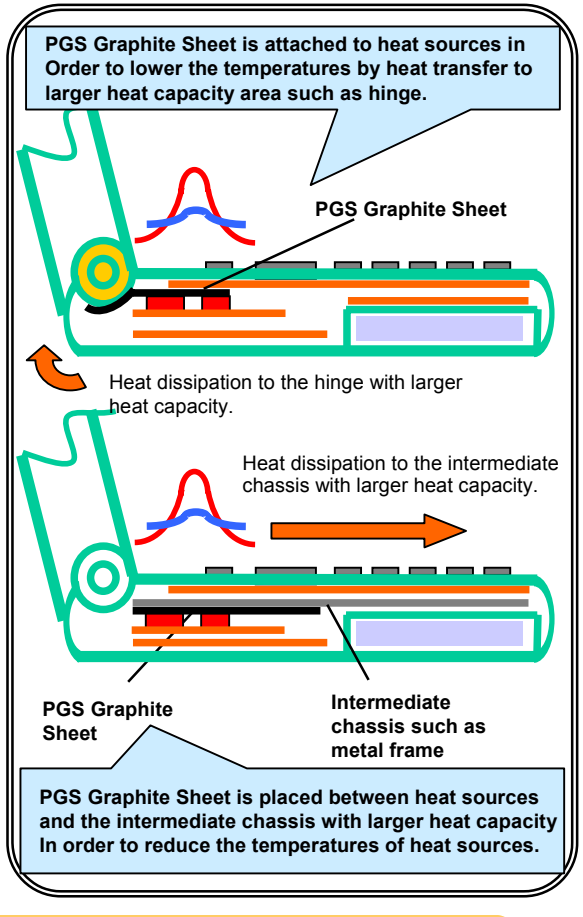
<Blocking and Sealing of Heat Source>



<Heat diffusion to the whole chassis>



<Heat transfer to the chassis with larger heat capacity>



PGS Graphite Sheet, an excellent heat transfer material, meets thermal design for various devices with various structures.