PGS(Pyrolytic Graphite Sheet) Graphite Sheet

Panasonic Electronic Device Co., Ltd
Panasonic Electronic Device Hokkaido Co., Ltd
PGS (Pyrolytic Highly Oriented Graphite Sheet) is made of graphite with a structure that is close to a single crystal. This is achieved by highly-oriented polymer film sheet, a process which has never been implemented before.

PGS is a heat sink sheet with high thermal conductivity and high flexibility.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thickness</td>
<td>0.10 ± 0.05 mm</td>
</tr>
<tr>
<td>Density</td>
<td>1 g/cm³</td>
</tr>
<tr>
<td>Thermal conductivity</td>
<td></td>
</tr>
<tr>
<td>a-b plane</td>
<td>600 to 800 W/(m·K)</td>
</tr>
<tr>
<td>c axis</td>
<td>Approx. 15 W/(m·K)</td>
</tr>
<tr>
<td>Electrical conductivity</td>
<td>10000 S/cm</td>
</tr>
<tr>
<td>Tensile strength</td>
<td>19.6 MPa</td>
</tr>
</tbody>
</table>
The decrease in Thermal resistance and Thermal spread

Two functions of PGS Graphite Sheet

- PGS Graphite sheet
- Heat source
- Heat sink

PGS Graphite sheet

- Heat source
- Heat sink
- Package

Surface temperature of the package

Without PGS

PGS inserted

PGS Graphite sheet

Heat source

MPUs, PAs, graphics chips, etc.

The conduction of thermal

Thermal spread

A B

B A
Thermal Transfer (1)

[ Heater ON ]

after 10 sec
Thermal Transfer (2)

[ Heater OFF ]

after 20 sec
[measuring method]

Heater  
P = 12W

Sample Size: 90 ~ 90 ~ 0.3 mm
Heater Size: 10 ~ 10 mm

at 25°C

Thermal Transfer (3)

after 30 minutes

Aluminum  
Copper  
PGS Graphite Sheet

PGS Graphite Sheet
**Thermal Transfer**

The conduction of thermal

Thermal spread

- Heat source (MPUs, PAs, graphics chips, etc.)
- Heat sink

![Diagram of Thermal Transfer](image)

**Thermal Interface**

The decrease in Thermal resistance and Thermal spread

- PGS Graphite sheet
- Package
- Surface temperature of the package

![Diagram of Thermal Interface](image)
Measurement of thermal resistance at high pressure

Measuring; Transistor method
The sample is placed between the transistor and the heat radiator. And voltage loaded to transistor under pressure. Then voltage loaded to transistor, with adding pressure by driving the screw.

The thermal resistance (R) is calculated from temperature difference between transistor (temperature t₁) and radiator (temperature t₂).

- Specimen size; S = 3.00 cm²
- Transistor; MTO-3P (Shin Dengen)
- Radiator; 100 x 40 x 22 mm
- Wattage; 0.341 V x 20 A = 6.82 W
- Measuring temperature; thermocouples

Calculating equation;

\[ R = \frac{(t₁ - t₂) \times S}{W} \] (c cm²/W)

Graph illustrating the comparison of different thermal interface materials at high pressure, showing the effectiveness of PGS Graphite Sheet compared to conventional materials like Ordinary Graphite, Phase change material, Silicon sheet, and Silicon Grease.
# PGS Graphite Sheet application development

<table>
<thead>
<tr>
<th>Type</th>
<th>PGS only</th>
<th>Adhesive type</th>
<th>Insulation type</th>
<th>Multilayered type</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Structure</strong></td>
<td></td>
<td>□ Double-sided adhesive tape attached type</td>
<td>□ Double-sided adhesive tape attached type</td>
<td>□ Polyether tape attached type</td>
</tr>
<tr>
<td><strong>Features</strong></td>
<td></td>
<td>□ Acrylic adhesive attached type</td>
<td>□ Acrylic adhesive attached type</td>
<td>□ Polyester tape attached type</td>
</tr>
<tr>
<td><strong>Thermal conductivity</strong></td>
<td>600~800 W/m·K</td>
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</tr>
<tr>
<td><strong>Withstand temperature</strong></td>
<td>400°C</td>
<td>80°C</td>
<td>80°C</td>
<td>80°C</td>
</tr>
<tr>
<td><strong>Standard sample</strong></td>
<td>1800 x 230 mm</td>
<td>900 x 115 mm</td>
<td>900 x 115 mm</td>
<td>900 x 115 mm</td>
</tr>
<tr>
<td><strong>Part No.</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Application examples
1. Optical Pick-Up for DVD

Heat Release from Laser Diode and Control IC

DVD Drive (Reading & Writing)

Optical Pick-Up

Each Graphite Sheet carries the heat generated in the laser unit to the metal chassis.

Attaching PGS Graphite Sheet

Metal Chassis

Laser Unit (contains Laser Diode and Control IC)

Attaching PGS Graphite Sheet
2. Mobile Phone

Small Size and Light Weight Type

Cross Section

The heat spot can go down by Graphite sheet attached to the backside of the case.

<Surface Temperature> under the normal working (while calling)

The Temp. on the outside surface of the case

The Temp. on the outside surface of the case

The heat spot cool 8 or 9 °C.

Rise of 18.81°deg

Rise of 9.23°deg
PGS Graphite Sheet

3. Semiconductor manufacturing equipment

Sputtering

![Diagram of sputtering process with substrate, plasma, target, backing plate, cooling plate, and PGS Graphite Sheet]

[Target temperature rise]

<table>
<thead>
<tr>
<th>Without PGS</th>
<th>after 2.5 hours</th>
<th>after 5.0 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>90 degrees Celsius or higher</td>
<td>90 degrees Celsius or higher</td>
</tr>
<tr>
<td>PGS inserted</td>
<td>65 to 70 degrees Celsius</td>
<td>70 to 75 degrees Celsius</td>
</tr>
</tbody>
</table>

PGS can efficiently cool sputtering targets. It can be easily replaced and reused.