



Panasonic G-TIM:
Graphite Thermal
Interface Material

24.02.2022

Agenda



Graphite Thermal Interface Material Overview

Increased thermal performance with G-TIM

Reliability Benefits of G-TIM

Assembly with Graphite Sheet

Where G-TIM Makes Sense

Conclusion

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Increased thermal performance with G-TIM

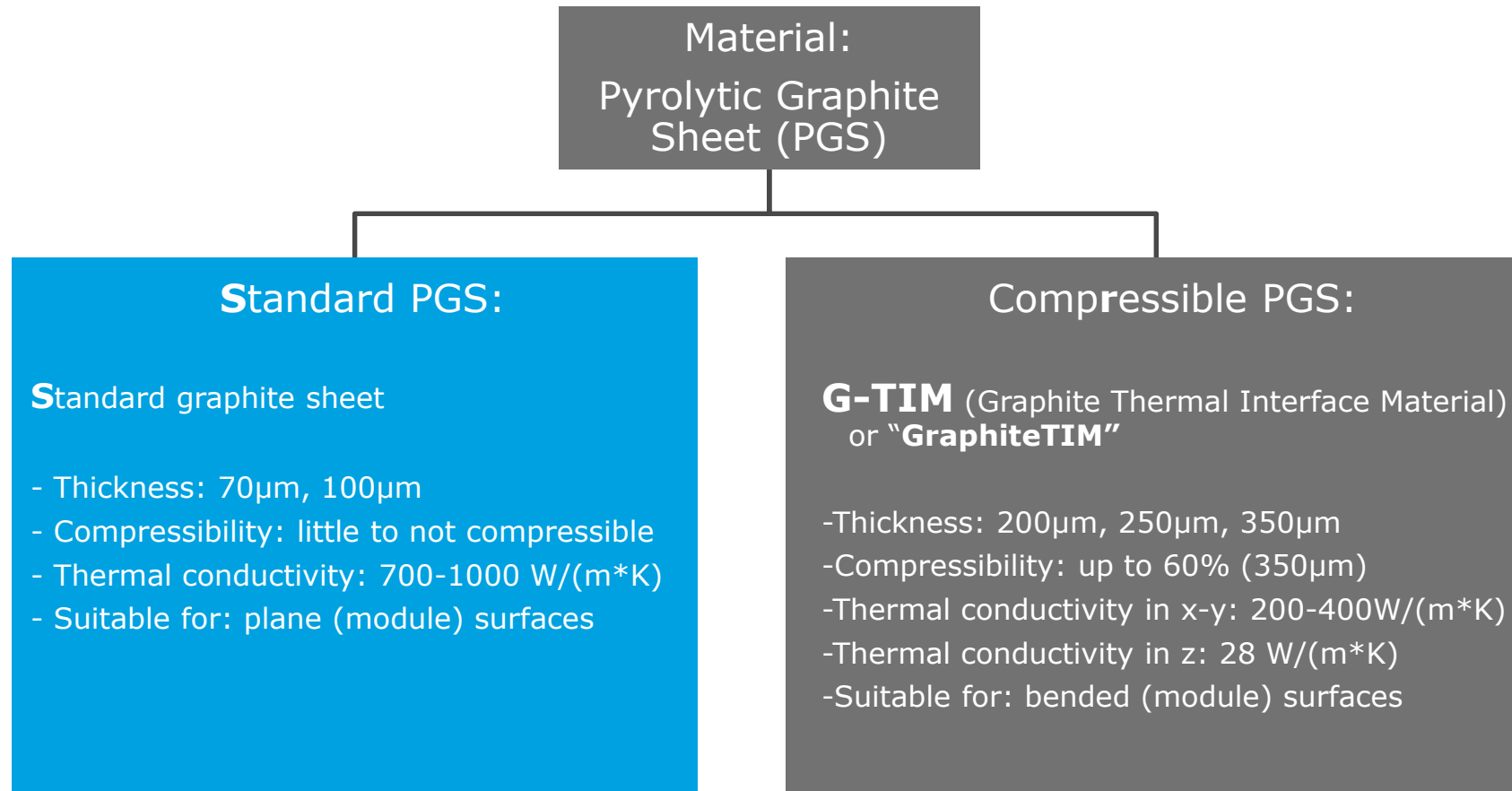
Reliability Benefits of G-TIM

Assembly with Graphite Sheet

Where G-TIM Makes Sense

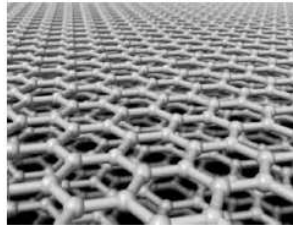
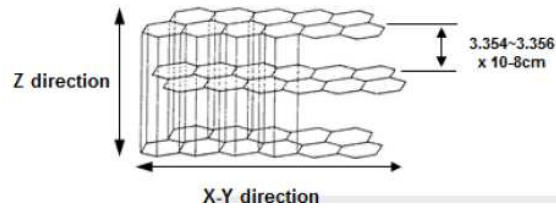
Conclusion

Overview of Panasonic Graphite Sheets

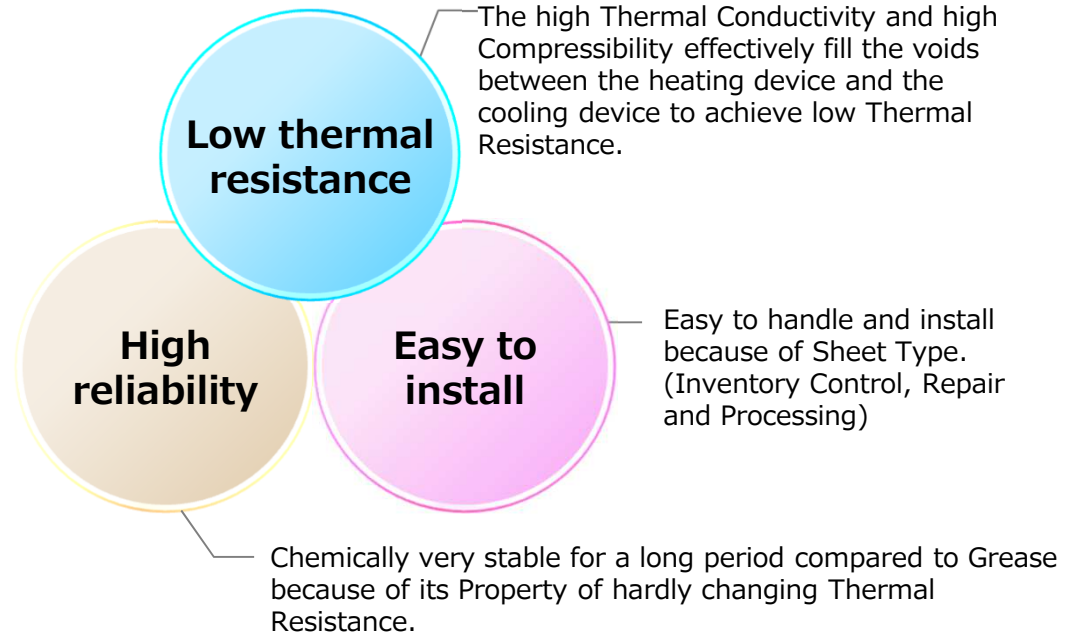


Overview of Panasonic G-TIM

PGS Crystal Structure

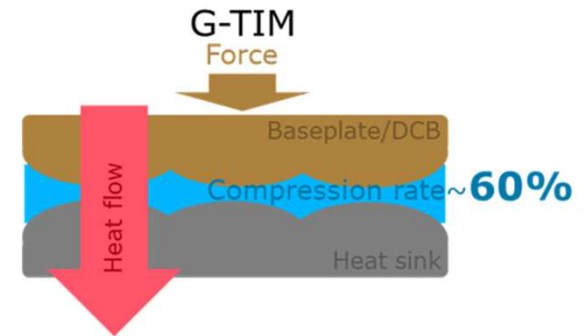
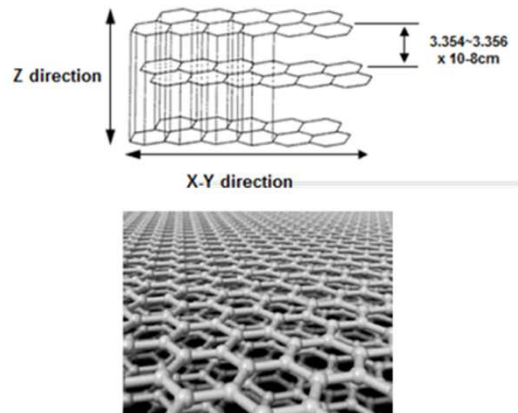


Further evolution of PGS Released G-TIM



Overview of Panasonic G-TIM

PGS Crystal Structure



PGS Crystal Structure

- Basis for all graphite TIM

G-TIM Introduction

- Latest evolution of PGS TIM
- Developed by Panasonic

Benefits Compared to Standard PGS

- Low thermal resistance thanks to increased compressibility

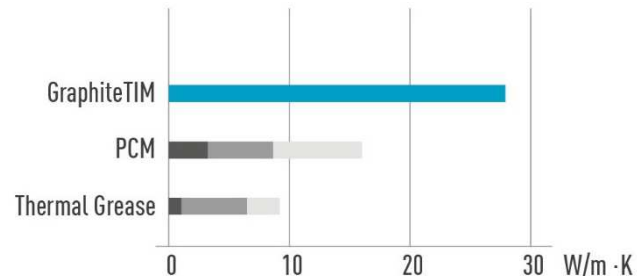
Features of Panasonic G-TIM

Added Value

High Compressibility reduces Thermal Contact Resistance by filling gaps between uneven surfaces

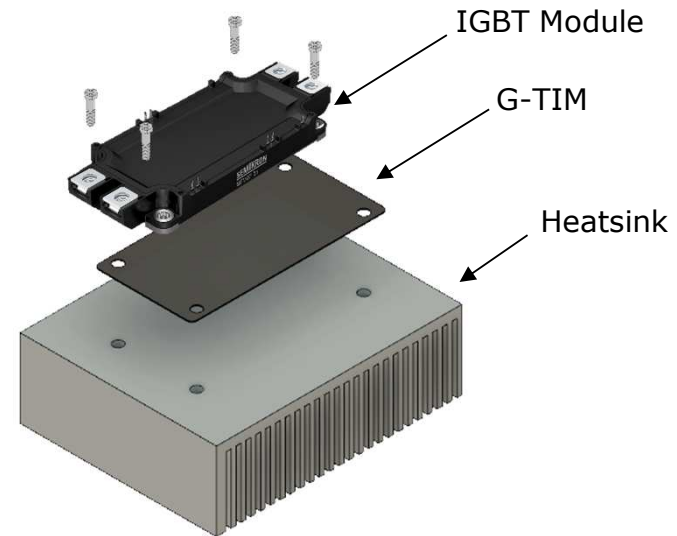
TIM Material with

- Excellent Workability
- High and long time Reliability compared to Conventional TIM Materials
- Thermal Conductivity (through thickness)



Practicability

Specifically designed as TIM for IGBT Modules



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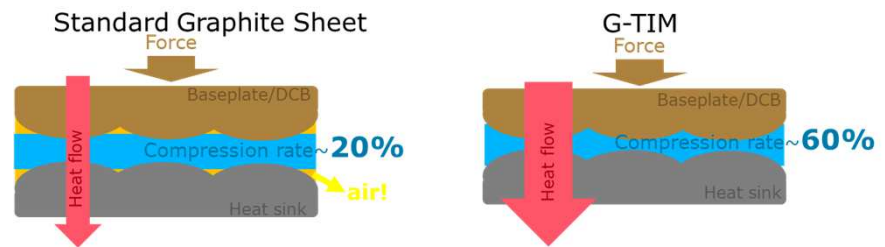
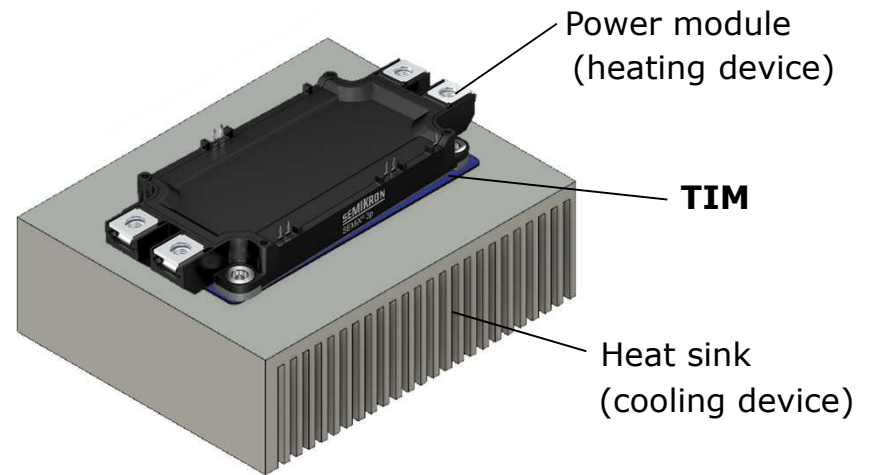
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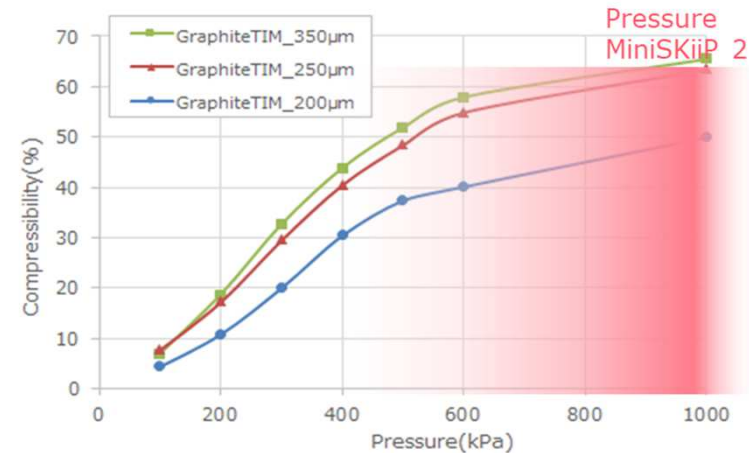
Panasonic G-TIM Offers Best Compressibility

- High Compressibility fills voids, increasing thermal conductivity
- Standard Graphite TIM has typical compression rate of 20%
- G-TIM offers compression rates up to 60%
- To achieve this high compression, **pressure must be >800 kPa**



Applied module pressure to compress the G-TIM

	Minimum (kPa)	Maximum (kPa)
MiniSKiiP	900	4000
SEMIX	1800	3700
SEMITRANS	1400	4700



Applied pressure depends on:

- Module area/construction
- Number of mounting points
- Mounting torque
- Screw diameter

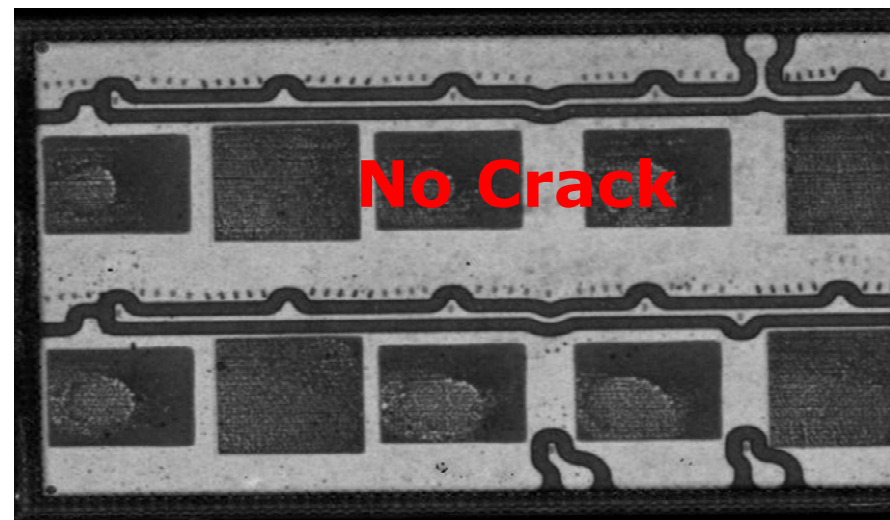
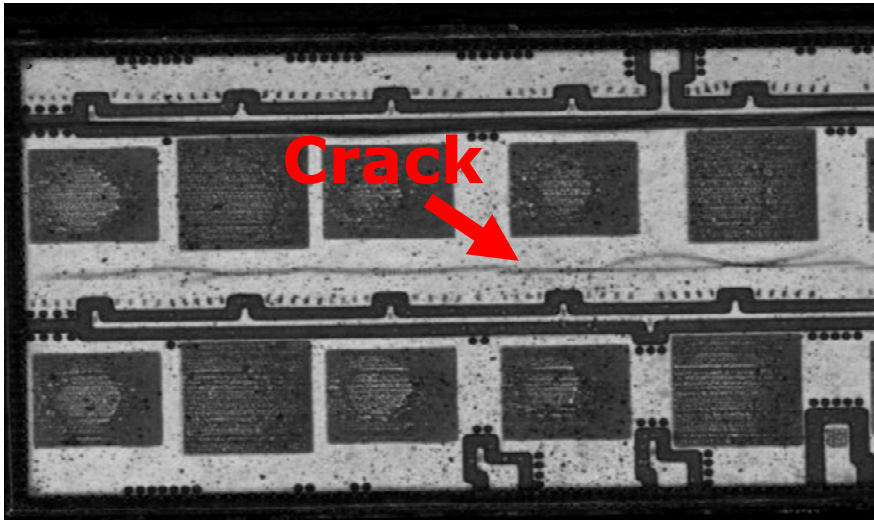
Resulting theoretical applied pressure for various modules shown in chart.

Based on minimum, this all works based on:

- Minimum torque (higher = better)
- High compression achieved only at pressure **>800 kPa**

All modules apparently have sufficient pressure to implement G-TIM

Limitations of G-TIM



Problem

- Baseplate-less devices are sensitive to cracks
- SAM analysis visualize cracks
- High risk with thick(e.g.350 μ m) G-TIM on baseplate-less device

Solution

- New G-TIM (<200 μ m) under development for baseplate-less module.
- This new type will reduce the possibility of cracking

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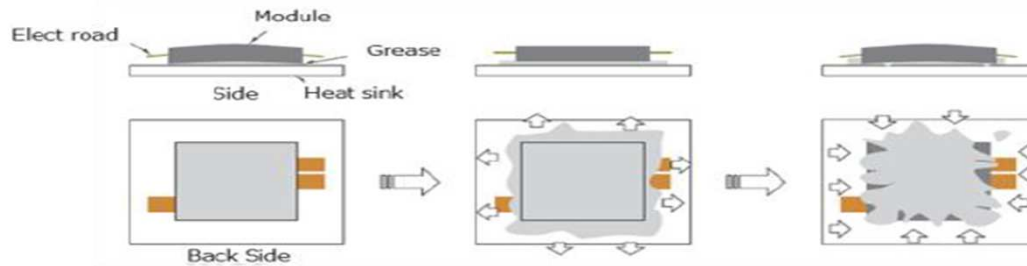
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Benefit of Panasonic G-TIM Related to Reliability

Reduced thermal stress, durable & robust

Pump out Test (Temperature Cycles $T = -40^{\circ}\text{C} \dots +100^{\circ}\text{C}$)

Product	Initial	120 times
GREASE		 Pump OUT!
G-TIM		 PERFECT!



G-TIM ⇒ “High Reliable Material”

Characteristic **NO CHANGE**

Power cycling - SEMiX603GB12E4p with Panasonic G-TIM

Test equipment: Mentor Graphics "MicRed PwT"

IGBT:

SEMiX603GB12E4p

TIM:

Pre-applied TIM HALA P8

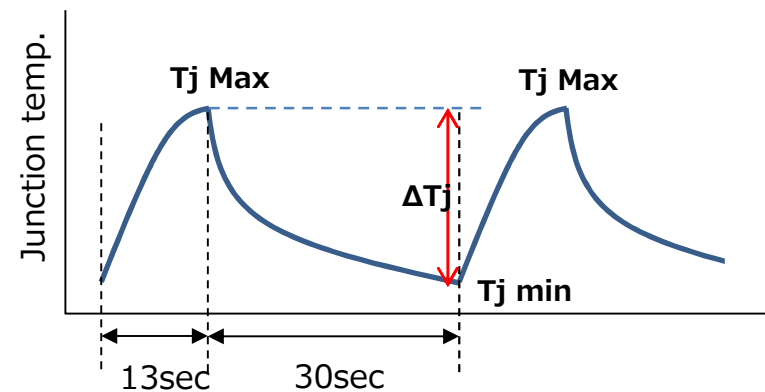
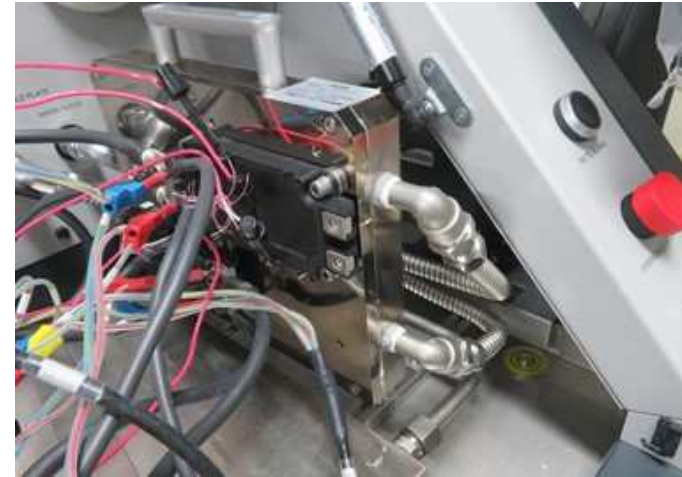
Panasonic G-TIM P/N : EYGR0612ZRWF*

*initial thickness:350 μ m

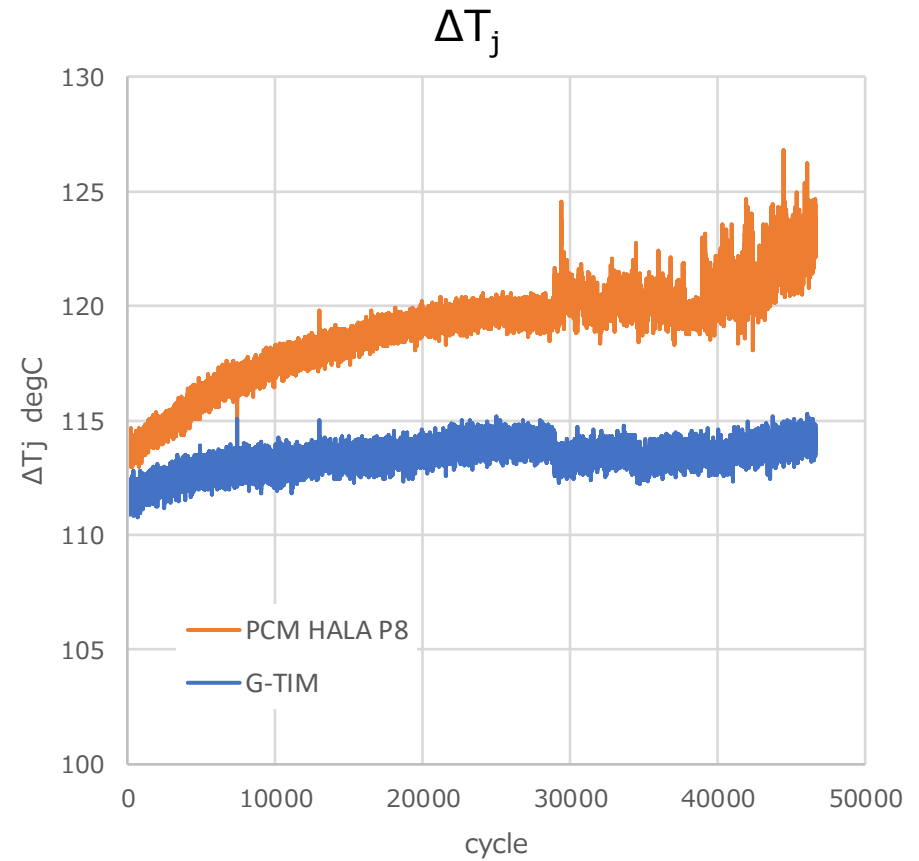
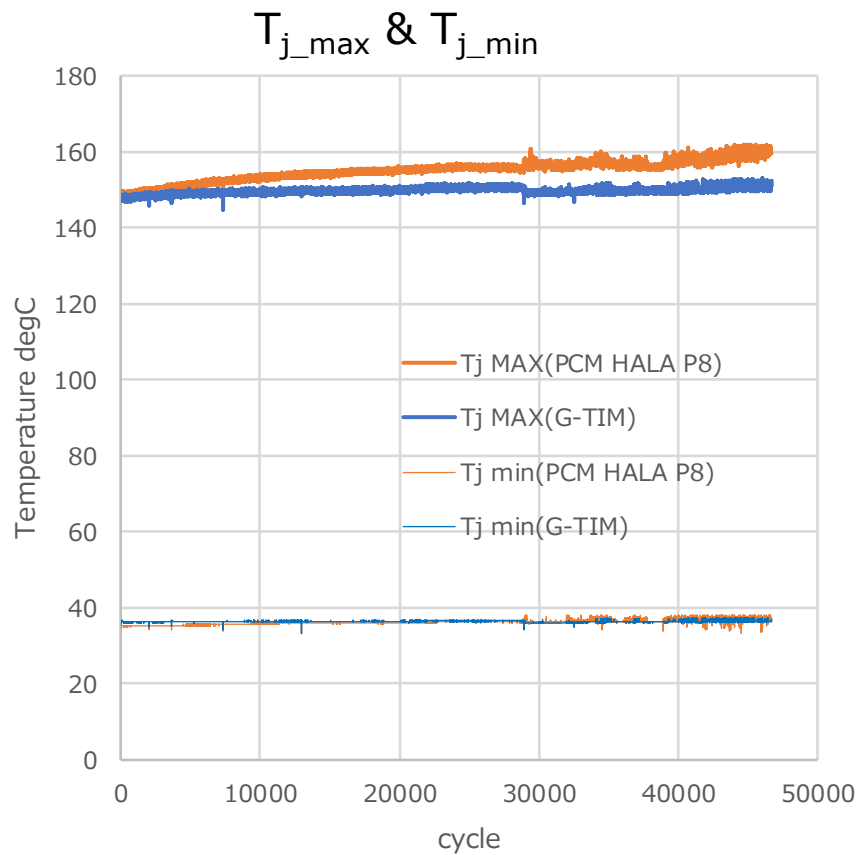
Test condition

Ic=460A(Pre-applied TIM HALA P8)

Ic=450A(G-TIM 350 μ m)



Power cycling - SEMiX603GB12E4p with Panasonic G-TIM



After 45000 cycles, G-TIM has smaller change in T_j MAX and ΔT_j .

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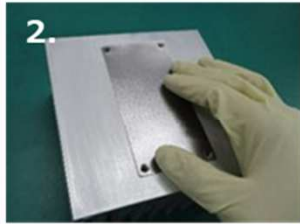
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Handling & Mounting instructions



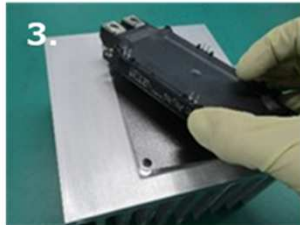
1.

1. Take out G-TIM from plastic bag gently. Don't pinch strongly.



2.

2. Clean heat sink surface and put G-TIM on it by fitting the holes with threaded position. (it doesn't matter to place top or back side of G-TIM)



3.

3. Put Power device on G-TIM carefully.



4.

4. Assure that the holes of G-TIM fit with the threaded position. If not, once putting off the power device, reposition the G-TIM.



5.

5. Place screws.



6.

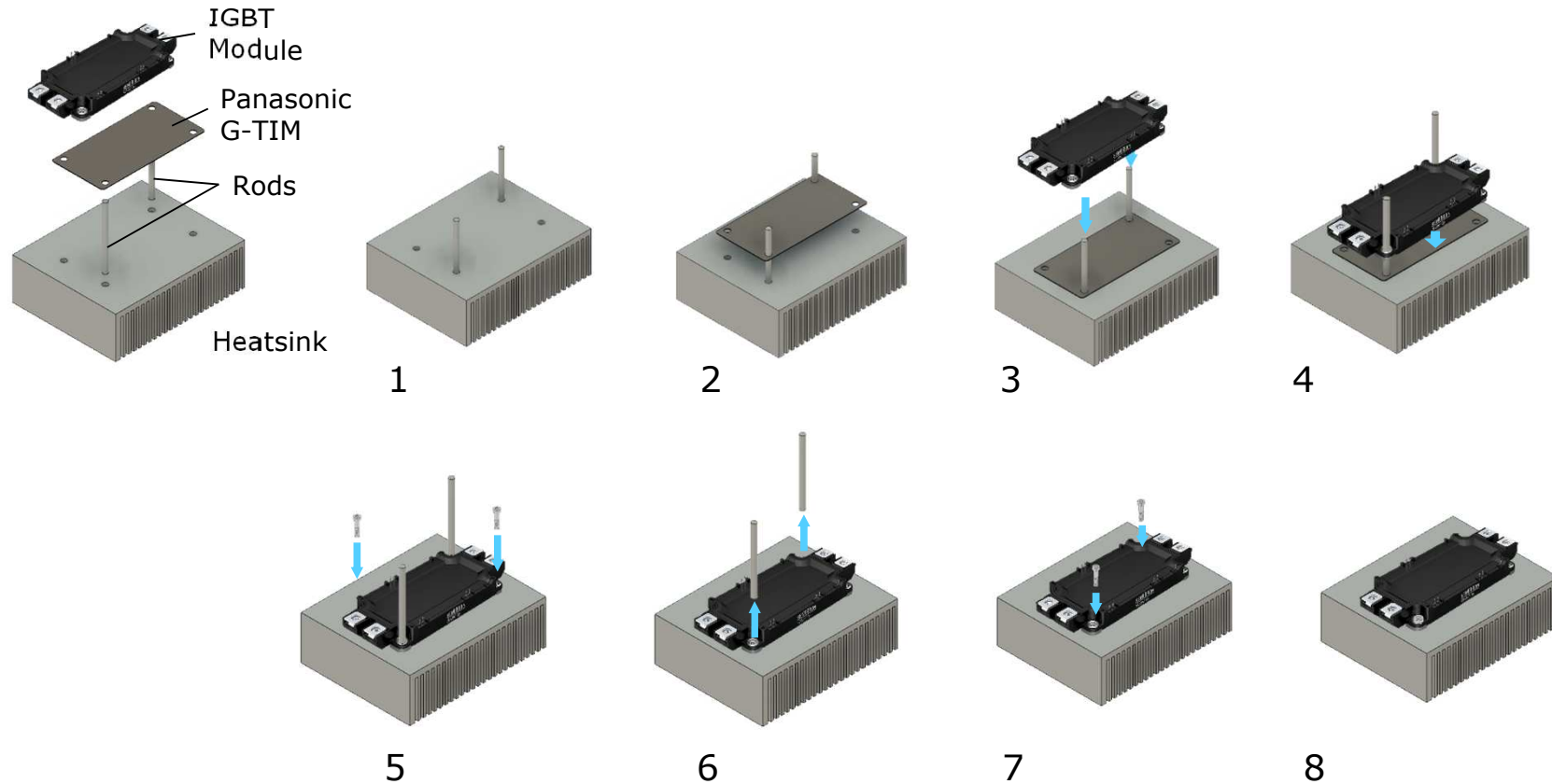
6. Tighten the screws in accordance to the mounting instructions of the certain device.

Notes:

- do not handle with bare hands, use gloves instead
- don't rub or touch with rough materials to avoid scratching
- do not use pointed or sharp objects such as tweezers for handling, as these can damage the G-TIM

Handling & Mounting instructions

Working example using a rod for the IGBT module.



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Comparison Pre-applied PCM/Grease vs. G-TIM

Pre-applied Phase Change Material (PCM)/Grease	Feature	Panasonic G-TIM
+++	Production Handling	+
+++	Cost	+
+++	Rth	++
++	Pump Out	+++
++	Shelf life	+++
+	Service/maintenance	+++
++	Max. operation temperature	+++

* The higher number of "+" denotes increased performance

Thermal Comparison: PCM, HPTP and G-TIM

		(PCM) Phase Change Material HALA P8	HPTP (High Performance Thermal Paste)	Panasonic G-TIM		
				200um	250um	350um
Compressibility @600kPa	% (ASTM D5470)	>80% (after melting) Thin layer improve Rth	>80%	40%	55%	55%
Density	gr/cm ³	2	4.2	0.36	0.34	0.28
Thermal Conductivity	W/mK	3.4(x-y, z)	2.8 (x-y, z)	400 (x-y) 28 (z)	250 (x-y) 28 (z)	200 (x-y) 28 (z)
Operation Temperature	°C	-40...+105	-40...+180	-55...+400 High Operation Temperature		
Typical Thickness	µm	baseplate: 50 ...100 baseplate-less: 10 ...50 Thin layer improve Rth		200	250	350

The data above are representative values, not guaranteed values

Even though Graphite typically has higher thermal conductivity, thickness also increased, increasing overall thermal resistance.

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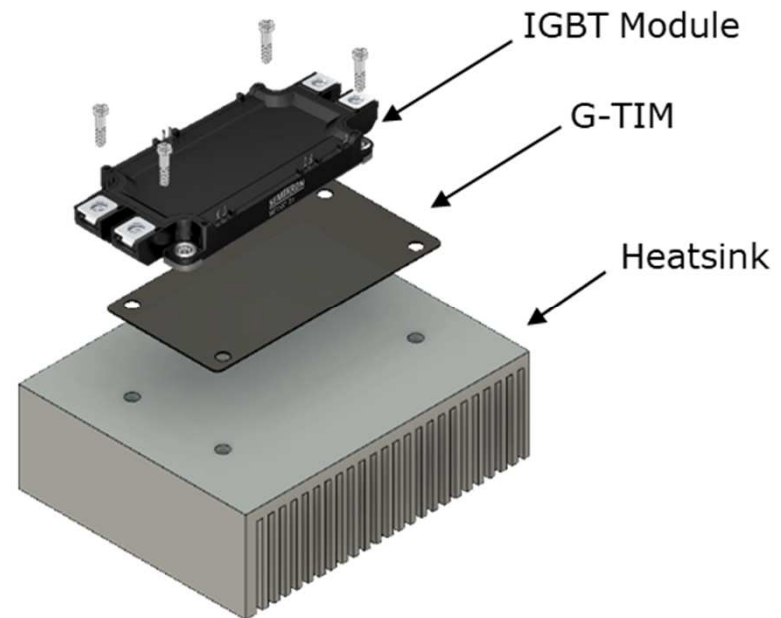
Summary

Graphite TIM thermal performance depends on:

- Compressibility
- Thickness
- Pressure applied by the module

G-TIM with 350 μ m thickness:

- Slightly higher thermal resistance for baseplate modules compared to PCM HALA P8
- Maintains reduced temperature and ΔT in power cycle test compared to PCM HALA P8
- Can have lifetime advantages over conventional TIM, while HPTP and PCM offer increased thermal performance

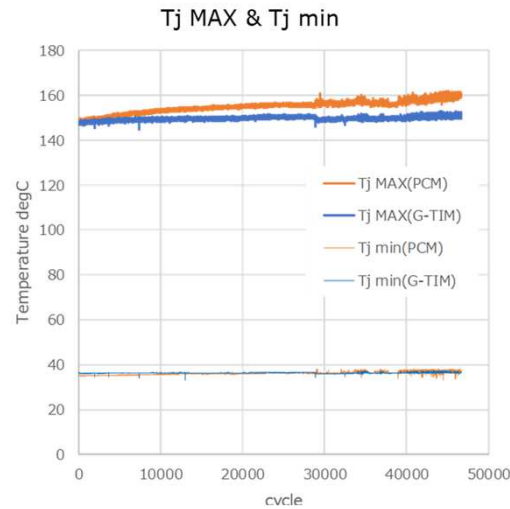
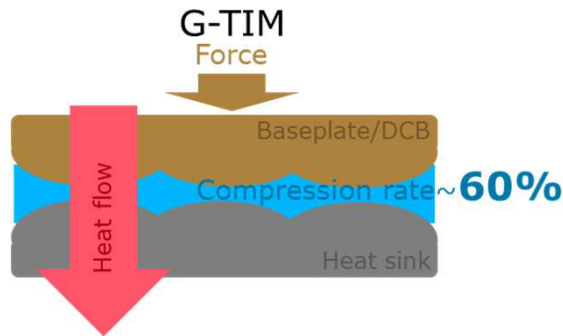


Assembly with G-TIM

Graphite Sheet Thickness Recommendation

- Baseplate modules require a TIM thickness of 50-100 μ m. Therefor G-TIM 250 μ m (137 μ m compressed) and 350 μ m (190 μ m) are recommended
- Too thick G-TIM could lead to cracks during assembly of baseplate-less modules
- Baseplate-less modules require a TIM thickness of \sim 10-50 μ m, so a new thinner G-TIM with a high compressibility is necessary.
- New G-TIM (<200 μ m) under development for baseplate-less modules.
- Respective mounting instructions still valid for all modules.

Conclusion



Thermal Performance

- With increased compression, G-TIM offers lower thermal resistance compared to standard graphite

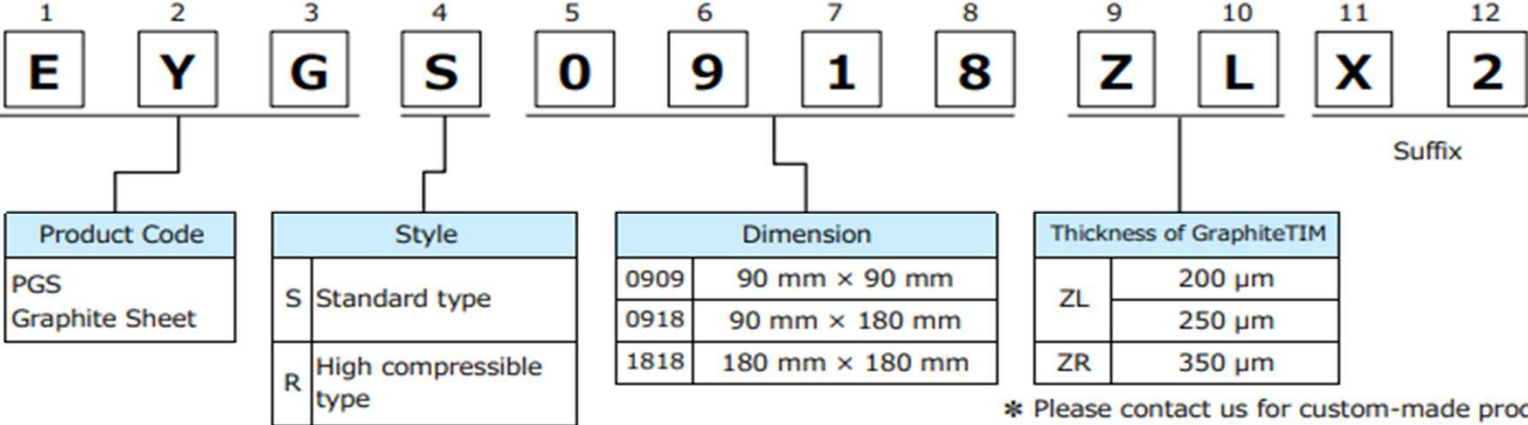
Reliability Increase

- No TIM pump out with G-TIM
- Lower temperature swings with G-TIM vs. conventional TIM

Increased Cost

- Higher material cost than conventional TIM
- Increased handling effort

Samples and Pairing with SEMIKRON Product



- Graphite TIM (G-TIM) is not offered by SEMIKRON
- Requests should be directly addressed to Panasonic
- Graphite Sheets are available for:



– See: <https://industrial.panasonic.com/ww/soft-pgs-cross>



Contact

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