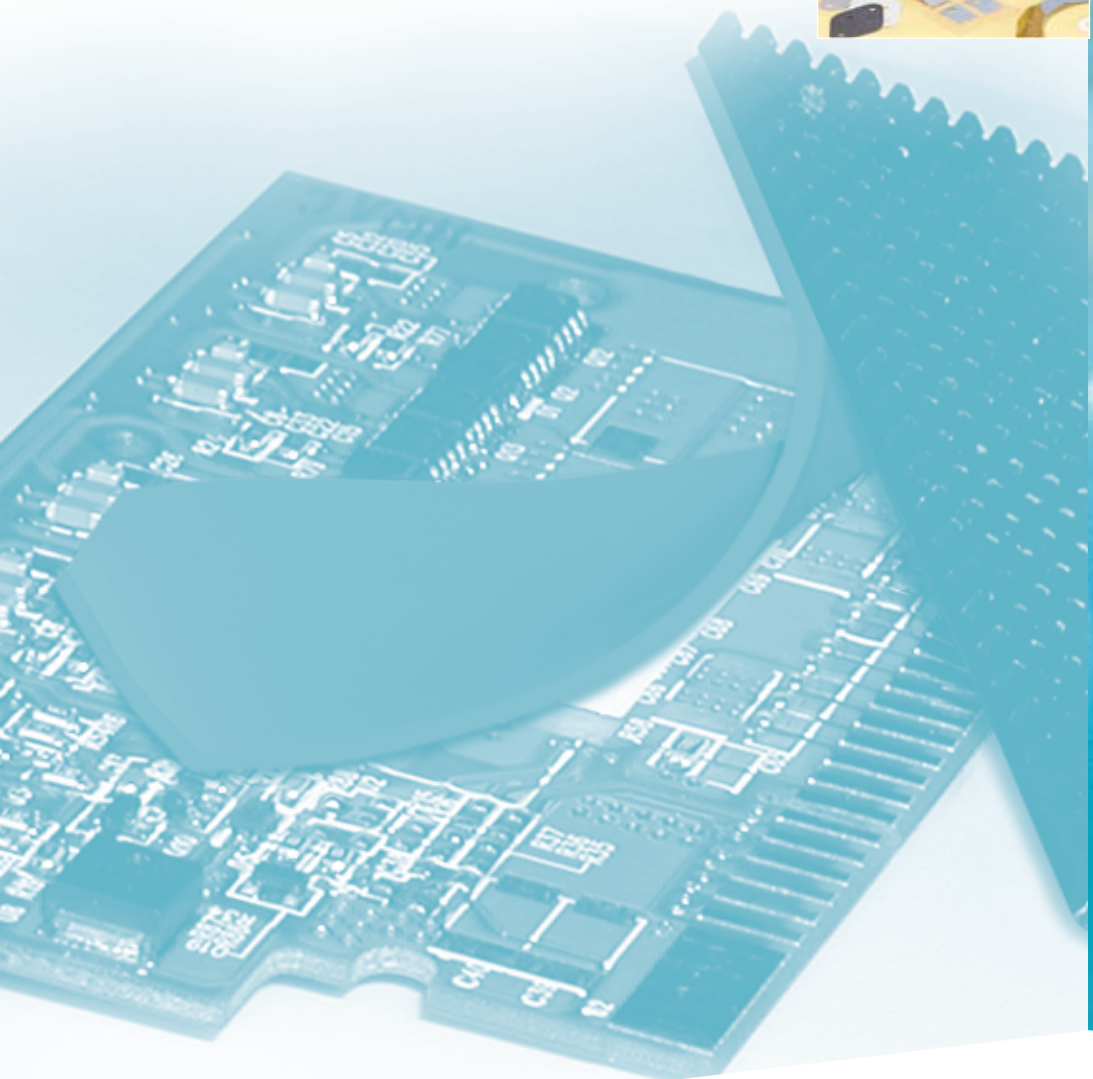
SEAL & DESIGN INC.
Corporate Headquarters
4015 Casilio Parkway
Clarence, New York 14031
Ph: 716-759-2222 • Fax 716-759-6425

ABLE SEAL & DESIGN
Canadian Division
5511 Steeles Ave West • Unit 5
North York, Ontario M9L 1S7
Ph: 416-741-0750 • Fax 416-741-0230

Simply the coolest
THERMA COOL®

Thermal Management

Solutions for Electronics



SAINT-GOBAIN
PERFORMANCE PLASTICS

Solutions for Electronics

ThermaCool® Interface Materials

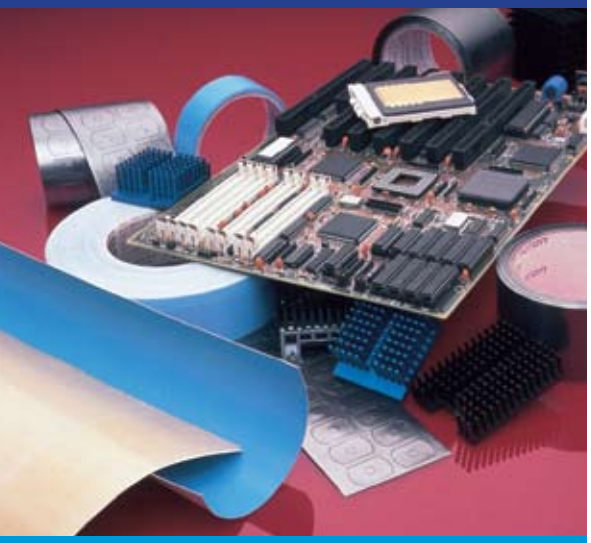
Providing Cost-Effective, Easy-to-Use Solutions to Difficult Cooling Problems

These products are based upon 50 years of tape manufacturing experience, designing thermal interfaces with creative materials and quality constructions to achieve maximum performance. The ThermaCool® product line give maximum thermal performance in a cost-effective form.

- ThermaCool thermal management products provide an effective path for heat dissipation with minimal complication to manufacturing processes. ThermaCool products are designed to simplify our customers' manufacturing processes.
- ThermaCool products ensure excellent system performance, which is critical to optimize operating efficiency and expected life of modern microprocessors and other electronic components. This is even more critical with increasing power density of microprocessors and electronic systems. With sufficient cooling, microprocessors will operate at speeds lower than their design capability and operating life may be significantly reduced.
- System designers no longer need to sacrifice the thermal reliability in order to simplify the assembly process. ThermaCool products allow designers to have effective thermal solutions while keeping assembly costs to a minimum.

What is Thermal Management?

A thermal management system consists of materials designed to remove the heat generated by an electronic device (such as a power transistor or a microprocessor) to the ambient environment in order to ensure the reliable operation of the system.

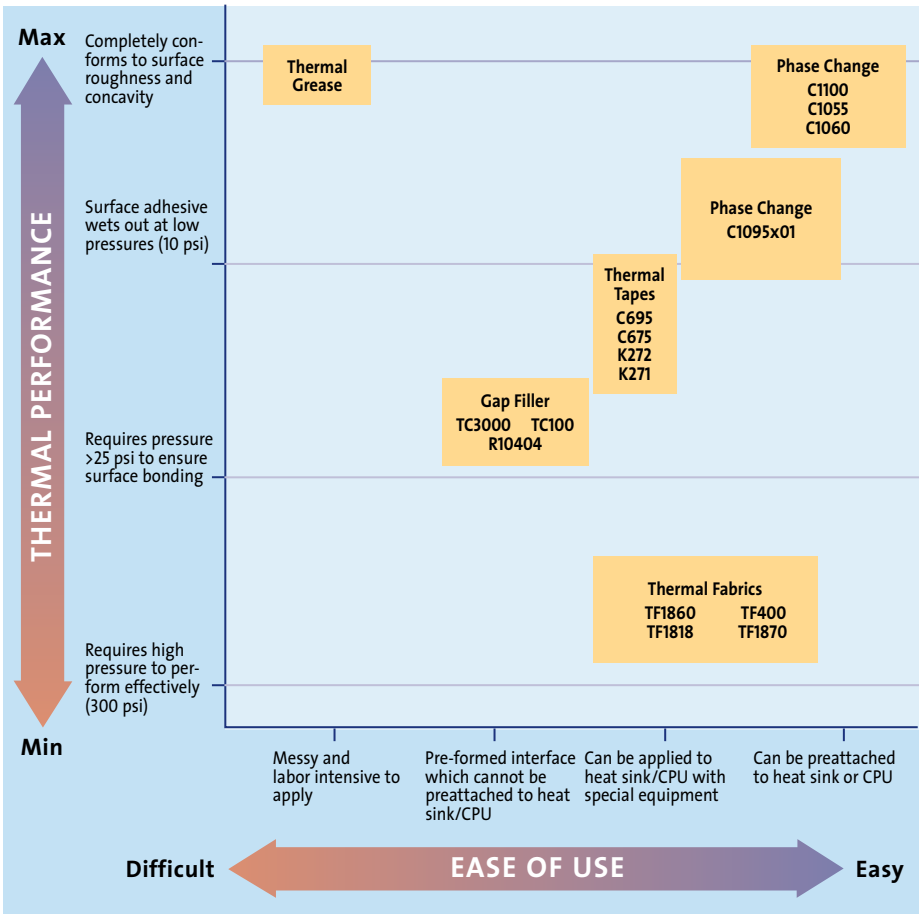


Contents

ThermaCool Thermal Interface Materials Are Designed For Easy System Assembly

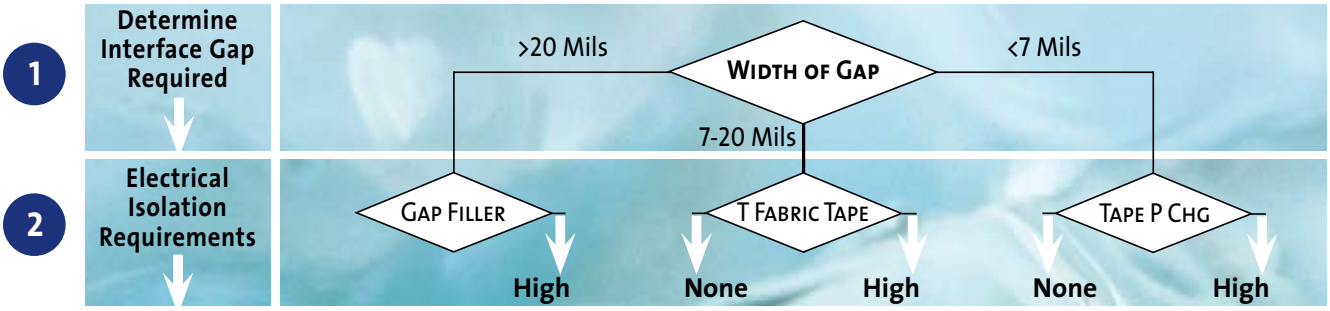
Saint-Gobain realizes that the competitive nature of today's computer assembly market requires automated mass production techniques. That's why our thermal management products are designed to provide an effective path for heat dissipation with minimal complication to the manufacturing process. In order to accomplish this objective, Saint-Gobain utilizes over 50 years of tape manufacturing experience to design thermal interfaces with creative materials and quality constructions that will deliver maximum performance. The result is a product line that balances the maximum thermal performance in a cost-effective form (see Diagram 1). Maximum thermal performance of a system is critical to optimize the processing speed and the expected life of modern microprocessors, and becomes even more crucial as the power of microprocessors and the power density of computer assemblies continue to increase. If a microprocessor is insufficiently cooled, it will operate at speeds lower than it is capable of. In addition, when a microprocessor is exposed to elevated temperatures for extended time periods, its operating life will be decreased or it can even be destroyed. Computer designers no longer need to sacrifice the thermal reliability of their systems in order to simplify the assembly process. Saint-Gobain allows designers to incorporate the necessary thermal interface while keeping their assembly costs to a minimum. This combination can produce a reliable system at a very competitive cost.

DIAGRAM 1



Choosing Thermal Interface Materials

PRODUCT SELECTOR GUIDE



3 Define Contact Pressure in Operation						
Low (Less than 15 psi)	TC2900 TC3005 TC3006 R10404			C1100 C1055 C1095 C1060	KC100
Medium	TC3001HCT TC3001 TC100U	C6910	TC100U Tab	C695 C675 TR3/5	K271 K272 K275
High (Over 100 psi)	TC100		TC1870 TC400 TC1860 TC1818		

STAGE 1

Determine interface gap to fill — If larger than 20 mils, a gap filler is used; below 20 mils, tapes and fabrics are used.

STAGE 2

Is electric isolation required?

STAGE 3

How much pressure ill be sued to create contact between two surfaces and interface material? Higer the force available, the harder the interface should be.

STAGE 4: CHOOSE THE LOWEST THERMAL CONDUCTIVITY OR IMPEDANCE

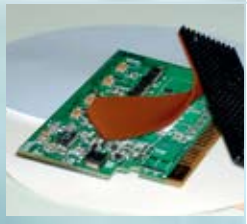
- The above steps will have narrowed the potential list of interface choices.
- Thermal resistance values should be measured under conditions as close as possible to the actual application.
- Test conditions must be the same in order to compare thermal resistance values.
- Depending on the application given performance can be governed by bulk thermal conductivity or thermal impedance, as depicted in diagrams at right. It can also be depicted in terms of “resistor in series” model.

Simply the coolest

THERMACOOL®

Product Line Overview

The ThermaCool product line provides cost-effective, high performance solutions to heat transfer needs in many electrical and/or electronic applications. From microprocessors to high power switch gear, ThermaCool products provides the right solution — *Simply the Coolest*



Gap Fillers

Thermally conductive, low durometer, filled silicone polymer sheets used to provide thermal solutions when interface gaps are greater than 20 mils.

- **TC100 —** Unreinforced silicone
- **TC100U —** Uncured material that cures in place
- **TC3001 —** New compliant products — positioned against Chromerics 1674
- **TC3001HCT —** Higher conductivity gap filler positioned against Bergquist A3000
- **TC3005 —** Very compliant gap filler positioned against Bergquist VO UltraSoft

Thermally Conductive Fabrics

Fabric reinforced silicone polymer sheets used to provide thermal solutions were interface gaps are less than 20 mils and high torque application is required.

- **TF1818 —** Thermally conductive reinforced elastomer
- **TF187X —** Higher performance thermally conductive reinforced elastomer
- **TF400 —** Medium performance product with excellent value — Chromerics 1674

Thermally Conductive Tapes

Tape systems with thermally conductive adhesives and substrates that can either be electrically isolating/thermally conductive or only thermally conductive.

- **Kapton Tapes —** K271, K272 and K275
- **Aluminum Foil —** C675
- **Graphoil Tape —** C695 and C6910
- **Transfer Adhesive —** TR-3 and TR-5
- Most formulations use acrylic adhesive but silicone system is available.

Phase Change Materials

High performance systems used to couple heat sink and microprocessors and other miniature electronic components and provide lowest thermal impedance of all ThermaCool thermal interface materials.

- **C1055 —** Older PCTIM maintained for prints
- **C1060 —** Fabric reinforced version of C1055
- **C1095 X01 —** No-stick PCTIM
- **C1100 and C1100F —** Highest performance product for higher power MPUs vs Shin-Etsu grease

Data sheets and other information for the Thermal Management Line can be found on the web site:

www.thermacool.saint-gobain.com

Thermal Fabrics

PRODUCT OVERVIEW

Thermally Conductive Fabrics are fiberglass-reinforced ceramic-filled silicone polymer sheets used to provide thermal transfer and electrical isolation where interface gaps are less than 20 mils and high torque application is required. The fiberglass/ceramic-filled silicone compound construction provides excellent cut-thru resistance, high thermal transfer and effective electrical isolation. These materials are typically used in computer power supplies and amplifiers where the combination of cut-thru resistance and high thermal transfer provides a cost-effective solution.

Product Name	CONSTRUCTION		MECHANICAL	THERMAL		COMMENTS
	Color	Thickness (mils)	Flame Rating Vertical Burn UL 94	Thermal Conductivity (W/mK) ASTM E1530	Thermal Impedance (°C in.²/W) ASTM E1530	
TF1867	Gray	7	VTM-0	0.9	0.65	Lowest cost fabric
TF1869	Gray	9	VTM-1	0.9	0.70	
TF407	Gray	7	V0	0.9	0.31	Medium performance material
TF409	Gray	9	V0	0.9	0.39	
TF412	Gray	12	V0	0.9	0.48	
TF1818	Gray	18	V0	0.8	0.89	Very thick fabric for high puncture
TF1877	Green	7	V0	1.3	0.24	Higher thermal performance
TF1879	Green	9	V0	1.3	0.28	

All products RoHS compliant

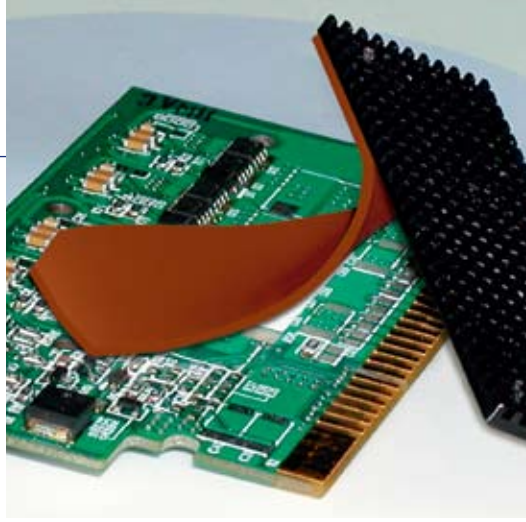
PRODUCTS AND DESCRIPTION

- **TF400 Series**: Cost-effective thermally conductive silicone coated fabric supplied in thickness of 7.0 and 9.0 mils thick.
- **TF1870 Series**: Similar to TF400 Series but improved thermal performance.
- **TF1818**: 18.0 mil thick thermally conductive silicone coated fabric. Increased break strength and extra smooth surface.
- **All Products:** Can be supplied with a thermally conductive acrylic adhesive on one side.

TYPICAL APPLICATIONS

- Products to fill the need of varying component clamping forces and methods
- Electrically isolating components while providing excellent thermal transfer to heat sinks
- Electronic modules for power supplies and telecommunications
- Fits between CPU and Heat Spreader
- Heat Transfer pads in Memory Modules

Gap Fillers



PRODUCT OVERVIEW

Gap Fillers are thermally conductive, compliant ceramic-filled silicone polymer sheets used to provide thermal solutions when interface gaps are greater than 20 mils. Gap Fillers can be used to span air gaps, enhancing thermal performance of computer memory modules, telecommunication equipment and other electronic devices. The ThermaCool Gap Filler family includes products in a variety of thicknesses and a range of hardnesses to effectively close gaps while providing the thermal transfer needed in demanding electronic applications.

Product Name	CONSTR.	MECHANICAL			THERMAL	COMMENTS
	Standard Thicknesses (mils)	Surfaces* Burn UL 94	Flame Rating Vertical	Hardness (Shore A) ASTM E1530	Thermal Conductivity (W/mK)	
TC2900	30–220	Neat, 1–6	V0[1]	5–10	1.3	Low cost, medium performance gap filler
TC3001	20–220	Neat, 1–6	V0	5–10	1.5	Soft gap filler
TC3005	20–220	Neat, 1–6	V0	<5	1.5	Very compliant for larger compression value
TC3001HCT	40–220	Neat, 1–6	V0[1]	5–10	3.0	Higher thermal conductivity gap filler
TC3006	20–220	Neat, 1–6	V0[1]	5–10/Shore 00	1.1	Extremely soft for very large compression
R10404	1/32"–1/4"	Neat, 1–6	V1	15	0.3–0.6	Conductive sponge
TC100	25, 32, 62	Neat, 1–6	HB	65	1.3	Very tough gap filler, medium performance
TC100U	15, 32, 62	Neat, 1–6	—	65[2]	1.3	Uncured material for bonding and gap filling

*

1	BN – on one side no stick	3	Polyimide Film	5	MT Kapton
2	PET film	4	Fabric Scrim	6	Thermal Fabric

[1] Pending
[2] After cure

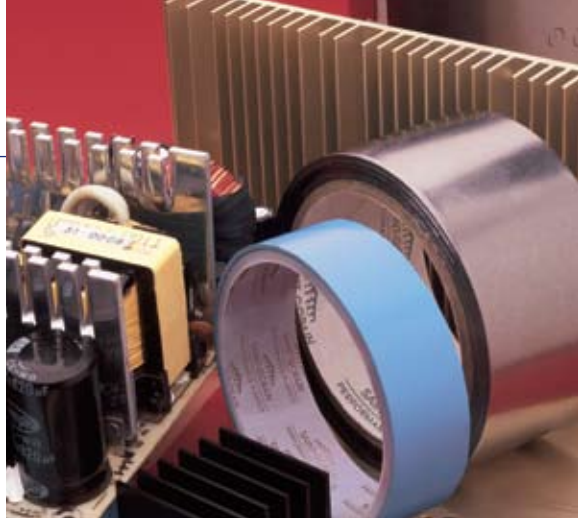
PRODUCTS AND DESCRIPTION

- **R 10404**: Thermally conductive closed cell sponge for gasketing heat transfer and cushioning. Provided in sheets or yard goods for ease of cutting in thickness from 0.032 –0.250.
- **TC100**: Thermally conductive solid silicone rubber, provided in yard goods from 0.025 – 0.062 thick for filling air gaps under high load force.
- **TC100U**: Similar to the TC100 but supplied in a "B" Stage configuration to fill gaps and bond dissimilar materials in place providing a thermal transfer path.
- **TC 3000 Family**: Thermally conductive conformable silicone rubber, provided in 24" x 24" sheets from 15–220 mils thick for filling air gaps under high load force. The product has UL94 V-0 flame rating. The product is naturally tacky and has a very low thermal resistance.
  - TC3001: Very soft (5–10 Shore A)
  - TC3002: Soft (25–30 Shore A)
  - TC3005: Extremely soft (<5 Shore A)

TYPICAL APPLICATIONS

- Filling areas of irregular surfaces to provide a thermal interface to the heat sink
- Electrically isolating components while providing good thermal transfer to heat sinks
- Fits between CPU and Heat Spreader
- Heat Transfer pads in Memory Modules
- CD ROM Cooling
- Cushioning to remove damage caused by vibration
- Heat Pipe Assemblies

Thermal Tapes



PRODUCT OVERVIEW

Thermally Conductive Tapes have thermally conductive pressure-sensitive adhesives applied to substrates that can either be electrically isolating/thermally conductive or only thermally conductive. They are used to join heat sinks to computer processors in place of mechanical fasteners, enhance the performance of heat sinks by laterally spreading heat, or electrically isolate components of a power supply while still providing an excellent thermal conduction path.

Product Name	CONSTRUCTION		MECH.	ELECTRICAL	THERMAL		COMMENTS
	Carrier	Thickness (mils)	Adhesion (oz./in.^{2})	Dielectric Strength (volts total)	Thermal Conductivity (W/mK) ASTM E1530	Thermal Impedance (°C in.^{2}/W) ASTM E1530	
K271	MT Kapton	4.5	30/60[1]	7000	0.6	0.40	One side adhesive, one side silicone on Kapton
K272	MT Kapton	6.0	None	7000	0.9	0.30	Two side silicone on Kapton
K275	MT Kapton		30/60[1]	6500	0.4	0.49	Two side adhesive on Kapton
C675	Aluminum Foil	6.0	30/60[1]	Non-insulating	2.0	0.10	Bonding tape to mpu for heat sinks
C695	Graphite Paper	6.0	3–5[2]	Non-insulating	2.0	0.12	Very high conductivity, good for heat spread
C6910	Graphite Paper	11.0	3–5[2]	Non-insulating	2.6	0.15	Thicker version of C695
TR3	PET	3.0	30	Non-insulating	0.4	0.3	Thermally conductive transfer adhesive – 3 mils
TR5	PET	5.0	60	Non-insulating	0.4	0.5	Thermally conductive transfer adhesive –5 mils

1 Adhesion to steel (value after thermosetting); 2 Adhesion to aluminum
All products RoHS compliant

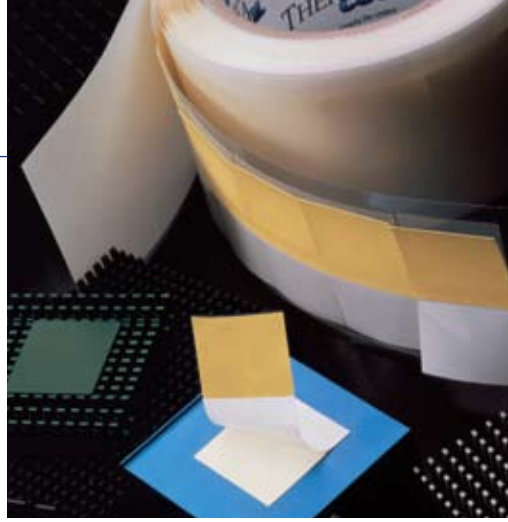
PRODUCTS AND DESCRIPTION

- **KAPTON Tapes**: Thermally conductive and electrically isolating
  - **K271** — One-sided adhesive coated Thermal Kapton MT® tape
  - **K272** — Two-sided silicone coated Thermal Kapton MT® tape
  - **K275** — Two-sided adhesive coated Thermal Kapton MT® tape
- **Metal Foil Tapes:** Thermally conductive metal foil tapes
  - **C675** — Aluminum foil with acrylic thermally conductive adhesive
- **Grafoil® Tapes:** Thermally conductive flexible graphite tape
  - **C695 and C6910** — Graphite tape with acrylic thermal adhesive on one side
- **Thermally Conductive Transfer Adhesives**
  - **TR3 & TR5** — Thermally conductive acrylic adhesives

TYPICAL APPLICATIONS

- Bonding heat sinks to ceramic or metal packaged microelectronic components on circuit boards
- Electrically isolating components while providing good thermal transfer to heat sinks or back planes
- Providing bonding methods for materials that are supplied without adhesive for ease in assembly
- Replacing mechanical fasteners with a powerful bonding system that allows rapid assembly

Thermal Phase Change



PRODUCT OVERVIEW

Phase Change Materials change from a solid to a liquid-like material at microprocessor temperatures, significantly enhancing thermal performance in computer applications. ThermaCool phase change products provide high performance heat transfer without the manufacturing or assembly problems associated with messy thermal greases. These phase change materials provide excellent thermal coupling between computer microprocessors and heat sinks, ensuring high system performance in a cost-effective format.

Product Name	CONSTRUCTION			THERMAL		COMMENTS
	Reinforcing Carrier	Thickness (mils)	Phase Change Temperature (°C)	Thermal Conductivity (W/mK) ASTM E1530	Thermal Impedance (°C in.²/W) ASTM E1530	
C1055	None	3.0	3.5 & 6.0	1.0	0.04	High performance phase change
C1060	Fiber glass	3.5	45	0.7	0.10	Reinforced version of C1055
C1095	Polymer Film	2.5	>50	0.6	0.13	No stick phase change for easy disassembly
C1100	None	3.5 & 6.0	37	1.0	0.03	Grease like performance, easy to use
C1100F	Aluminum Foil	3.5 & 6.0	40	1.0	0.05	No stick version of C1100

All products RoHS compliant

PRODUCTS AND DESCRIPTION

- **C1055 & C1060**: Thermally conductive products designed to exhibit exceptional viscoelastic (creep and flow) properties. Effects of viscosity and elasticity determine conformability. Minimal force is required for this material to flow and achieve total wet-out. As temperature decreases the material does not stiffen. The modulus remains uniform between 0°C and 130°C. These unique viscoelastic properties of the C1055, combined with the inherent low thermal resistance, insure minimal contact resistance and a highly effective path for heat dissipation.
- **C1095 x01:** A thermally conductive polymeric interface material designed specifically for application requiring a thermal interface material (TIM) that will not create any bond line adhesion between a heat sink or other heat dissipating devise and the metal case surface of a microprocessor (MPU) or other heat generating device.
- **ThermaCool C1100:** family of high performance phase changing compounds which self adhere to the heat sink at room temperature. This adhesive quality also creates a conformable interface between the sink and MPU and dramatically improving heat transfer.

TYPICAL APPLICATIONS

- Creates high performance thermal coupling between flip chip or heat spreader to heat sink
- Materials can be provided in a non-bonding formulation to prevent any adhesion between microprocessor and heat sink, while still having excellent thermal performance
- Replacing messy thermal grease in rapid microelectronic assembly

Saint-Gobain's Thermal Test Methods

Saint-Gobain employs two standard thermal conductivity/thermal resistance test methods.

ASTM E1530

One is the guarded heat flow meter method, which conforms to ASTM E1530 (Diagram 1) and is mostly applicable to samples that range in thickness from 0.5 – 25mm. In this method an even reproducible pressure is applied to the test sample by pneumatic cylinders that allow test pressures ranging from 0 psi (contact) to 300 psi. The sample is held between two polished metal surfaces where the upper plate is heated and the lower plate is chilled, establishing a temperature gradient through the stack. The lower plate is also part of a calibrated heat flux transducer.

ASTM D5470

The other testing method is for thermal transmission properties of thin thermally conductive electrically insulating materials, which conforms to ASTM D5470 and is applicable to samples ranging in thickness from 0.02 – 10mm. In this method an even reproducible pressure is applied to the test sample by pneumatic cylinders that allow test pressures ranging from 0 psi (contact) to 500 psi. The sample is held between two polished metal surfaces where the lower plate is heated and the upper plate is chilled, establishing a temperature gradient through the stack that is measured via 4 thermocouples, as depicted on Diagram 2. Thermal impedance can be determined by measuring the temperature resistance across the sample.

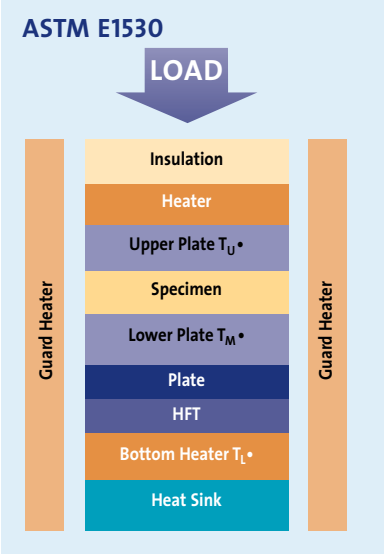


DIAGRAM 1

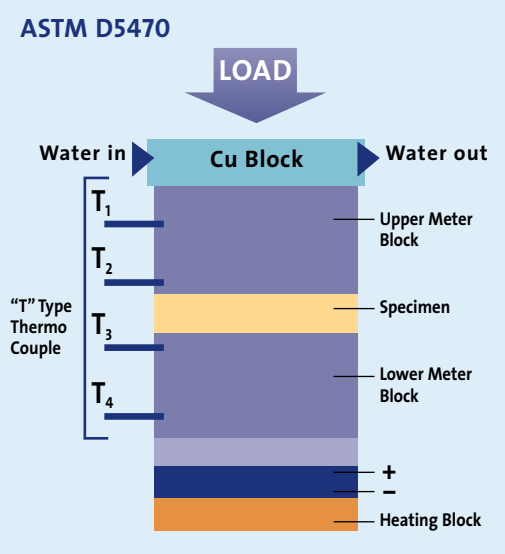


DIAGRAM 2

Definitions for Thermal Interface Design

INTERFACE GAP

The gap which results between the microprocessor and the heat sink due to the stack-up of flatness specification tolerances. Two nominally flat surfaces will always produce an interface gap when placed together.

CONTACT RESISTANCE

In thermal transfer, air equals resistance. Thus, contact resistance is a theoretical measure of the volume of air voids along the interface of any two surfaces. These microscopic voids are formed by surface roughness, surface concavity or the interface material ineffectively conforming to a component's surface. This is illustrated in the magnified section of Diagram 2.

THERMAL CONDUCTIVITY

The ability of a material to conduct heat after the heat has entered that material. Thermal conductivity values can be misleading when used to evaluate thermal interface materials since actual performance is affected by the contact resistance with both the heat sink and the microprocessor. Thermal conductivity is typically expressed in units of W/m-K.

THERMAL IMPEDANCE

A defined parameter which is calculated by dividing the temperature difference across the interface by the power output of the microprocessor. Thermal impedance values are quite valuable in thermal management design since they inherently reflect the impact of contact resistances on interface performance. Low thermal resistances indicate a system which dissipates heat effectively. Thermal impedance is typically expressed in units of °C-in^2/W.

DIELECTRIC STRENGTH

A measure of the voltage required to cause a breakdown of a specific thickness of interface material. Dielectric strength is typically expressed in units of volts/mil.

CONTACT PRESSURE

The pressure between the microprocessor and the heat sink. This pressure is typically generated and maintained by the heat sink clips which attach to a socket. Contact pressure is typically measured in pounds per square inch (psi).

APPLICATION PRESSURE

The pressure required to attach an interface material to a heat sink or to a microprocessor. Application pressure is typically measured in pounds per square inch (psi).

Thermal Management Materials Competitive Offsets

THERMAL TAPES

Description	ThermaCool	Chomerics	Bergquist
Graphite foil with 1 side PSA	C695	N/A	N/A
Aluminum foil with 2 side PSA	C695	Thermattach T405, T412	Q-Pad II
MT Kapton with 2 side PSA	K275	Thermattach T404, T414	Bond-Ply 660
MT Kapton with 1 side PSA/1 side silicone	K271	ChoTherm 1680	Sil-Pad K4, K6
Transfer Adhesives	TR3 & TR5	Thermattach T413	Bond-Ply 100

THERMAL FABRICS

Description	ThermaCool	Chomerics	Bergquist
Low Cost Thermal Fabric	TF400	ChoTherm 1674	Sil-Pad 400
Mid Performance Fabric	1818, 1877, 1879	ChoTherm 1674	Sil-Pad 600
High Performance Fabric	TF500	ChoTherm 1671, 1678, T500	Sil-Pad 800, 900S, A1500

THERMAL GAP FILLERS

Description	ThermaCool	Chomerics	Bergquist	Fujipoly
Non Conformable Conductive	TC100	N/A	N/A	Sarcon GTR
Non Conformable Conductive — Uncured	TC100U	Therm-A-Form T646	N/A	N/A
Conformable Closed Cell Sponge	R10404	N/A	N/A	N/A
Conformable Low Hardness	TC3001	Therm-A-Gap A174/T174/F174	Gap-Pad A2000	Sarcon HR, GR-d, GR
Conformable Medium Hardness	TC3002	Therm-A-Gap A274/T274	Gap-Pad 1500, 1500R	Sarcon HR, GR-d, GR
Very Conformable Very Soft	TC3005	Therm-A-Gap A574/574	Gap-Pad VO Ultra Soft, Gap-Pad 1500	N/A

THERMAL PHASE CHANGE

Description	ThermaCool	Chomerics	Bergquist	Fujipoly
High Power MPU	C1055, C1100	Thermflow T725	Hi-Flow 225U, 225UT, 625	T-PCM 900, T-PCM-HP105
High Power MPU with Al Foil one side	C1100F	Thermflow T766	Hi-Flow 225FT, 225FAC	N/A
Reinforced	C1060	Thermflow T443	Hi-Flow 115-AC, 200G	N/A
Non Stick one side	C1095-X01	N/A	N/A	N/A

DISTRIBUTED BY:

Corporate Headquarters
4015 Casilio Parkway
Clarence, New York 14031
Ph: 716-759-2222 ● Fax 716-759-6425

Canadian Division
5511 Steeles Ave West ● Unit 5
North York, Ontario M9L 1S7
Ph: 416-741-0750 ● Fax 416-741-0230

SAINT-GOBAIN
PERFORMANCE PLASTICS

Saint-Gobain Performance Plastics Corporation
14 McCaffrey Street
Hoosick Falls, New York 12090-0320
www.fff.saint-gobain.com

For Customer or Technical Support:
(800)962-2666
Tel: (518) 686-7301
Fax: (800) 526-8479

Saint-Gobain Performance Plastics Corporation
717Plantation Street
Worcester, MA 01605
Tel: (508) 852-3072
Fax: (508) 852-3759
www.fff.saint-gobain.com

Simply the coolest
THERMA COOL®