

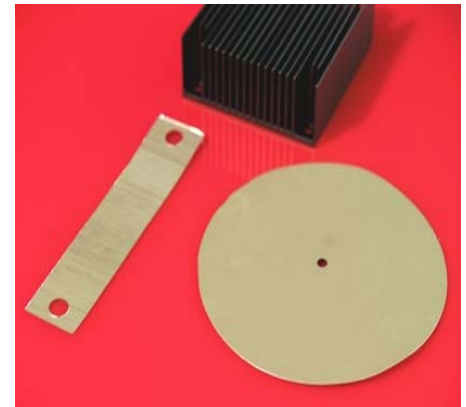
SilverPHASE 50

Electrically Conductive Phase Change Thermal Material

50°C/122°F Phase-Change Temperature

SilverPhase is a high performance silver filled phase change thermal interface material which utilizes an aluminum substrate carrier to act as a thermally and electrically conductive carrier in order to deliver a uniform thickness of silver filled phase change compound on both sides. SilverPhase 50 not only offers efficient thermal transfer by phase changing during normal device operating temperatures, but provides a reliable electrically conductive path across the interface. All at the same time driving out the air from within the interface and adjusting for any surface imperfections or flatness concerns that may exist across the contact surfaces leading to an overall low thermal impedance.

Being able to manufacture SilverPhase 50 in multiple compound thicknesses as well as aluminum substrate thicknesses allows us to meet a wide range of electronic cooling applications ranging from Power Electronics, Transistors, Diodes, Microprocessors or any type of heat generating *isolated* power device requiring efficient and reliable thermal transfer into a heat sink/case sink.



- High Performance Electrical & Thermal
- Excellent for High Power Density Devices
- Solutions for many types of surfaces
- Excellent replacement for thermal greases
- Rolls, Sheets, Die Cuts
- Thixotropic / Prevents Compound Run-Out
- Multiple Standard Material Constructions
- Cost Effective "Drop in Place" Solution / Reworkable
- Fully Customizable—centered around specific requirements

Typical Device Applications	• Power Modules (IGBT)	• LED	• Diodes / Relays	• Power Semiconductor	• Heat Sink/Case Sink
	• Power Electronics	• Transistors	• Microprocessor	• RF Components	• Large Surface Area Transfer

SilverPhase 50 Thermal Compound Properties

- * Phase Change Temp.....50°C / 122°F
- * Volumetric Expansion.....15%
- * Volume Resistivity.....2 Ohm-cm
Based upon 2 mil aluminum carrier version
ASTM B114, B193
- * Thermal Impedance...see page 4 for details on specific material construction performance (ASTM D5470)

Standard SilverPhase 50 Coating Thickness

- * S10.....0.001" (0.025mm) per side
 - * S15.....0.0015" (0.038mm) per side
- Contact us for custom SilverPhase 50 coating thickness options

Standard Aluminum Substrate Thickness

- * AL1.....0.001" (0.025mm)
- * AL2.....0.002" (0.051mm)

Standard aluminum type is 1145 (O) soft temper
Custom aluminum types as well as copper substrate options available.

SilverPhase Delivery Formats / Typical Lead Times

- * Log rolls.....3 to 10 business days
 - * Sheets.....3 to 10 business days
 - * Die cut individuals.....10 to 15 business days
 - * Multiple die cuts per card.....10 to 15 business days
 - * Die cut continuous reels.....15 to 20 business days
- Laser cutting available for tight dimensional tolerance requirements

Stocking and blanket order program options available for qualified customers. For more information, please contact us at 1-888-201-5546 or e-mail info@timtelthermal.com

SilverPhase 50 Pre-Apply Attachment Options

- * ZE2 = high tack silver filled pressure sensitive
- * LT05 = low tack pressure sensitive (repositionable)
- * HT1 / HT2 = high tack pressure sensitive (permanent)
- * Discrete PSA placement or 100% backed options

See page 2 for detailed pre-apply attachment options and configurations

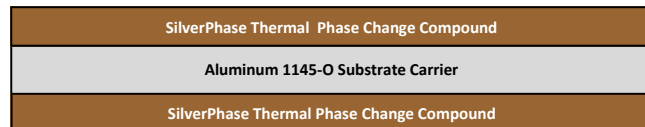
Other Information

- * Manufactured to ISO 9001:2008 Standards
- * RoHs Compliant / Halogen Free Compliant

What is SilverPhase 50?

SilverPhase 50 is a solvent free thermal interface material that is designed to provide efficient thermal transfer and electrical conductivity by providing precision phase-change and a uniform bond line thickness across a device/component mounting interface. The ability to manufacture SilverPhase 50 in a variety of phase-change thicknesses, aluminum substrate thicknesses as well as within rolls, sheets and pre-form die-cuts allows us to meet a wide range of requirements within multiple industries. SilverPhase's inherent flexibility from manufacturing to installation makes it an ideal solution for applications ranging from low volume (even prototypes) and/or high volume environments. SilverPhase is manufactured to superior quality guidelines set forth by our ISO 9001:2008 Quality Standards and offers a quick turnkey solution from design to production.

Standard SilverPhase Pad Construction



See page 2 for detailed material construction options and material codes

Superior Alternative to Thermal Grease

SilverPhase 50 is designed as a pre-formed thermally/electrically conductive "drop in place" pad that offers excellent thermal transfer characteristics not only through design of the compound formulation itself, however, through its uniform pad thickness in X, Y, Z dimensions as well. From an installation perspective, thermal greases are difficult to dispense as well as provide inadequate coverage and a uniform thickness across the interface most often leaving trapped air leading to poor thermal transfer. Not to mention the thermal grease clean up required in unwanted areas afterwards.



Since SilverPhase 50 is manufactured with a specific thickness and die cut pattern, it can be placed instantly and immediately ready for component mounting. Due to its thixotropic formulation design, compound is held within the interface with no worries of run-out into unwanted areas during installation or device/component operation. Upon initial phase-change of the SilverPhase 50 compound, SilverPhase begins its wetting out process allowing it to fill in any microscopic surface imperfections or uneven surface conditions across the interface as well as drive out any trapped air leading to increased thermal transfer performance keeping the device/component cool and reliable.

SilverPhase 50 pre-formed pads are shipped in clean sizable packs or continuous die cut reels instantly ready for cost effective installation and reliable thermal performance.

SilverPhase 50

Electrically Conductive Phase Change Thermal Material

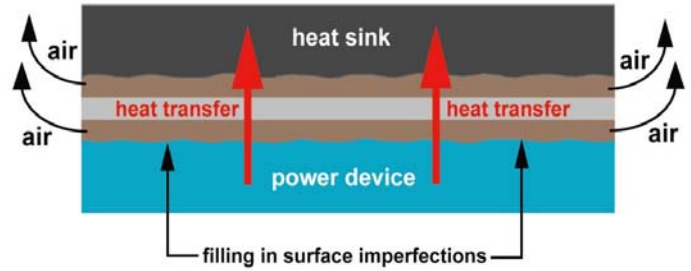
50°C/122°F Phase-Change Temperature

Thinner vs. Thicker

SilverPhase 50 is manufactured in a range of compound coating thicknesses as well as aluminum substrate thicknesses in order to meet various surface flatness conditions, overall interface size and/or nominal gap filling requirements. It is typically recommended that for larger surface area conditions with surface finishes exceeding 64 microns and/or flatness conditions exceeding 0.002" or more, thicker compound coating thicknesses should be considered to allow the SilverPhase 50 compound to adjust for these features during initial phase change. Filling a nominal gap requirement with smooth interface surfaces can typically be accomplished with thicker substrate options.

Driving Out the Air

A primary advantage of utilizing the SilverPhase 50 phase-change system is the ability to drive out air from within the interface during initial device cycling causing phase change and surface wetting of the thermal compound coating.



Note: during initial phase-change, it is recommended to re-check your torque settings if device utilizes a screw mounting system. Applying additional torque during initial phase change will thin the material bond line slightly leading to improved thermal performance.

Standard SilverPhase 50 Material Constructions

SilverPhase 50 is manufactured standard within a range of phase-change coating thicknesses as well as aluminum 1145-O (soft) aluminum substrate thicknesses allowing us to target standard and custom device / mounting application requirements. Below is a table of standard SilverPhase 50 material constructions to choose from.

Standard SilverPhase Material Constructions	0.001" / 0.025mm Aluminum 1145-O	0.002" / 0.051mm Aluminum 1145-O
S10 (0.001" / 0.025mm) compound per side	AL1-S10 0.003" / 0.076mm	AL2-S10 * 0.004" / 0.102mm
S15 (0.0015" / 0.038mm) compound per side	AL1-L15 0.004" / 0.102mm	AL2-S15 * 0.005" / 0.127mm

Custom substrate types and thicknesses available
Double laminated SilverPhase constructions available

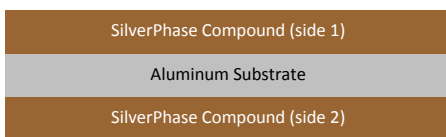
Custom aluminum substrate with either the S10 or S15 coating could include:
0.003" (0.076mm) aluminum 1145
0.005" (0.0127mm) aluminum 1145
0.010" (0.254mm) aluminum 1145

** hard temper aluminum available upon request

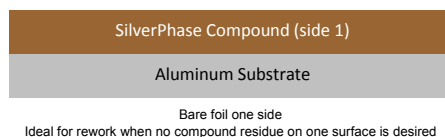
* Popular SilverPhase Material Constructions

SilverPhase 50 Standard and Custom Material Constructions

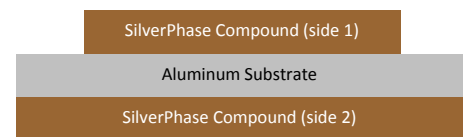
Standard Double Coated Construction



Single Side Coated



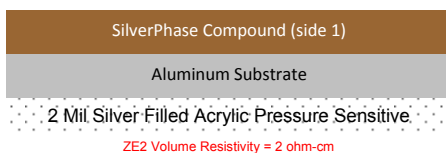
Discrete Coating Placement



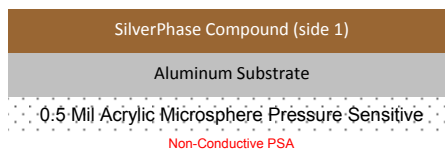
SilverPhase 50 Pre-Apply Attachment Options (100% surface backed)

Note: the introduction of an additional tacking layer to 100% one side of SilverPhase will impact the overall thermal performance of the material.

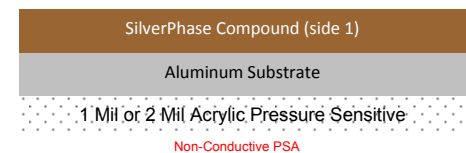
High Tack Permanent Silver Filled (ZE2)



Low Tack Repositionable (LT05)



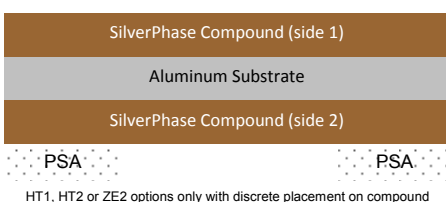
High Tack Permanent (HT1 or HT2)



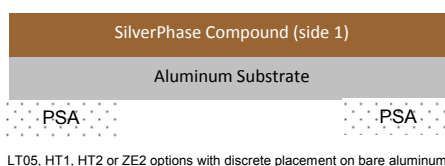
SilverPhase 50 Pre-Apply Attachment Options (Discrete PSA Placement)

Note: Discrete placement designed for applying PSA outside of primary thermal via so thermal performance will not be impacted.

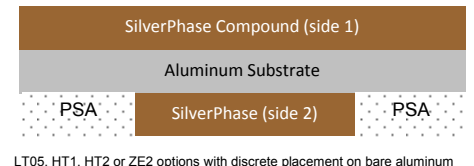
Discrete PSA Placement on Compound



Discrete PSA Placement on Uncoated Side



Discrete PSA with Discrete Coating Placement



SilverPhase 50 Physical Properties / Form Characteristics

Characteristic	SilverPhase 50
Base Formulation (Compound)	Proprietary / Silver Filled
Phase Change Temperature	50°C / 122°F
Viscosity @ Phase Change	Thixotropic
Overall Thickness Tolerance	Target Thickness +/- 10% (typical)
SilverPhase 50 Color	Beige
Separator Liner / Color	Paper / White
Available Formats	Master Rolls / Slit Rolls / Die Cuts (piece or reels)
Maximum Master Roll Width	5.000" (12.7cm)
Standard Master Roll Lengths	25ft / 50ft / 100ft
Custom Roll Lengths and Widths Available	Yes (customer defined)
Standard Sheet Sizes	5.0" x 24.0" (12.7cm x 61.0cm)
Custom Sheet Lengths and Widths Available	Yes (customer defined)
TIMTEL Die Cutting Capabilities	Steel Rule Die / Flexible Die / Rotary Die / Laser Cutting
Typical TIMEL Die Cut Delivery Formats	Individuals, Multiples on a card, or Continuous Reel
Typical TIMTEL Die Cut Dimensional Tolerance	0.005" (0.13mm) to 0.010" (0.25mm) (determined at design review)

Thermal Outgassing (SilverPhase 50 Compound Only)	Result
Total Mass Loss, % TML	0.138
Collectible Volatile, Condensable Matter, % CVC	0.130
Water Vapor Gain, % WVR	0.021

Note: Thermal outgassing test performed per ASTM E595-93 using thermal compound formulation only. Due to no outgassing, SilverPhase 50 is suitable for aerospace application.

SilverPhase 50 Storage & Shelf Life	Result
Storage Condition and Temperature	Cool Dry Location at or below 95°F / 35°C
Shelf Life	Indefinite if stored per storage conditions above
Transit Methods / Conditions	Due to the temperature sensitive design of our thermal materials, it is recommended to ship air freight during warmer months to prevent phase-change of thermal compound during long ground transit conditions within elevated temperature environments (May through September)

Formulation Revisions (post testing of SilverPhase 50 by customer)

Due to the flexibility of technology and capability, not always does our **standard** SilverPhase 50 formulation or form factors 100% optimize a unique application requirement. This is why at TIMTEL, we can provide our customers with minor to major formulation adjustments to fit better within the scope a specific customer defined requirement/characteristic. This is accomplished through base compound modification and/or filler particle type, size or structure. These options are available to customers that have tested the standard formulations and can offer feedback from this testing so it can be used as a baseline for further modification/development.

Application Re-Work / Clean Up

Reworking your application with SilverPhase 50 is simple. Simply detach your device from its heat sink or case sink and remove the pad. Depending on the amount of SilverPhase compound left on your application surface, introduction of new SilverPhase 50 material may be required when re-assembling. SilverPhase 50 compound residue on the application surface can be cleaned up using mineral spirits solvent or isopropyl alcohol and a cloth towel. Other clean up methods include slightly heating the compound and gently wiping away softened unwanted adhesive. **For best results, make sure all application surfaces are clean and free of debris before applying the SilverPhase Pad.**

Flexibility Across Markets and Application Requirements

Due to SilverPhase 50's unique formulation and form factor capability allows it to be a viable candidate within various market and application types where a high performing thermally conductive material is required. SilverPhase 50 is available in a variety of delivery formats including master rolls, slit rolls, die cut individuals or die cuts on a continuous reel

Thermal Performance Testing and Characteristics

Below is thermal impedance data based upon ASTM D5470, *Standard Test Method for Thermal Transmission Properties of Thermally Conductive Electrical Insulation Materials*.

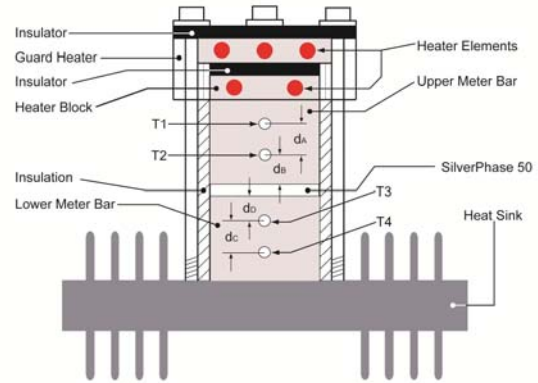
What is thermal impedance and why do we measure it?

Thermal impedance allows us to consistently measure the thermal transfer ability of a thermally conductive interface material taking into account a device's power density, interface area as well as bond line thickness (thermal material thickness). By measuring the temperature at 2 points (shown right) in both the upper and lower metering bars, the temperature of the interface surfaces can be determined and thus the thermal impedance can be calculated due to the temperature differential of these 2 surfaces measured in °C-in²/watt (°C-cm²/watt)

For more information on the full test procedure, please contact us at 1-888-201-5546 or send an e-mail to info@timtelthermal.com

Below are thermal impedance values for common versions of SilverPhase 50 materials. For thermal impedance values for a standard material construction listed on this data sheet but not presented below, please contact us toll free at 1-888-201-5546 or e-mail info@timtelthermal.com

General Test Setup / Overview for Measuring Thermal Impedance



$T_A = T_2 - d_B / d_A (T_1 - T_2)$ = Temperature of upper meter bar surface in contact with SilverPhase 50 Pad

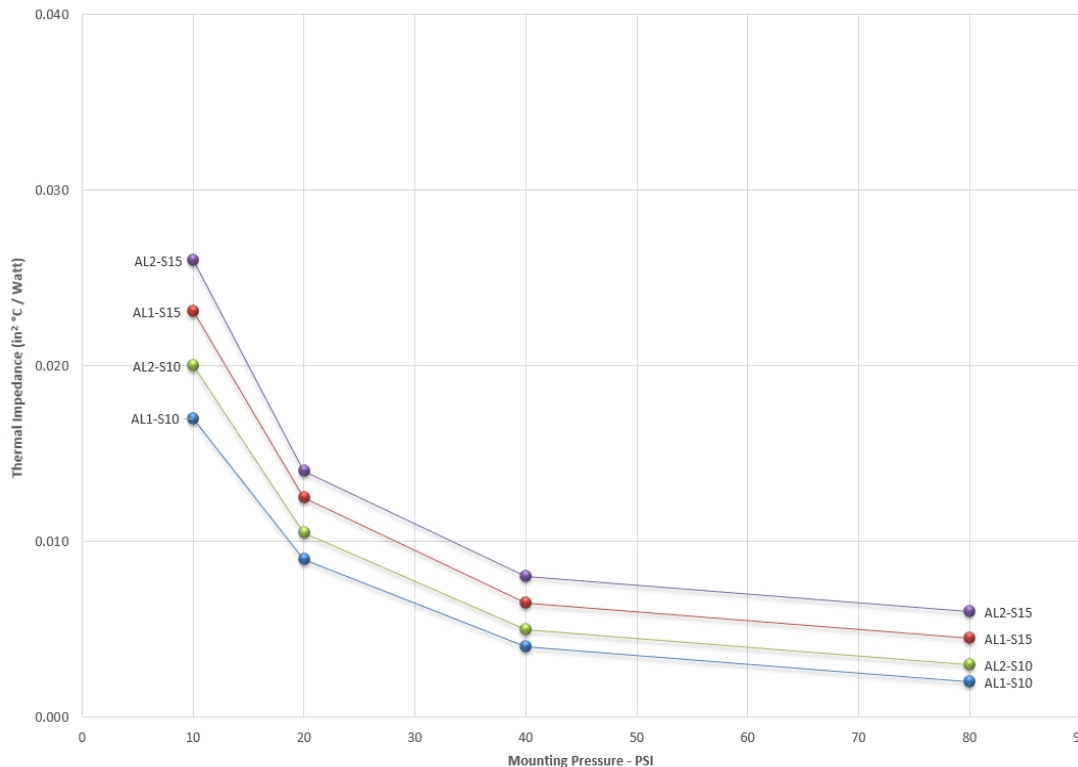
$T_B = T_3 + d_D / d_C (T_3 - T_4)$ = Temperature of lower meter bar surface in contact with SilverPhase 50 Pad

Thermal Impedance is calculated as follows: $(T_A - T_B) \times \text{Area} / \text{Power Applied} = \text{°C-in}^2/\text{watt}$

Type	@ 10 PSI	@ 20 PSI	@ 40 PSI	@ 80 PSI
AL1-S10	0.017 °C-in ² / Watt	0.009 °C-in ² / Watt	0.004 °C-in ² / Watt	0.002 °C-in ² / Watt
AL1-S15	0.023 °C-in ² / Watt	0.013 °C-in ² / Watt	0.007 °C-in ² / Watt	0.005 °C-in ² / Watt
AL2-S10	0.020 °C-in ² / Watt	0.011 °C-in ² / Watt	0.005 °C-in ² / Watt	0.003 °C-in ² / Watt
AL2-S15	0.026 °C-in ² / Watt	0.014 °C-in ² / Watt	0.008 °C-in ² / Watt	0.006 °C-in ² / Watt

Note: Thermal Impedance Testing is available upon request for customers who require a non-standard SilverPhase 50 material thickness, custom constructions, revised substrates or PSA pre-tacking options within pressure ranges of 10 PSI to 80 PSI

Thermal Impedance vs. Mounting Pressure



SilverPhase 50 Samples

Thermal material evaluation is always critical when designing in a new material or developing a new product. Sheet samples of SilverPhase 50 are available for preliminary testing to determine the optimal SilverPhase 50 thickness as well as overall material construction best suited within the scope of your application requirements.

Want to test samples per your required die cut part? Our razor plotter sampling machine allows us to provide customers SilverPhase 50 material already cut to their required outline for testing. Plotter formed samples provide our customers the ability to test not only the SilverPhase material itself, but their required outline as well without incurring the expense of production tooling.

Contact TIMTEL to request sample sheets or plotter formed samples for testing.