PRODUCT DATA SHEET

Heat-Spring®

Ultra-Low Thermal Resistance No-Reflow Thermal Interface Material as Pressurized TIM1.5/TIM2/TIM3

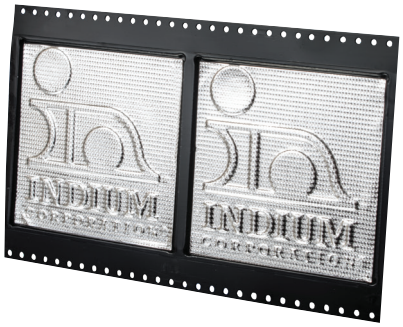
Introduction

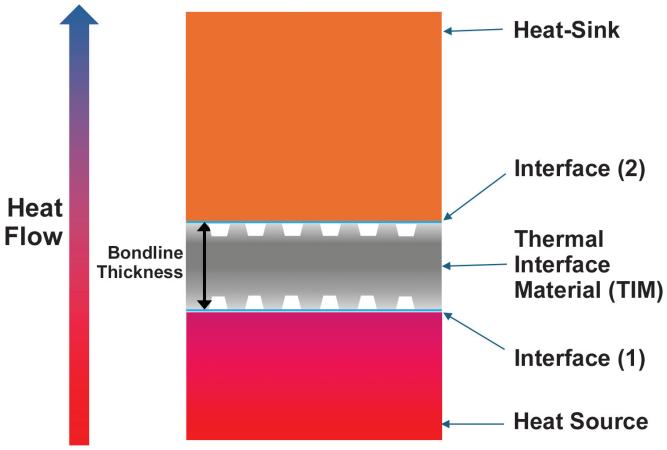
Indium Corporation's patented **Heat-Spring®** preforms provide high reliability, ultra-low thermal resistance between two surfaces, even if those surfaces are warped, rough, or not coplanar.

Features

- Ultra-low thermal resistance that improves with time
- No reflow or high-temperature cure needed
- Indium metal bulk thermal conductivity of 86W/mK
- Proven in multiple high-reliability customer applications
- Highly sustainable: easily reworkable and recyclable
- Clean application; no residue
- Suited to warped, non-coplanar, or uneven surfaces
- Inherently suited to direct immersion cooling in standard dielectric fluids
- Alloy type, **Heat-Spring®** type, thickness and area are adjustable
- Suitable for all standard pick and place tools
- Designs available for Burn-In and Test applications
- Internationally-patented and patent-pending technology

Thermal resistance is a function of TIM material choice and design, bondline thickness, pressure, temperature, time, and the nature of the two interfaces (below).

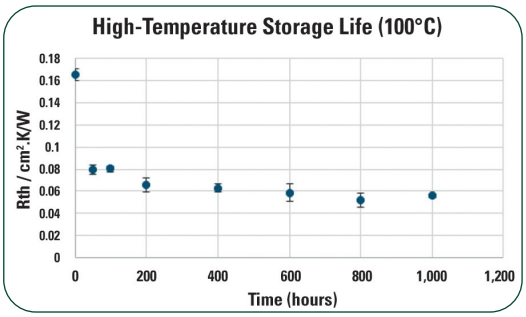


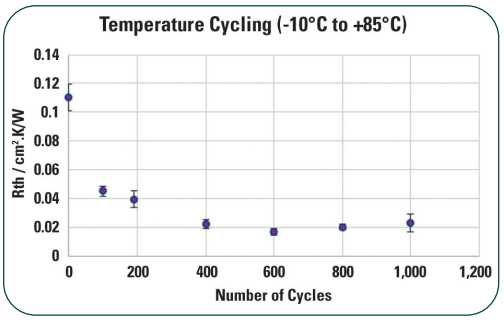


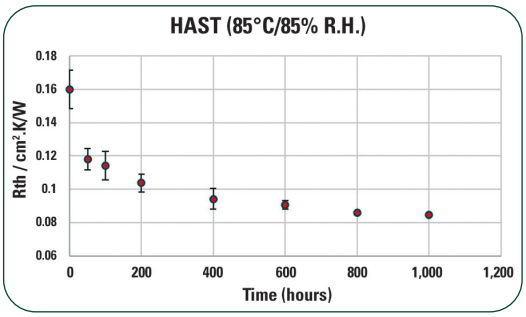
Heat-Spring® Reliability Data

Heat-Spring® Details

Alloy	99.99% In
Heat-Spring® Type	HSD
Initial Metal Thickness	0.004"
Pressure	31psi







Packaging

- Standard: Tray; tape & reel
- Customized packaging

Shelf Life

Shelf life is the length of time a product will retain its properties under specific storage conditions. The shelf life for a **Heat-Spring®** varies with the alloy, but is typically from the date of manufacture when stored in its original sealed container in a nitrogen dry box.

From One Engineer To Another®

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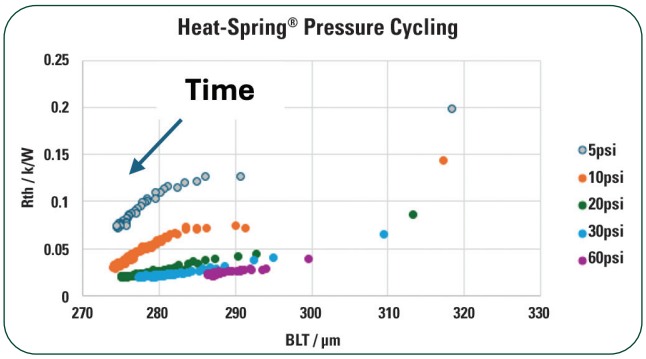
Heat-Spring®

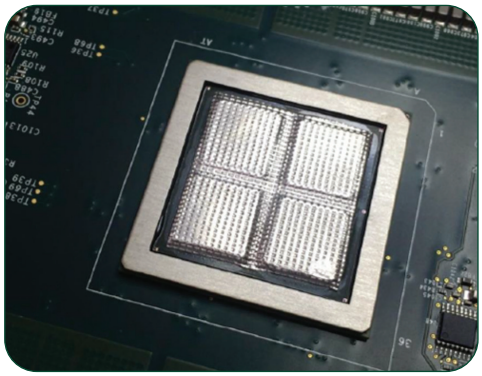


Pressure Cycle
5psi
10psi
20psi
30psi
60psi
30psi
20psi
10psi

Alloy	99.99% In
Heat-Spring® Type	HSD
Initial Metal Thickness	0.010"
Temperature	85°C

- TIMA5 thermal conductivity equipment used
- Copper heads (5.1cm²) with high oxidation levels

Immersion Fluid Compatibility



Customer test vehicle after immersion

Multiple studies with large semiconductor OEM and ODM customers, server customers, and immersion cooling fluid and equipment vendors have proven the long-term reliability of **Heat-Spring®** in these environments.

Heat-Spring® Reliability Data

Choosing the Right Heat-Spring®			Thinnest Metal Foil		Coplanarity Tolerance (Max)		Recommended TIM Pressure In (99.99%) and 90In10Ag		Recommended TIM Pressure Sn+		
Heat-Spring®	**Suitability**	**Key Customer Applications**	**mils**	**microns (µm)**	**mils**	**microns (µm)**	**psi**	**kPa**	**psi**	**MPa**	**Standard Alloys (Customer Usage)**
HSD	Higher pressure; small area; flatter and more coplanar surfaces	TIM1.5 and 2 for power and logic packages and devices	4	100	3	75	30–40	260			90In10Ag, 99.99%In
HSHP	Higher pressure; larger area; rougher, less coplanar, or highly warped surfaces	TIM2 and 3 for larger area power modules	6	150	6	150	30–40	260	100	1	99.99%In, Sn+
HSx	Lower pressure; smaller area; more warped and bowed surfaces	TIM1.5 for larger logic/memory combinations	12	300	10	250	20–30	130			90In10Ag, 97In3Ag, 99.99%In

**Preliminary data in red for reference. For more information, please contact our technical support.*

Contact our engineers: askus@indium.com

Learn more: www.indium.com

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Heat-Spring®

Uses of Heat-Spring®

Heat-Spring®, a soft metal alloy thermal interface material (SMA-TIM), is a patterned, pliable, compressible metal foil that is designed to be used as a thermal conduit between two compressed surfaces. **Heat-Spring®** is intended for use in a variety of high-performance applications, including TIM1.5 (TIM0), TIM2, TIM3, burn-in, and immersion cooling. Common package assemblies include:

- Bare die to heat-sink (mobile ICs and GPUs)
- Heat spreader to spreader
- Heat spreader to heat-sink
- Heat spreader board to heat-sink (LEDs)
- Base plate to liquid cold plate (IGBTs and SiC packages)
- Power amplifier to heat spreader and heat spreader to plate (power assemblies)
- Heat spreader to cooling solution
- Test modules (burn-in)

Heat-Spring® HSD
- The original and most flexible standard option with regards to thermal performance
- Recommended for smaller interfaces with flat, smooth, and more coplanar surfaces

Heat-Spring® HSHP (High Profile)
- Taller pattern, ideal for more irregular, non-coplanar surfaces. The higher profile accommodates the irregular substrate features
- Ideal for assemblies that incorporate an extruded, unfinished heat-sink, or field-fit plates that have surface scarring or machine marks
- Recommended for immersion cooling
- Minimum thickness: 150 microns
- Indium Corporation offers a Liquid Immersion Cooling HSHP Kit, which contains 12 pieces of the HSHP pattern Heat-Spring® in Indalloy®4 (99.99In) for testing in your thermal application. Visit **buy.solder.com** to find out more.

Heat-Spring® HSx
- Specialty pattern for more warped and irregular surfaces
- Allows for lower pressure usages

Geometries
- **Heat-Spring®** is primarily offered as squares and rectangles. Discs, washers, frames, and custom shapes are also available
- Standard X and Y dimensions are between 2.5–100mm. Contact technical support for requests outside standard dimensions

Heat-Spring® Selection Considerations

Pure indium is the recommended material for **Heat-Spring®** due to its high thermal conductivity and high compressibility, allowing for lower interfacial resistance. Although less compressible, other alloys may be used in applications with a larger surface area. The increased rigidity of these alternative compositions promotes more even compression of the **Heat-Spring®**.

When selecting an alloy, a key consideration is the temperature which the thermal interface will reach when the device is in operation. The melting point of the alloy must be sufficiently above the maximum operating temperature in order to avoid extrusion of the **Heat-Spring®**.

Maximum Suggested Operating Temperature for Metallic TIMs

TIM Composition	Suggested Maximum Operating Temperature (°C)
52In/48Sn	100
97In/3Ag, 90In/10Ag	110
100In	125
Sn+	200

When selecting a thickness, a thinner bondline thickness allows for lower theoretical thermal resistance. A thicker **Heat-Spring®**may be selected depending on the coplanarity of the surfaces. A greater thickness offers more compliance, which provides proper contact and prevents tearing. **Heat-Spring®** is specified using a z dimension which represents its fully compressed material thickness.

It may be optimal to decrease the X and Y dimensions of the **Heat-Spring®** to localize the pressure of the contact area. This can provide better deformation of the pattern, therefore decreasing surface resistance and increasing thermal transfer.

Preparation

Heat-Spring® arrives clean and requires no surface preparation. The surfaces in contact with **Heat-Spring®** should be clean of any organic compounds or particulate matter. Any debris that can cause a standoff or inhibit contact can reduce performance. A rough or scuffed surface can enhance adhesion and increase surface area.

Handling and Cutting

Heat-Spring® is safe to handle with bare hands. It is recommended that it is handled with gloves in order to prevent contamination of the surface with oils. **Heat-Spring®** is highly malleable and is best handled with a suction device (from the center), tweezers (from the corner), or other methods that avoid applying pressure to the pattern.

Heat-Spring® can be slid across a surface to the desired position. Do not bend the edges of the foil as it may fold over on itself, potentially causing a void under compression.

Heat-Spring® can be cut with scissors, chopped with a blade, punched with a die, or laser-cut. It is not recommended to "slice" the foil with a blade, as this can cause **Heat-Spring®** to bunch together.

Pre-Attach

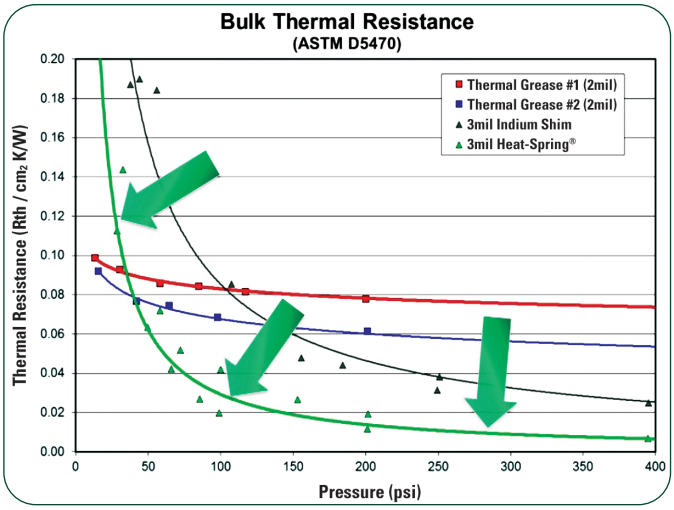
Pure Indium **Heat-Spring®** is quite adhesive and can be pressed onto a surface for pre-attachment. There are several ways to do this, but try not to deform or remove the pattern where

heat conduction will occur. **Heat-Spring®** can be pre-attached using an arbor press with a platen and foam, attaching it to a heat-sink or cold plate. Simply place the pure indium **Heat-Spring®** so that it is contacting the object that can receive a heavy pressure load. Layer antistatic foam over the heat-spring and a platen on top of that. Then press the platen with pressure to evenly and strongly press the **Heat-Spring®** to the desired object. This technique has been demonstrated with both pure aluminum and copper. Alternatively, the indium can be pressed along the perimeter of the interface along a sacrificial frame boundary in which high pressure can be performed to allow the flow stress of the indium to creep and stick.

An alternative pre-attach technique is to use InTACK®. This tacking agent can be applied on corners of the **Heat-Spring®** or across the entire heat-transfer surface. InTACK® has been proven to improve initial thermal performance. In use, the material will begin to evaporate upon elevated temperature exposure without leaving a residue or inhibiting heat transfer.

Pressure Application

The requisite amount of pressure depends primarily on the selected alloy. Generally, a greater amount of pressure will improve thermal transfer, and is recommended. Excessive



pressure may cause extrusion of the material.

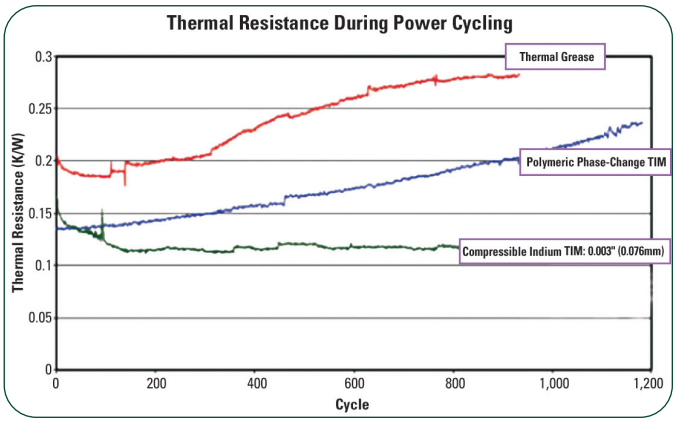
When applying pressure, incrementally thread all screws following a star pattern before tightening to the desired torque to ensure uniform application of pressure loading.

Performance Over Time

Unlike thermal grease or polymeric TIMs, there is no expected degradation with **Heat-Spring®** through thermal cycling. Pure metal will not pump-out or bake-out over time.

Once the device is operational, the **Heat-Spring®** thermal resistance will decrease significantly over the initial thermal transfer. This phenomenon is referred to as plastic deformation, and is a function of both pressure and time. The heat and pressure cause the metal patterning to creep and mold to the micro-imperfections of the surface. The thermal resistance will ultimately stabilize and maintain optimum performance.

The pattern should be evenly compressed across the contact area. However, the patterning is not expected to be completely flattened with the intended degree of deformation.



Immersion Cooling

For immersion cooling applications, 100In HSHP is recommended. **Heat-Spring®** is compatible with all coolants. Unlike organic TIMs, pure metal **Heat-Spring®** does not dissolve in the immersion fluids. Pre-dip the **Heat-Spring®** in the coolant before insertion into the interface to remove air from the pockets. Attach the CPU to the heat-sink first, then install the entire processor and heat-sink into the socket. This will prevent damage to pin grid arrays (PGAs) that may not withstand the pressure required to compress the **Heat-Spring®**.

Recycling/Reclaim

Heat-Spring® is 100% recyclable. Contact technical support for reclaim opportunities.

All of Indium Corporation's solder paste and preform manufacturing facilities are IATF 16949:2016 certified.
Indium Corporation is an ISO 9001:2015 registered company.

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