APPLICATION NOTE
Use of Heat-Spring®

Introduction

Heat-Spring®, soft metal alloy thermal interface materials (SMA-TIMs), is a patterned, pliable 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 TIM2, TIM3, TIM1.5, 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)
- Power amplifier to spreader and spreader to plate (power assemblies)
- Spreader to cooling solution
- Test modules (burn-in)

Product Line-Up

Heat-Spring® HSD

- The original and best standard option with regards to thermal performance
- Recommended for smaller interfaces with flat, smooth, and parallel surfaces
- Minimum thickness: 100 microns

Heat-Spring® HSHP (High Profile)

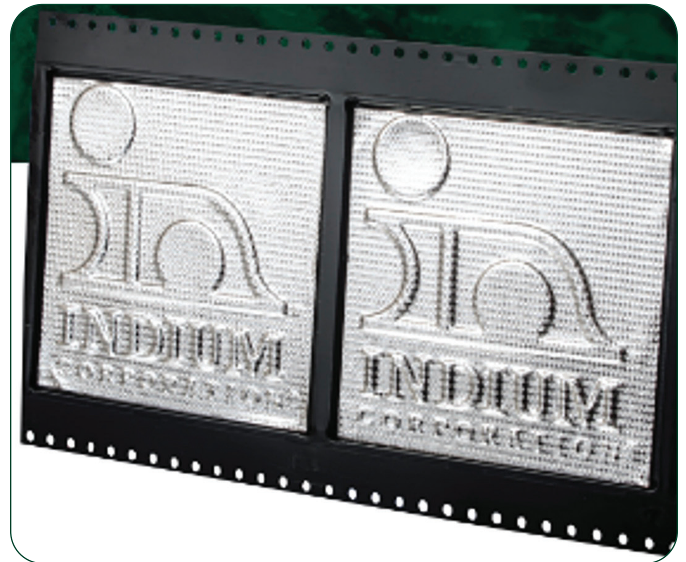
- Taller pattern, ideal for more irregular, non-planar surfaces. The higher profile accommodates the irregular substrate features
- Ideal for assemblies that incorporate an extruded, unfinished heat-sink, or field-fit plates that have surface scarring or machine marks
- Recommended for immersion cooling
- Minimum thickness: 150 microns

Heat-Spring® HSK

- Redesigned configuration for burn-in and test applications
- Features pure indium with a single-side pattern and an aluminum clad barrier layer on the opposite side to provide resilience through many insertions
- The thin aluminum layer on the side facing the device under test (DUT) prevents the soft metal from adhering to the surface, eliminating staining and cracking
- Minimum thickness: 150 microns

HSD and HSHP Alloys

- 100 In (recommended)
- 97In/3Ag
- 90In/10Ag
- 52In/48Sn
- Sn+ (pure Sn or Sn with Cu)



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

Form No. 100139 (A4) R0

APPLICATION NOTE

Use of Heat-Spring®

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 planarity 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 are 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.

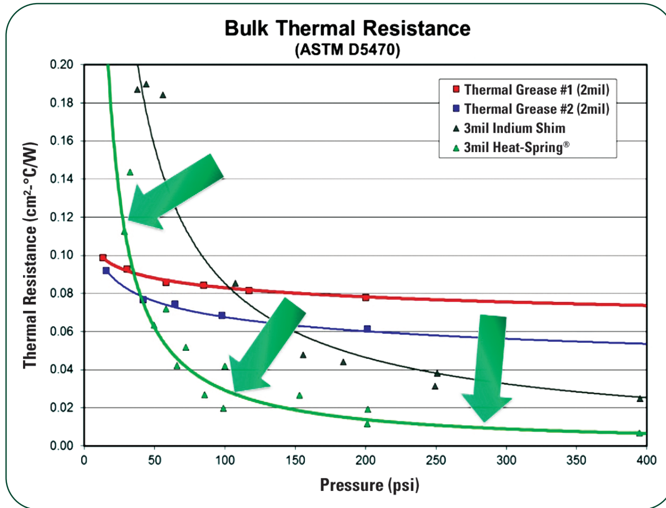
An alternative pre-attach technique is to use InTACK™. This tacking agent can be applied on corners of the **Heat-Spring®** or across the entire heat-transfer surface. InTACK™ has been proven to improve initial thermal performance. In use, the material will begin to evaporate upon elevated temperature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

APPLICATION NOTE

Use of Heat-Spring®

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. For pure indium **Heat-Spring®**, a minimum of 40psi is recommended. A minimum of 100psi is recommended for Sn+.



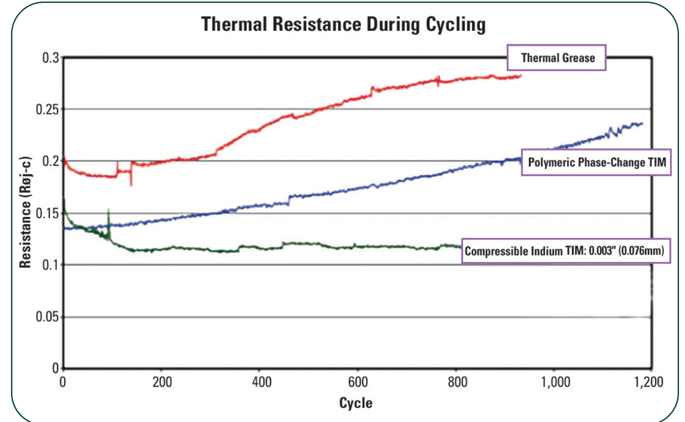
When applying pressure, incrementally thread all screws following a star pattern before tightening to the desired torque to ensure uniform application of pressure loading.

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 the plastic deformation process, 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 cannot withstand the 40psi of pressure required to compress the **Heat-Spring®**.

Packaging

- Custom tray
- Tape & reel

Shelf Life

The shelf life for **Heat-Spring®** is two years from the date of manufacture when stored in their original sealed container in a nitrogen dry box.

Recycling/Reclaim

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

This product data sheet is provided for general information only. It is not intended, and shall not be construed, to warrant or guarantee the performance of the products described which are sold subject exclusively to written warranties and limitations thereon included in product packaging and invoices. All Indium Corporation's products and solutions are designed to be commercially available unless specifically stated otherwise.

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.

Contact our engineers: **askus@indium.com**
Learn more: **www.indium.com**

ASIA +65 6268 8678 • CHINA +86 (0) 512 628 34900 • EUROPE +44 (0) 1908 580400 • USA +1 315 853 4900

©2024 Indium Corporation