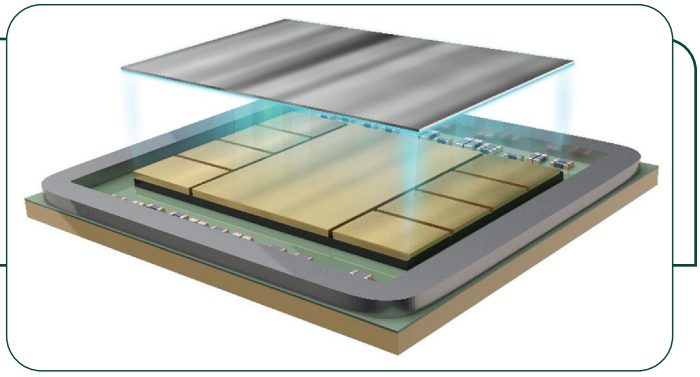
PRODUCT DATA SHEET

Indium-Based Solder TIMs

High-Performance Thermal Interface Materials for Advanced Semiconductor Applications

Introduction

Indium-based solder TIMs (Thermal Interface Materials) provide exceptional thermal conductivity and mechanical compliance for high-power density semiconductor packages. Due to indium's unique properties, these solder TIMs are ideally suited for applications demanding superior thermal performance and high reliability.

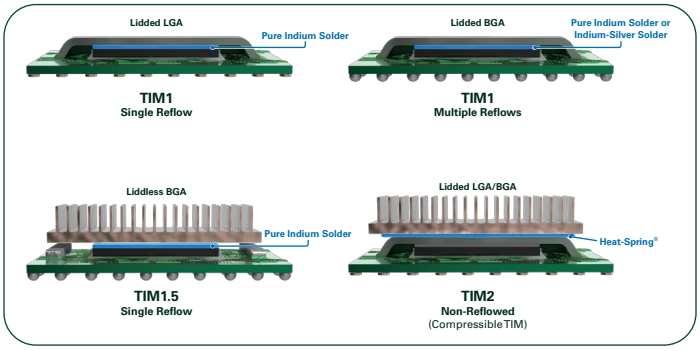


Features

- High thermal conductivity: 86W/mK
- Solder TIMs (sTIMs) are reflowed solder joints, typically indium or indium-silver, which provide the lowest thermal resistance of all TIMs
- Excellent wetting behavior on common substrate finishes (Cu, Ag, Au, Ni/Au)
- Low melting point: ~157°C (pure Indium)
- Soft and ductile, accommodating CTE mismatch and reducing stress
- RoHS-compliant
- Indium and indium alloys are recyclable

Applications

Indium solder TIMs are widely used in TIM1 and TIM1.5 applications, including BGA packages that see multiple reflows.



TIM1 (Die-to-Lid Interface)

- Direct interface between silicon die and lid or heat spreader
- Indium's excellent wetting and compliance allow for the lowest thermal resistance of all TIMs
- Common in CPUs, GPUs, ASICs, high-performance FPGAs

TIM1.5 (Bare Die-to-Heat-Sink Without Lid)

- Interface between bare die and direct-attached heat-sink, vapor chamber, or cold plate
- **Indium sTIMs** are reworkable
- Common in high power density CPUs, GPUs, high-frequency RF devices, power electronics, and space/aerospace modules

Wetting Characteristics

Indium exhibits excellent wetting behavior on a wide range of metal surfaces. This ensures strong metallurgical bonding and uniform solder spread, critical for minimizing voids and maximizing thermal transfer.

- Wettability: Excellent on Au, Ag, Cu, Ni finishes
- Flux requirements: Usually requires no-clean flux or oxide-removal step
- Contact angle: <30° on clean substrates, indicating good wetting

Thermal Reliability

Indium sTIMs provide consistent thermal conductivity over extended temperature cycling and high-temperature storage.

Test Type	JEDEC Standard	Conditions	Result
Thermal Cycling (TCT) (J)	JESD22-A104	0–100°C, 2,000 cycles	Pass: No delamination, cracking, or voiding
High-Temp Storage (HTS)	JESD22-A103	150°C for 1,000 hours	Pass: Minimal thermal degradation
HAST (Unbiased)	JESD22-A110/A118	110°C/85% RH for 264 hours	Pass: No corrosion, voids, or IMC spalling

Void formation: Achieve <1% overall voiding under proper assembly and reflow conditions*.

** Contact an Indium Corporation Applications Engineer to learn more.*

From One Engineer To Another®

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Mechanical Reliability

The ductility of indium allows it to conform to surfaces under low pressure, making it ideal for interfaces between materials with differing coefficients of thermal expansion (CTE). It is soft (6X softer than pure lead) and it anneals at room temperature—so it can accommodate differential thermal expansion with minimal stress on the interface.

- CTE mismatch tolerance: Excellent, reduces delamination and fatigue
- Shear strength: Moderate; well suited for thermal applications
- Fatigue life: Long-term mechanical integrity under cyclic loading

Design Considerations

- Bondline Thickness (BLT): Unlike traditional thermal greases, liquid metals, or polymer-based TIMs, **Indium sTIM** bondlines are thicker in most applications. Thicker bondlines (>.2mm) are not uncommon for **Indium sTIM** to account for uniform coverage across the surface and strong mechanical reliability, while still providing low overall thermal resistance due to indium's high thermal conductivity and ductility.

Metallization

- Most commonly used on Ti/NiV/Au stack with a thin Au layer, often 50–100nm
- Thick Au layers can lead to excessive $AuIn_2$ formation
- Reflow temperature for indium (~170–200°C) allows intermetallic compound (IMC) formation without overgrowth
- IMC control is critical in TIM1/TIM1.5 where thermal resistance must remain low and stable

IMC Reliability Implications:

- Thin, uniform IMC layers are beneficial:
  - Ensure strong metallurgical bonding
  - Maintain low thermal resistance
- Excessive IMC growth (especially brittle ones like $AuIn_2$) can increase mechanical fragility and lead to delamination or cracking under thermal cycling
  - Contact an Indium Corporation Application Engineer to learn more about the impact of IMCs

Warpage Performance

The low yield strength and compliance of indium helps to minimize warpage during and after assembly, which is especially important in advanced node flip-chip and 3D-IC packages.

- Warpage compensation: Superior compared to higher-stiffness solders
- Assembly pressure: Minimal pressure required for good contact

Product Forms

- Preforms: Custom stamped or laser-cut shapes
- Alloys: Indium and indium-silver are common. Learn which alloy is best for your application by contacting Indium Corporation
- Thicknesses as low as 0.1mm
- Up to 100mm x 100mm
- Flux: No-clean pre-coated flux preforms are preferred to avoid additional in-line spray flux processes

Storage and Handling

- Shelf life: Up to 1 year in dry, ambient conditions from date of manufacture
- Storage:
  - Store in unopened original vacuum sealed bag
  - Less than or equal to 55% Relative Humidity (RH)
  - Less than or equal to 30°C

Handling Considerations:

- Pure indium is extremely soft and can easily bend, rip, or dent during handling; therefore, avoid manual handling as much as possible
- If needed, use vacuum nozzle to pick and place
  - If not possible, use flat plastic tweezers to pick and place with care, putting as little pressure as possible on the preforms
- Bulk indium metal is not a hazardous material and no additional safety precautions are required
  - Indium also has an extremely low vapor pressure relative to its melting temperature
- For automated handling, standard pick and place procedures can occur with the following considerations:
  - Minimal down force should be applied to minimize "witness" marks during pick-up
  - Consult with pick and place vendor for best nozzle size, shape, and material

Indium sTIMs offer a highly reliable, high-performance thermal interface solution for leading-edge semiconductor applications. With their excellent wetting, thermomechanical reliability, and ability to compensate for high-warpage packages, they are ideal for TIM1 and TIM1.5 interfaces in high-performance computing, telecom, automotive, and aerospace applications.

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**

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