



# INDUSTRY LEADER IN **LIQUID METAL TECHNOLOGY** FOR THERMAL MANAGEMENT

As the world's foremost leader in metal-based thermal interface materials, Indium Corporation has been a trusted supplier of gallium-based liquid metals for decades.



# LIQUID METAL TECHNOLOGY



## Technical Expertise, From One Engineer To Another®:

- High-performance metal-based TIM leader with intimate knowledge and experience in high volume TIM0, TIM1, and TIM2 applications
- Global technical support to help customers ensure the chosen TIM withstands the thermo-mechanical stresses and maintains its thermal properties throughout the predicted lifetime of the application
- Prototype and characterization of customized materials for customers at incredible speed
- Established equipment partnerships with dispensing and jetting suppliers for high-volume applications

## Liquid Metal Leaders:

- Indium Corporation has been manufacturing and supplying gallium-based liquid metals for more than 60 years
- Low and high volume production available in the U.S. and Asia
- Stable supply of gallium metals ensures your material availability

## Quality:

- ISO9001 and IATF-16949 Certified
- Liquid metal is packaged and shipped in accordance with DOT/IMDG/IATA requirements

## Your Trusted Supplier

From mining and refining to product packaging and logistics, we set the standard for processing indium and gallium. Quality and lot-to-lot consistency is assured because we control the process from the very first step. As a global supplier of solder TIM solutions, we are ready to help introduce your system to the benefits of liquid metal as a high-performance cooling solution.

## Packaging

Indium Corporation has been supplying gallium-based alloys worldwide for decades. As a class 8 (corrosive) material, packaging and transport of gallium-based alloys must meet certain regulations. Our intimate knowledge and expertise ensures safe and compliant transportation of gallium-based liquid metals to your facility. Liquid Metal TIMs are packaged in syringes and bottles which conform to all regulations and can be transported via air, highway, rail, or ocean.

**Syringes:** 10g (3cc), 20g (5cc), 30g (10cc), 50g (30cc), 100g (55cc)

## Available Alloys

Indalloy® Number	Composition	When to choose	Recommended Operating temperature	Liquidus (°C)	Solidus (°C)	Thermal Conductivity (@85°C W/mK)	Electrical Resistivity (10 <sup>8</sup> Ω·m)	Specific Gravity (gm/cm <sup>3</sup> )
51E	66.5Ga/20.5In/13Sn	Lower melting point eutectic alloy best used in dispensing and printing applications	-50–200°C	11	11	37	28.9 (1)	6.32
300E	78.6Ga/21.4In	Highest thermal conductivity and best for jetting applications		15.7	15.7	44	27*	6.16
306 (AKA)	68.5Ga/21.5In/10Sn	Widely used in high-end gaming platforms		19	10	35*	29*	6.31*

Other Liquid Metal Alloys available upon request. Please contact Indium Corporation to discuss your specific needs.

\*Estimated

Contact our engineers: [askus@indium.com](mailto:askus@indium.com)

Learn more: [www.indium.com](http://www.indium.com)

# LIQUID METAL FAQ:

## *What is liquid metal?*

- Simply stated, a liquid metal is a pure metal or metal alloy that is liquid at or near room temperature. At Indium Corporation, we consider liquid metals for use in TIM0 and TIM1 thermal applications of CPU/GPUs to be liquid between 7.6°C and 17°C (45.68°F – 62.6°F) and be an alloy containing gallium and various other elements such as indium, tin or zinc. By alloying gallium with other metals, properties such as liquidus temperature, viscosity, and thermal conductivity can be changed. In general, as gallium content decreases, so does the liquidus temperature and bulk thermal conductivity. As the gallium content increases, so does the liquidus temperature of the alloy. For example, pure gallium is liquid at 29.8°C (85.6°F) with a thermal conductivity of 28.1W/mK, whereas Indalloy®300E (78.6Ga/21.4In) has an eutectic liquidus temperature of 15.7°C (60.3°F) and an estimated thermal conductivity of 21W/mK.



## *Where does Indium Corporation produce gallium-based alloys?*

- We supply gallium-based liquid metal alloys worldwide from either our Rome, NY facility in the U.S.A. or from our facility in Cheongju-si, South Korea.

## *Which gallium-based alloy should I choose?*

- Indium Corporation offers several gallium-based liquid metal alloys.

## *Which gallium-based alloy is best for my application?*

- Using pure gallium as a TIM is not advised given pure gallium tends to expand by 3% when it changes phases, adding significant stresses into the assembly. In addition, with a liquidus of 30°C, applying pure gallium in a high-volume process becomes a significant challenge. The first consideration is the usage temperature. A eutectic material has a single melting point (in the Indalloy nomenclature, a eutectic alloy is designated xxxE). Non-eutectic alloys have a lower (solidus) and an upper (liquidus) point. During application of the liquid metal (brushing, dispense, or jetting), the greater the temperature difference between the liquidus or eutectic temperature, the lower the surface tension (ease of application/"wetting"). However, in thermal applications, the bulk thermal conductivity has to be considered, and typically the higher the indium content and the fewer additives in the alloy, the higher the thermal conductivity.
- Indium Corporation adds constituents such as Sn, In, and Zn to our liquid metals for TIM applications. The addition of Zn provides corrosion resistance and lubricity as well as reducing thermal resistance. The addition of In provides additional ductility to the alloy and improves bulk thermal conductivity, while the addition of Sn lowers the liquidus temperature and reduces viscosity and surface tension allowing for ease of spreading onto the die. Please consult your Indium Corporation sales or technical support representative to choose the best alloy based on your specific needs and application methods.



## *What surfaces are compatible with gallium-based liquid metal?*

- Pure gallium is corrosive against other metals, such as aluminum and steel. The Ga will diffuse into them making their structure fragile. However, gallium-containing alloys are compatible with the vast majority of other materials including most metals as well as many non-metallic surfaces. Copper, nickel, and direct-to-silicon are all common TIM surfaces for use with gallium-based thermal interface materials. For TIM0/1 applications, the silicon die is made by a mixture of silicon and copper and is perfectly safe to use with Ga-containing alloys on direct die applications. However, for the heat-sink and IHS, gallium does diffuse into copper. In static environments this may not be of concern, but when operating in variable temperature environments—such as a CPU/GPU—it could lead to early failure. While the Ga/Cu alloy layer never gets more than a few hundred atoms thick, we recommend an electroless nickel plating of 20nm or more if using a Cu IHS or heat-sink.



# LIQUID METAL FAQ:

## *Can I apply to aluminum or aluminum alloys, or can anodizing the aluminum protect it from liquid metals?*

- None of these are acceptable uses. Aluminum or its alloys may be susceptible to sudden catastrophic failure shortly after contact with gallium-based liquid metals. Anodizing of any type or thickness may be susceptible to pinholes and/or scratches, and a thick anodized coating will negatively impact the effectiveness (thermal resistance) of the overall thermal solution.

## *Can liquid metal be applied in high-volume applications?*

- Yes. Indium Corporation has tested our liquid metals in dispensing and jetting applications, and has established partnerships with top-rated equipment manufacturers to help you deploy a consistent, reliable process using liquid metal. Please consult your Indium Corporation sales or technical support representative.



## *How much liquid metal do I need to put down on my die to achieve the lowest thermal resistance and greatest reliability?*

- As a general rule, a 25.4mm x 25.4mm die needs 15–20 milligrams of liquid metal to spread onto the entire surface. However, factors such as surface area, desired bondline thickness, application method, and operating conditions all need to be considered when calculating the proper amount of liquid metal for your specific application. Please consult with Indium Corporation's Technical Support to help you determine the right volume of liquid metal for your application.



## *Is liquid metal electrically conductive?*

- Yes, liquid metals are electrically conductive so the material should not come in direct contact with electric circuitry. If electrical isolation is required, metallic-based TIMs are not the best choice unless combined with an isolation layer.



Contact our engineers: [askus@indium.com](mailto:askus@indium.com)  
Learn more: [www.indium.com](http://www.indium.com)

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.

**From One Engineer To Another®**

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