

## PRODUCT DATA SHEET

# Commercial Tin Metal

### Introduction

Indium Corporation is a leading global supplier of pure tin, tin alloys, and compounds. **Tin metal** is primarily obtained from the mineral cassiterite ( $\text{SnO}_2$ ) and is extracted by roasting cassiterite in a furnace with carbon. Rigorous quality standards and advanced analytical instrumentation, such as ICP and GDMS, assures consistent product quality from one lot to another.

### History

Tin was one of the earliest metals known to mankind, dating back to at least 3000 BC. During the Bronze Age, 10–15% tin was added to copper to form bronze, an alloy that is harder than either pure tin or copper. Bronze found widespread use in tools and weapons until steel was discovered. Later, the Romans were known to use solder, a low-melting alloy of tin and lead, and also used tin-coated copper vessels.

### General Properties

Tin is a non-toxic, soft, pliable metal easily adaptable to cold-working by rolling and extrusion. Tin exists in two allotropic forms: normal white metallic  $\beta$  tin and grey powdery  $\alpha$  tin (also referred to as tin pest). The undesired transformation of the more common  $\beta$  tin to  $\alpha$  tin generally occurs at temperatures lower than  $13.2^\circ\text{C}$ . Metallic tin has a white, silvery color and when highly polished, has a high light reflectivity. The melting point is low compared with other common structural metals. Conversely, the boiling point is high and loss by volatilization from a liquid melt or during alloying with other metals is insignificant. It alloys readily with most common metals, imparting hardness and strength to the alloys. A tin coating adheres well to many metal surfaces and improves the corrosion protection, appearance, and workability of the base metals. The physical properties of tin are not affected to any appreciable extent by small amounts of impurities in the tin.

### Applications

- Since tin is plentiful and non-corrosive, it makes an excellent protective coating material for other metals.
- Tin has long been used as a solder in the form of an alloy with lead and/or other metals. Lead-free solders are becoming more popular, especially those containing tin, copper, and silver. Solders are used primarily for electrical/electronic interconnection soldering and the soldering of copper water pipe.
- Tin has been used as an alloying agent since antiquity. Mixed with varying amounts of copper to form bronze, these alloys have been used as weapons, tools and other utensils, and bell housings. Tin is also used in fusible alloys, Babbitt metal, dental alloys, pewter, and advanced specialty alloys.



- **Tin metal** is used in the manufacture of plate glass by floating molten glass on molten tin. This is known as the Pilkington float glass process and it is the standard process used today to produce glass with a very smooth surface. Additionally, sintered ceramic bricks comprised of tin oxide (stannic oxide) are used as the furnace lining that contains the molten glass.
- Tin molten deposited or electrodeposited onto steel forms a galvanized coating, which protects steel from corrosion.
- Tin molten deposited or electrodeposited onto copper electrical or electronic terminations protects the copper from oxidation, which allows for reliable soldering.
- Tin can be manufactured into various tin compounds. These compounds are used in plating bath formulation; as anti-cavity agents used in toothpaste; to stabilize plastic resins; as antifouling boat hull coatings; in wood preservative coatings; and many other applications.
- Thin film coatings on glass or plastic containing doped tin oxide can function as a transparent conductive coating. Examples include indium oxide doped with tin oxide (ITO) and tin oxide doped with fluorine or antimony (FTO, ATO). Such coatings are used in LCD, plasma, and OLED TVs and displays, freezer case windows, aircraft, train and automobile windshield demisting, low-E window glass, privacy glass, automatic dimming mirrors, static dissipation, and other applications. Primary deposition is by D.C. magnetron sputtering or spray hydrolysis using ceramic sputtering targets or a solution of metal halides, respectively.
- Tin oxide slurry is used for polishing glass and marble.
- Tin is also used as a negative electrode in advanced Li-ion batteries.

From One Engineer To Another®



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### Physical Properties

Atomic Number	50
Atomic Weight	118.71
Melting Point	505.08K (231.93°C or 449.47°F)
Boiling Point	2,875K (2,602°C or 4,715°F)
Density	7.29g/cm <sup>3</sup> β tin 5.77g/cm <sup>3</sup> α tin 6.97g/cm <sup>3</sup> liquid at mp
Phase at Room Temperature	Solid
Vapor Pressure	986x10 <sup>-6</sup> Pa at 1,000°C
Surface Tension	544mN/M at MP
Viscosity at Melting Point	1.85MPa (=cP)
Specific Heat @ 20°C	222J/(kgK)
Latent Heat of Fusion	14.2cal/g
Thermal Conductivity @ 20°C	65 W/mK
Coefficient of Linear Expansion	19.9 x10 <sup>-6</sup> at 0°C
Shrinkage on Solidification	2.8%
Volume Conductivity	15IACS
Brinell Hardness @ 20°C	3.9 (10kg, 5mm, 180s)
Tensile Strength @ 15°C	2,100psi
Latent Heat of Vaporization	520+/-20cal/g

### Available Physical Forms of Tin

- Ingot
- Shot
- Custom fabrication (e.g., perform, sphere, wire, tubing, etc.)

### Grades Available

- 3N5
- 4N
- 4N8
- 5N

### Technical Support

Indium Corporation's internationally experienced engineers, material scientists, and metallurgists provide in-depth technical assistance to our customers. Thoroughly knowledgeable on all aspects of material science and metallurgy as it pertains to tin metal, its uses, and its applications, our technical service staff is available to provide rapid response to all technical inquiries. We believe that our long-standing emphasis on providing our customers with superior technical service clearly differentiates Indium Corporation from our competitors.

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.

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

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### Typical Impurities (ppm)

Impurity	Grade			
	3N5	4N	4N8	5N*
Ag	15	<1	<1	<1
Al	5	<1	<1	<1
As	25	10	10	3
Bi	28	2	<2	<2
Cd	5	<0.5	<0.5	<0.5
Co+Ni	18	<1.5	<1.5	<1.5
Cu	8	2	<0.5	<0.5
Fe	20	7	1	2
In	39	16	1	<1
Pb	20	22	3	3
S	22	—	—	—
Zn	5	<0.5	<0.5	<0.5
<b>Total ppm Level</b>	<b>&lt;500</b>	<b>&lt;100</b>	<b>&lt;20</b>	<b>&lt;10</b>

\*Limited availability

Please note that the above ppm levels are typical for the grade indicated, but will vary from lot to lot depending on the source of tin. They are listed for reference purposes only and should not be used for designing product specifications. Only the total impurities are guaranteed to be less than the maximum allowed in each grade:

- 3N5 grade: total impurities <500ppm
- 4N grade: total impurities <100ppm
- 4N8 grade: total impurities <20ppm
- 5N grade: total impurities <10ppm

If you have specific requirements for one or two elemental impurities, Indium Corporation may be able to accommodate your specifications for those impurities.

### Safety Data Sheet

The SDS for this product can be found online at <http://www.indium.com/sds>



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