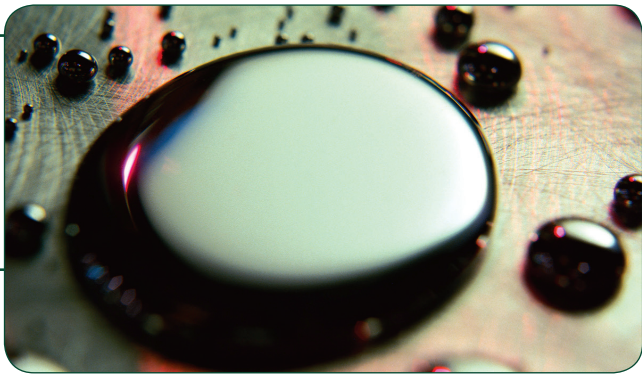
PRODUCT DATA SHEET

Liquid Metal

Gallium and Gallium Alloys



Introduction

Several low-melting-point **Indalloy®** alloys are liquid at room temperature. These gallium-based alloys are non-toxic replacements for mercury. The gallium-based alloys have far lower vapor pressure than mercury, reducing both the amount and toxicity of metal vapor exposure.

Excellent Thermal and Electrical Conductivity

Metals conduct heat and electricity with their valence electrons. This very effective conduction mechanism is a property of liquid as well as solid metals and alloys. Accordingly, liquid metals have thermal conductivity far superior to non-metallic liquids. Liquid metals are used in applications for dissipating concentrated heat loads such as thermal interfaces for microprocessors, reactors, and heat exchangers. Liquid gallium alloys are inherently high-density and low-viscosity (similar to that of water, <8 cP at room temperature[1]). As an electrically conductive metal, gallium alloys are used for mercury replacements in switches and contacts.

Wetting to Metallic and Non-Metallic Surfaces

These alloys will wet to most metallic and non-metallic surfaces. This wetting behavior and lubricity enable gallium alloys to serve as high-temperature lubricants in journal bearings. However, gallium will attack (it alloys with) some metals, even at room temperature. At higher temperatures, gallium dissolves most metals although the refractory metals, particularly tungsten and tantalum, are resistant to this dissolution. Columbium, titanium, and molybdenum also have this resistance, but less than tungsten and tantalum[2,3].

Structural materials such as steel, stainless steel, and nickel alloys can generally tolerate gallium service up to the 300–500°C range. However, even at ambient temperatures, gallium is particularly aggressive in dissolving aluminum; care should be taken to avoid contact with aluminum components.

Like indium, gallium and gallium alloys have the ability to wet to many non-metallic surfaces such as glass and quartz. Gently rubbing the gallium alloy onto the surface may help induce wetting.

Note: These alloys form a thin, dull-looking oxide skin that is easily dispersed with mild agitation. The oxide-free surfaces are bright and lustrous.

Applications

Typical applications for these materials include thermostats, switches, barometers, heat transfer systems, thermal cooling and heating designs, and TIM2 interfaces.

Packaging

Alloys are packaged in polyethylene bottles and 3cc, 5cc, and 6 oz. syringes, and are shipped in accordance with applicable federal regulations.

Note: Gallium alloys expand when they solidify. Accordingly, these alloys should not be stored in glassware below the melting temperature.

Storage and Shelf Life

Unopened bottles and syringes have a guaranteed shelf life of one year. Syringes should be stored in an upright position with the tips down. If stored in polyethylene bottles, it is recommended that as the material is removed from the bottle, the volume should be replaced with dry argon. This minimizes the possibility of oxidation on the surface of the alloy. If the alloy has been stored below its melting point and has solidified, it should be remelted and thoroughly shaken or mixed before use. When reheating the alloy in its original packaging, do not exceed 65°C.

1. Smithells, Colin J, ed. *Metals Reference Book,* 5th edition, London, UK 1976.
2. *Pergamon Texts in Inorganic Chemistry Volume 12, The Chemistry of Aluminum, Gallium, Indium and Thallium* by K. Wade & A.J. Banister, University of Durham, Pergamon Press, 1975.
3. Lyon, Richard N, ed. *Liquid Metals Handbook,* 2nd edition, Washington DC, 1952.

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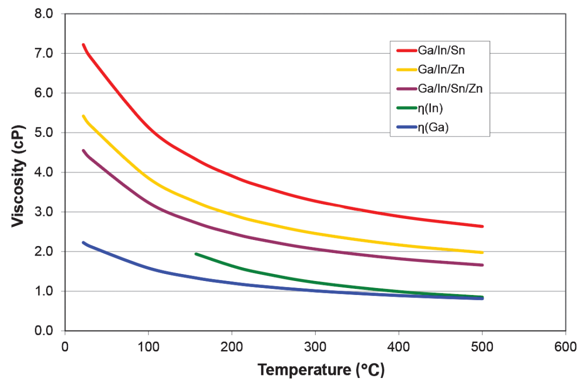
Indalloy® Number	Liquidus (°C)	Solidus (°C)	Composition	Density (lb/in³)	Specific Gravity	Thermal Conductivity (W/mK)	Electrical Resistivity (10^{-8} Ω-m)
46L	7.6	6.5	61.0Ga/25.0In/13.0Sn/1.0Zn	0.2348	6.50	15*	33*
51E	10.7	10.7	66.5Ga/20.5In/13.0Sn	0.2348	6.50	16.5[1]	28.9[1]
51	16.3	10.7	62.5Ga/21.5In/16.0Sn	0.2348	6.50	16.5[1]	28.9[1]
60	15.7	15.7	75.5Ga/24.5In	0.2294	6.35	20*	29.4[2]
77	25.0	15.7	95Ga/5In	0.2220	6.15	25*	20*
14	29.78	29.78	100Ga	0.2131	5.904	28.1[3]	14.85[4]

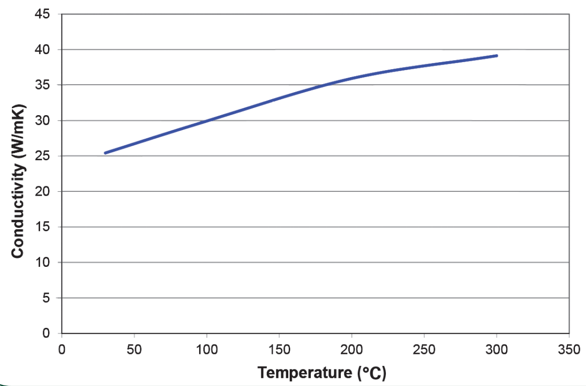
*Estimated

1. Geratherm Medical AG, Material Safety Data Sheet, 93/112/EC, 2004.
2. Michael D. Dickey, et al., Eutectic Gallium-Indium (EGaIn): A Liquid Metal Alloy for the Formation of Stable Structures in Microchannels at Room Temperature, *Advanced Functional Materials,* 2008, 18, 1097–1104.
3. C.Y.Ho, et al., Thermal Conductivity of the Elements, *Journal of Physical Chemical Reference Data*, Vol. 1. No 2, 1972.
4. Charles Kittle, *Introduction to Solid State Physics,* 7th Ed., Wiley and Sons, 1996.

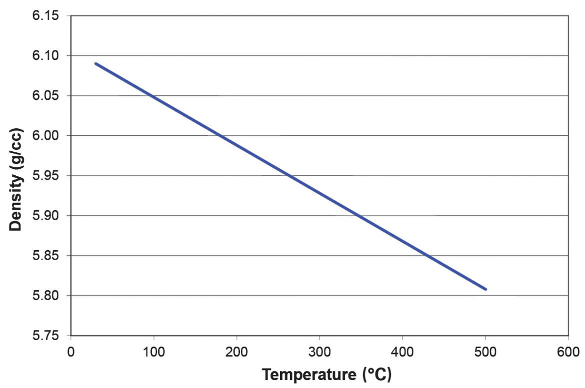
Estimated Viscosity of Gallium Alloys



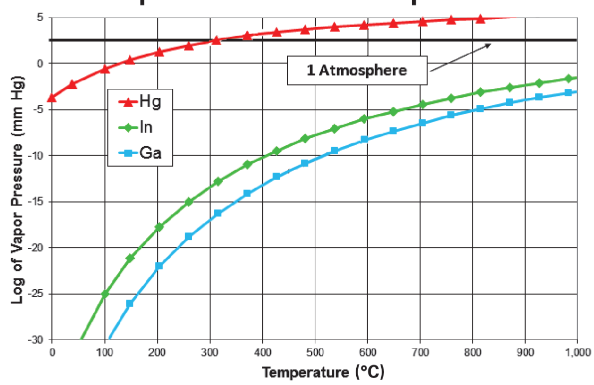
Thermal Conductivity of Gallium



Density of Gallium



Vapor Pressure versus Temperature



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