PRODUCT DATA SHEET

m2TIM™ and Liquid Metal Thermal Interface Materials

Introduction

Metal thermal interface materials (TIM) are known to have higher isotropic thermal conductivity than any non-metals. 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. In addition to the high thermal conductivity of all metals, those in the liquid form will also exhibit low interfacial resistance ensuring that they can dissipate heat quickly. Liquid metals are used in both TIM1 and TIM2 applications.

The key parameter in heat dissipation between two surfaces is low thermal resistance. The ASTM D5470 test method describes the metrology of evaluating thermal resistance. In the case of solder TIMs and liquid metal TIMs, very low thermal resistance is achieved. The high thermal conductivity of the metal TIM makes it less sensitive to the TIM thickness. Additionally, the wetting of the molten metals to the surfaces results in an extremely low interfacial resistance at the surfaces.

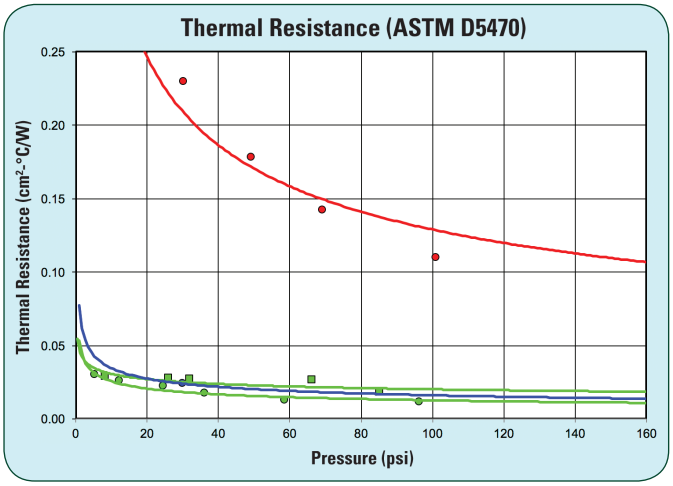

Chart compares thermal resistance of solid metals (red line) vs. metals in liquid or molten state (green and blue lines).

m2TIM™ is a unique solid/liquid hybrid approach that combines liquid metal with a solid metal preform to provide very reliable thermal conductivity while eliminating the need for a solderable surface.

InGa and InGaSn alloys are liquid at room temperature. Using one of these alloys alone would provide superior thermal conductivity, but would also require containment of the liquid. Introducing a solid solder preform into the process provides a material that absorbs the liquid and provides the necessary containment without compromising the thermal conductivity.

This hybrid approach provides excellent surface wetting and low interfacial resistance, as well as eliminating the risk of pump-out of the liquid alloy.

Application Limitations

It must be noted that gallium is not compatible with aluminum, but can be overcome this by anodizing the aluminum. Other surface treatments can also be effective.

Technical Support

Indium Corporation sets the industry standard in providing rapid response, onsite technical support for our customers worldwide. Indium Corporation's team of Technical Support Engineers can provide expertise in all aspects of materials science.

Safety Data Sheets

The SDS for this product is available by contacting askus@indium.com

From One Engineer To Another®

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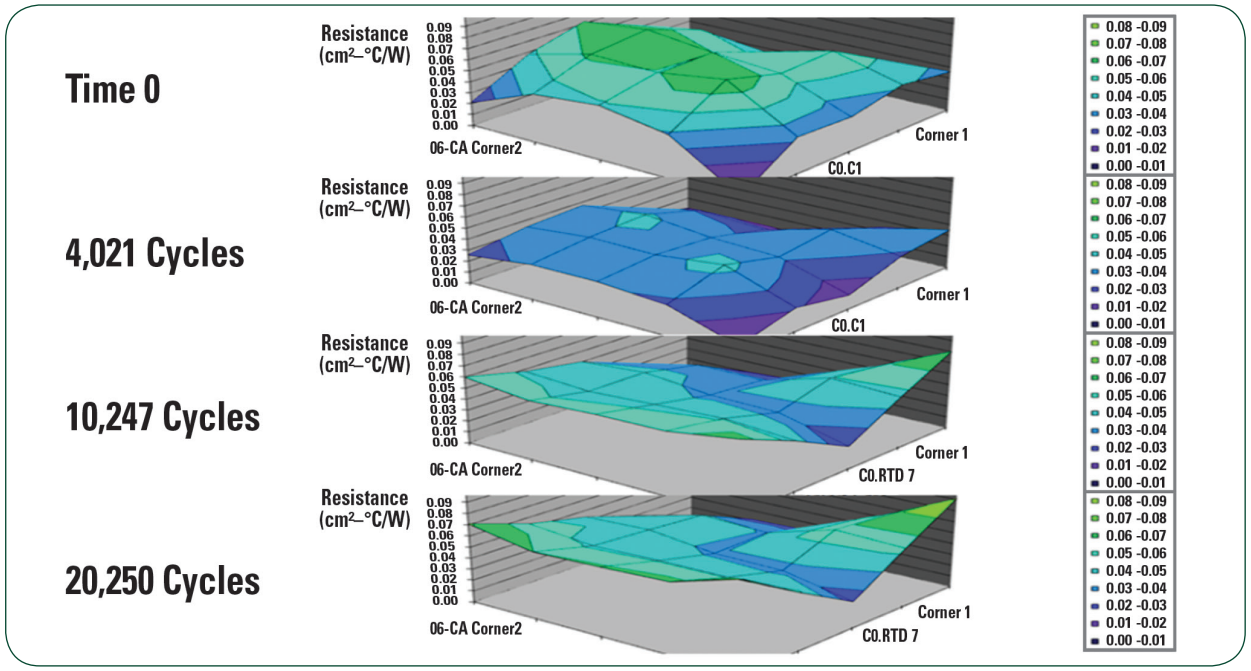
Power Cycling of m2TIM™

When running over 20,000 cycles from 0–80 watts (105°C maximum junction temperature), the thermal resistance of the system remains extremely low.



Options for Liquid Alloys

Indalloy® Number	Liquidus (°C)	Solidus (°C)	Composition	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	6.50	15*	33*
51E	10.7	10.7	66.5Ga/20.5In/13.0Sn	6.32	16.5[1]	28.9[1]
51	16.3	10.7	62.5Ga/21.5In/16.0Sn	6.50	16.5[1]	28.9[1]
60	15.7	15.7	75.5Ga/24.5In	6.35	20*	29.4[2]
77	25.0	15.7	95Ga/5In	6.15	25*	20*
14	29.78	29.78	100Ga	5.90	28.1[3]	14.85[4]

*Estimated

References

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.

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