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Metallic Thermal Interface Material Selection for Burn-In

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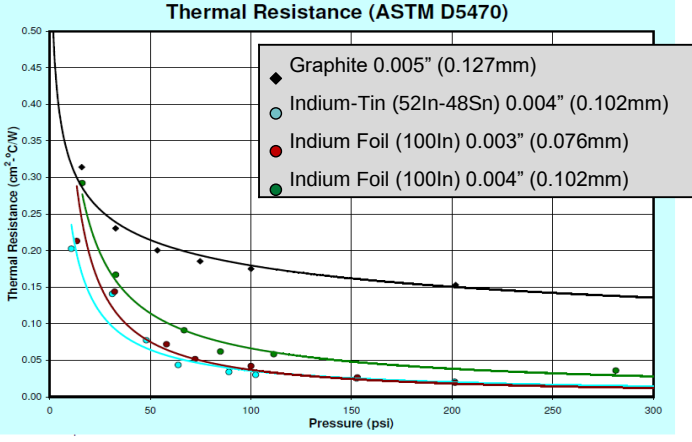
Thermal Interface Materials (TIMs): Burn-in/Test Applications

- Purpose: Present an overview of metallic TIM developments:
  - Many types of TIMs are commercially available;
  - Only certain TIM types are suitable to meet burn-in requirements;
  - TIMs are used for these burn-in test head applications:
    - Planar test head surfaces, to contact die or package lid
    - Internal to test head, to interface (both sides) of a TEC
    - Internal to test head, to interface (both sides) to heater
  - Selection is highly design specific and often customized.

Maximize Thermal Performance w/ *Minimum* TIM Thickness: Standard Practice (if mechanical requirements allow)



Thermal resistance target range for burn-in applications -- but mechanical/material challenges prevent use of these *very thin layers* of otherwise well-performing TIMs.

- A family of metallic TIMs is available to meet different requirements.
  - Flat indium foil is an excellent high power selection as a thin TIM;
  - Durable, compliant, also available with aluminum cladding;
  - Indium metal can be recycled to minimize total cost.
  - Additional TIMs have been developed to meet specific burn-in mechanical requirements, especially for non-flat surfaces.

Burn-In Design Requirements: Thermal vs. Mechanical

	Parameter	Typical Value
Thermal	Thermal Resistance, TIM	< 0.30 - 0.35°C-cm^2/W
	Operating Temperature	-15°C to +120°C *(Note 1)*
	Thickness	Minimized
	Contact Pressure Range	30 – 100 PSI (2-7 bar) *(Note 2)*
	Surface Wetting, Ideal	100%
	Thermal Conductivity	Isothermal *(Note 3)*

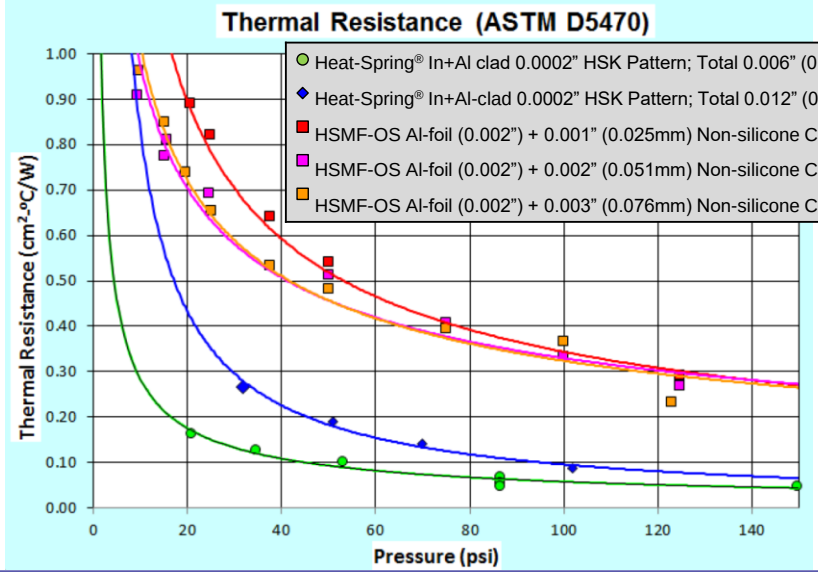
Notes:
1: Higher temperatures required in certain market segments.
2: Wide range of pressures, depending on specific equipment design.
3: Heat dissipation in-plane and through-plane are both required.
4: All parameters are heavily design specific to individual test systems.

Conflict

	Parameter	Typical Value
Mechanical/Material	Strike Angle, Planarity	Variable *(Note 4)*
	Residue, Markings	None
	Durability	Maximized no. of cycles
	Separation	No adhesion
	Conformability	Multiple DUT package sizes

Thermal Performance Adapted to Non-Flat Surfaces

- New Al foil w/non-silicone compound coating (single side only):



Metallic TIM Developments for Burn-In/Test

TIM Types	Attributes	Disadvantages
Indium foil, flat	High bulk thermal conductivity value	Tackiness, potentially leaving residue
	Compliant, conformal	Cost scale*: B
	Multiple thicknesses available	Potentially subject to tearing in some apps during multiple cycles, especially with high force/uneven strike angle
	Customized shapes	
	Customized attachments	
Al-clad indium flat foil	Bulk thermal conductivity moderated by Al cladding	Cost scale: C (See note below regarding relative cost scaling and reclamation of indium metal for customer credit.)
	High durability for high pressures	
	Cladding diffusion barrier for Au, Cu	
	Customized shapes, attachments	
	No bleed, residue	
Newest TIM material developments for burn-in/test		
Heat-Spring®	*Patterned* In-alloy foils for compliancy, compression	Cost scale*: C
	High bulk thermal conductivity	Subject to tearing during multiple cycles over time
	Multiple thicknesses and patterns available for differing requirements	Requires minimum 20-30PSI clamping force for thermal resistance equal to other solutions
	Al-clad version offers excellent durability for high force strike	
	No residue, no marking	
HSMF	Two Al-foils combined with polymer compound for low force designs	New, with fewer approved attachment mechanisms to date. Cost scale: A
	Compliant, compressible	
HSMF-OS	Single Al-foil coated with polymer compound for zero residue, greater compliancy, improved thermal resistance and durability.	New, first approvals, with fewer attachment mechanisms developed for test heads
	Lowest cost. Cost scale: A	

* *Note on relative costs: Recovery and reclamation of indium metal lowers the final use cost versus initial purchase cost. Cost scale is relative to each material shown, lowest typical cost denoted by (A); highest typical cost denoted by (C) as simple typical rank ordering.*