Product Training Module: Cooling for LED Applications

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Introduction

- Purpose
  - This training module is used to give an introduction to t-Global Technology's thermal management for LED systems
  - Objectives
  - To identify the key design criteria for cooling LED systems
  - To identify the key design criteria for product selection
  - To identify the key materials used in LED cooling
- Content
  - Introduction and background to cooling of LED systems
- Learning time
  - 30 mins

Thermal Management in LEDs

- LEDs are solid state devices which convert electricity to light and heat
- The wall-plug efficiency (optical power out divided by electrical power in) of LED packages is typically in the region of 5-40%, meaning that somewhere between 60 and 95% of the input power is lost as heat.
- As the junction temperature of an LED is increased, both the forward voltage and the lumen output decrease.
- The output wavelength also shifts with a change in junction temperature.

Thermal Management in LEDs

- Failure to remove this heat results in reduced life times and lower efficiency
- Most significantly, the junction temperature affects the lifetime of the LED
- Heat should be conducted away from the backside of the LED in an efficient manner, and then removed from the area by convection.
- This latter process can be passive, involving convection from the outside of the package or from a finned heatsink with a large surface area

Thermal Management in LEDs

- The main ways of passively managing the thermal demands for LEDS are:
  - Thermally Conductive Adhesives / Tapes
  - Heat sinks plus a TIM material
- To obtain efficient thermal management it may be necessary to use all of the above techniques in combination

Thermally Conductive Adhesives and Tapes

- Thermally conductive adhesives and thermally conductive adhesive tapes can be used to passively manage the junction temperature of LEDS
- Thermally conductive adhesive tapes, such as t-Global's LI98, provide an excellent path or thermal transfer as well as a reduction in engineering complexity due to the removal of screws, clips and other fixtures

LI98 Benefits

Benefits of using athermal adhesive tape

- Can be supplied as sheets, die-cut parts or on rolls.
- Is available in thickness of 0.15 and 0.25mm depending on the design criteria.
- Can be used to provide an effective thermal interface between components
- Provides superior lap shear strength (as measured using ASTM D1002)
- Offered in various custom die-cut configurations to suit a range of applications
- Can be used to eliminate mechanical attachments
- Has proven reliability under various mechanical, thermal and environmental stresses
- The material is REACH and ROHS compliant

LI98 Product Data Sheet

Property	Li-98		Li-98C	Unit	Test Method
Colour	White	White	White	-	Visual
Thickness	0.15	0.25	0.2	-	ASTM D374
Reinforcement Carrier	Fiberglass mesh			-	-
Density	1.85	1.85	1.9	g/cm³	ASTM D792
Tensile Strength	200	400	200	psi	ASTM D412
Glass Transition Temperature	-30	-30	-27	℃	-
Short Time Use Temperature (30 sec)	200	200	200	℃	-
Continuous Working Temperature	-30 to 120	-30 to 120	-30 to 120	℃	-
Thermal Conductivity	0.95	0.95	1.8	W/m.k	ASTM D5470
Thermal Impedance @ <1psi	1.0	1.8	0.7	℃ in ²/W	ASTM D5470
Thermal Impedance @ 50psi	0.9	1.5	0.5	℃ in ²/W	ASTM D5470
Initial Tack	11	10	14	cm	PSTC-6
Lap Shear Strength	61	61	65	N/cm²	ASTM D1002
Die Shear Strength @ 25℃	120	120	118	N/cm²	-
Die Shear Strength @ 80℃	69	69	68	N/cm²	-
Holding Power 1000g @ 25℃ using 1 in 2	>10000	>10000	>10000	min	PSTC-7
Holding Power 1000g @ 80℃ using 1 in 2	>10000	>10000	>10000	min	PSTC-7
180° Peeling Strength (aluminum)	4	5	4	N/cm	ASTM D3330
Dielectric Breakdown Voltage (Vac)	>2	>3	>3	kV	ASTM D149
Dielectric Breakdown Voltage (Vdc)	>3	>4	>4	kV	ASTM D149

· REACH Compliant · RoHS Compliant

LI98 Design Guide Lines

- For optimal performance the interface should have a flatness of 0.025mm/25mm
- Prior to attachment ensure that the surface are clean and free from dust and wipe with a solvent such as IPA or toluene
- Cut tape to size such that the area of the tape is slightly smaller than the area of the heat sink
- Apply to centre of heat sink and smooth out using hand pressure
- Apply heat sink using a pressure of 30PSI for 10 seconds
- To remove the tape use a sharp blade of knife
- Slowly insert blade under one edge and use a gentle upwards pressure to separate the component
- Once the two surface have been separated the tape can be removed and discarded
- Any adhesive residue can be removed using a solvent such as IPA or acetone

LI98Frequently Asked Questions

- **Can LI98 supplied in different formats?**

  Li98 can be supplied in sheet form or die cuts. T-Global specialise in custom designs to suit most requirements.

- **How does LI98 respond to ageing and thermal cycling tests?**

  LI98 does not exhibit any measurable changes in property when tested using all common industry standard environmental test regimes

- **Can LI98 be reworked?**

  It is not recommended to rework LI98.

- **What is the shelf-life of the product?**

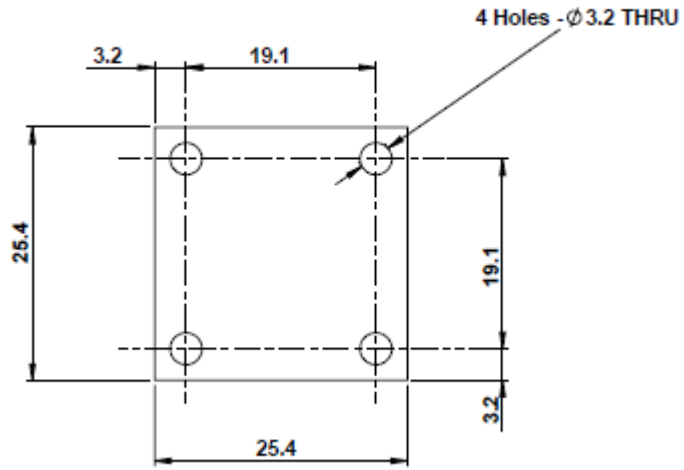
  The shelf life is six months from the date of manufacture. After these dates adhesive strength must be re-characterised.

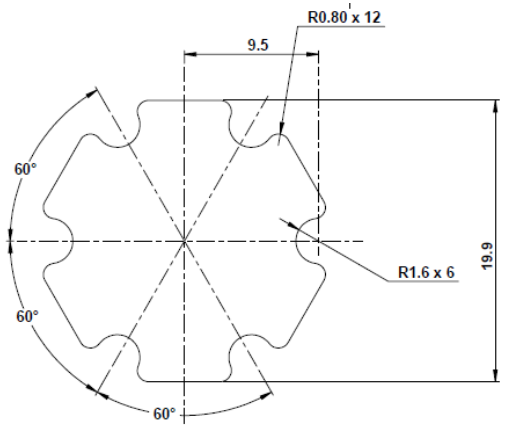
- **Will LI98 soften with temperature?**

  Up to the maximum working temperature, as specified on the individual product datasheet, the materials will not suffer with temperature.

LI98 Die Cuts

- LI98 is available as die cut parts suitable for attaching standard LED MCPCB board configurations to heatsinks





Heat Sinks for LED applications

- Heat sinks provide a thermal path from the LED source to the outside medium
- It is essential that a thermal interface material is used between the LED and the heatsink
- If clips or fasteners are employed a grease or phase change material can be used, if a simpler design is possible then a thermally conductive adhesive tape can be used.
- T-Global provides:
  - XL-25 ceramic heat spreaders
  - S606 thermal grease
  - PC99 phase change materials

XL-25 Ceramic Heatspreaders

- XL-25 ceramic heat spreaders can be used to ensure good thermal management
- They are especially useful when EMI issues may be of concern
- These materials also have a low coefficient of expansion which makes them excellent for applications where thermal cycling occurs
- XL-25 is available in a number of form factors

XL-25 Product Data Sheet

Property	XL-25	Unit	Test
Colour	Grey	-	Visual
Thickness and Size	See table	-	-
Thermal Conductivity	6.79	W/m.k	-
Insulation Strength	>500	Voltage	ASTMD 149
Specific Gravity	1.89	g/cm^3	CNS 619
Surface Resistance	$>10^9$	Ohm	ASTMD 257
Flexural Strength	47.5	Kgf/cm^2	CNS 12701
Porosity	30	%	CNS 619
Working Temperature	<500	℃	-
Linear Thermal Expansion Coefficient	4.13	10-6	RT~300℃
Main Composition	SiC / $Al2O_3$ / SiO_2		-
Hardness	5 - 6	Moh's	DIN En101-1992

Size:					
10*10*2	20*15*2	20*20*2	30*30*2	32*20*2	40*25*2
85*70*2	50*50*3凸	40*40*3凸	20*20*2.3	30*30*2.3	

S606 Thermal Grease

- Thermal grease can be used to provide a path of thermal transfer between the heatsink and the LED
- The material can be screen printed, stenciled, ink jetted or applied using a small syringe
- A thermal grease is especially effective whereby a high fixture force, such as generated by screws or clips, is possible
- A thermal grease also allows a degree of reworkability
- It is possible to obtain very think bond lines using a thermal grease which can give excellent thermal performance

S606 Product Data Sheet

Property	S606	S606B	S606C	Unit	Test Method
Colour	White	White	Grey	-	Visual
Thermal Conductivity	3.6	1.8	5	W/m.k	ASTM D5470
Weight Loss	<0.5	<0.5	<0.5	%	ASTM E595
Specific Gravity	2.3	2.3	2.3	g/cm³	ASTM D792
Working Temperature	-40 to 180	-40 to 180	-40 to 180	℃	-
Volume Resistance	10^{12}	10^{12}	10^{12}	Ohm-cm	ASTM D257
Standard Package	1kg	1kg	1kg	Kg / pot	-
· **REACH Compliant** · **RoHS Compliant**					

PC99 – Phase Change Materials

- The PC99 series is t-Global Technology's core thermally conductive phase change materials (PCM) product range
- Each member in the family has been developed to address specific industrial needs where low thermal impedance is a key design driver
- All products in this series are available as standard sheets or custom-die cut parts

Phase Change Materials

- Phase Change Materials (PCM) are solid pads at room temperature that melt at operating temperatures forming intimate contact on the mating surfaces to produce low thermal resistance
- PCM materials combine the consistency and ease of use of elastomeric pads with the low thermal impedance of thermal grease.
- This low thermal resistance path maximizes heat sink performance and improves the reliability of LED systems

Phase Change Materials

- PCM materials offer the advantage of:
  - Higher viscosity than grease so increased stability and less susceptible to pumpout
  - Application and handling is easier than grease
  - No cure is required for optimum performance
  - Delamination is not an issue
- This allows PCM materials to be used in the most demanding LED applications

PC99

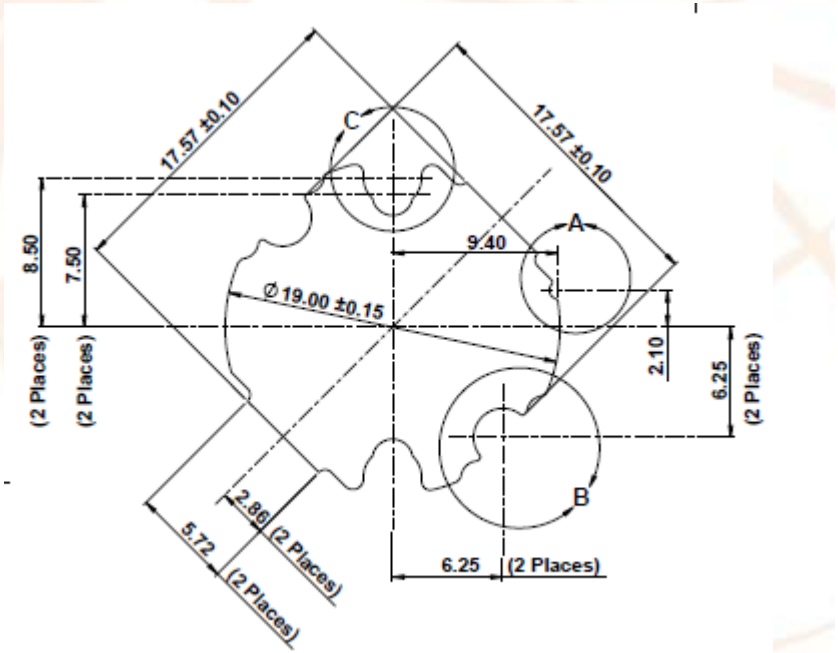
- PC99 is a phase change material which has a thermal conductivity of 1.5 W/m.k
- It is available in thickness of 0.06 and 0.12mm
- The phase change temperature is 51C
- The operating temperature range for this product -30 – 125C
- PC99 is designed to be a low-cost solution to minimize the thermal resistance between power dissipating electronic components and heat sinks.
- This low thermal resistance path maximizes heat sink performance and improves component reliability

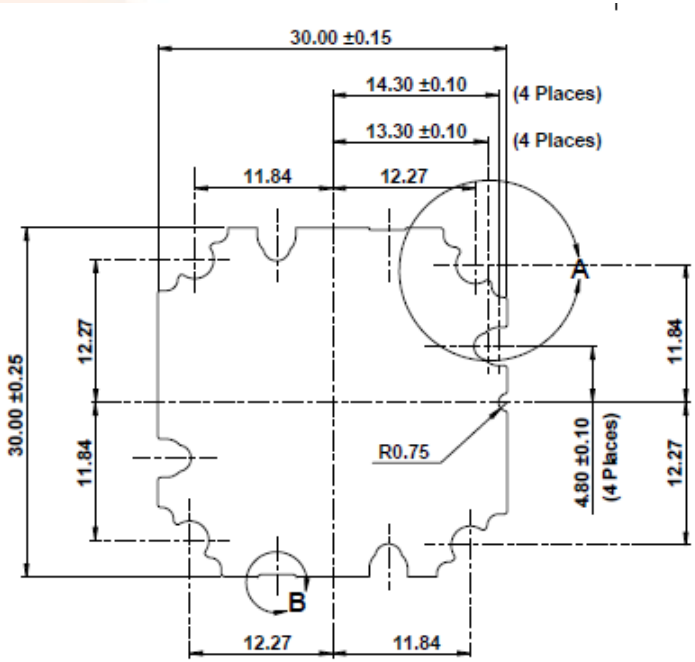
PC-99

- PC99 materials are solid and easy to handle. This allows them to be consistently and cleanly applied as dry pads to a heat sink or component surface.
- PC99 softens as it reaches component operating temperatures.
- With light clamping pressure it will readily conform to both mating surfaces.
- This ability to completely fill interfacial air gaps and voids using PC99 pads results in performance superior to any other thermal interface materials.

PC-99

- PC99 can be supplied as custom die cuts suitable for some of the common LED configurations.





PC-99 Datasheet

Property	PC99	Unit	Tolerance	Test Method
Colour	Yellow	-	-	Visual
Thickness	0.06 / 0.12	mm	-	ASTM D374
	0.0024 / 0.0047	inch	-	ASTM D374
Appearance	Sticky	-	-	Visual
Phase Change Softening Point	52	℃	-	-
Specific Gravity	2.35	g/cm³	±0.2	ASTM D792
Working Temperature	-40 to 200	℃	-	-
Surface Resistance	>10^{12}	Ohm-cm	-	ASTMD 257
Elongation	5	%	±13	ASTMD 412
Tensile Strength	0.1	Kgf/cm²	-	ASTMD 412
Standard Shape	Sheet ones	-	-	-
Thermal Resistance 30psi	0.1	℃-cm²/w	-	-
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Summary

- Thermal management is critical for LED efficiency and life times
- The junction temperature can be managed by using passive cooling
- When using a heat sink it is essential that a TIM material is also used
- A thermally conductive adhesive tape can be used to lower the total cost of ownership for LED systems
- Ceramic heat spreaders can use used as effective heat sinks