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TR TECHNICAL REPORT

Heatsink pastes

HSP 2740 and HSP 2741

Base: Epoxy resin (EP)

- **black** 1-pack systems
- solvent-free
- application by means of screen or stencil printing
- can be applied in variable structures and layer thicknesses
- simplify the thermal management of pcbs/assemblies
- excellent heat conductivity
- low-cost and reliable alternative to "conventional" bonded heatsink foils
- UL approval acc. to UL 94 for **HSP 2741** (see item 2)

Index: **HSP = heatsink paste**

LP 112207 E-6 / 0210904e.006

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Please read this technical report, the corresponding material safety data sheet and the Technical Information sheets TI 15/3, TI 15/11 and TI 15/13 (see Item 4 and 7) carefully before using the product.

1. General information

The heatsink pastes **HSP 2740** and **HSP 2741** are highly thermally conductive 1-pack systems based on epoxy resin (EP) that are applied by means of screen or stencil printing and thermally cured.

All symbols that are used in this technical data sheet and on our containers, such as , are explained on our website www.peters.de in the section "Service – Symbols on labels".

2. Application

The heatsink pastes **HSP 2740** and **HSP 2741** constitute an extremely low-cost as well as reliable alternative in printed circuit board production to the currently used bonded heat sinks that can only be processed at substantial expense. The outstanding heat-conducting properties enable the industry to do without the use of heat-conducting metal sheets, fraught with high material and process costs, for the thermal management of printed circuit boards or flat packs in many fields.

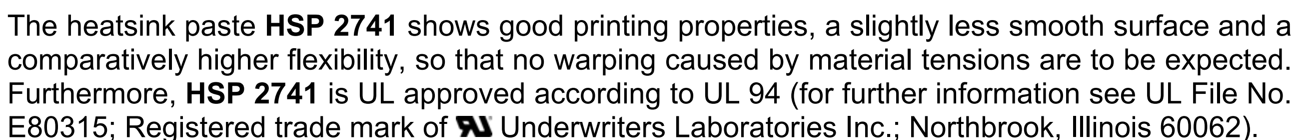
On account of their excellent heat-conducting properties the heatsink pastes **HSP 2740** and **HSP 2741** are printed chiefly on printed circuit board areas with heat vias and thus heat is already dissipated where it occurs. In particular, the unavoidable thermal transition resistances are minimised.

However, the heatsink pastes **HSP 2740** and **HSP 2741** are not suitable for printing on Pb/Sn surfaces which melt during soldering and cause the heatsink pastes to lift.

The heatsink pastes are also used for the thermal management of LEDs. They increase the luminance and lifespan of the LEDs by effectively reducing the heat generated during operation.

Compared to **HSP 2741** the heatsink paste **HSP 2740** is distinguished by a better resistance in electroless processes, a higher dielectric strength, very good printing properties as well as by a very smooth, silk-mat surface. **HSP 2740** meets the requirements according to UL 94.

Please take into account that owing to the higher degree of cross-linking HSP 2740 possesses a lower flexibility, thus thinner base materials (< 1 mm), higher layer thicknesses and/or larger heatsink paste areas may lead to warping of the printed circuit board. Therefore, please perform your own pretests (see also item 7 "Processing").



The heatsink paste **HSP 2741** shows good printing properties, a slightly less smooth surface and a comparatively higher flexibility, so that no warping caused by material tensions are to be expected. Furthermore, **HSP 2741** is UL approved according to UL 94 (for further information see UL File No. E80315; Registered trade mark of Underwriters Laboratories Inc.; Northbrook, Illinois 60062).

Due to the large number of – partly extremely aggressive – chemical finish processes available, the compatibility in particular with HSP 2741 must be verified. Please perform appropriate pre-trials accordingly (see also Section 7 "Processing").

3. Special notes

The following comparison of the application processes illustrates the essential advantages of the "printed heatsink" in the form of a possible application model: As the flow charts show, production of printed circuit boards is simplified by using printable heatsinks as especially cost- and time-intensive process steps are cut down. Moreover, many steps in the processing of "conventional heatsinks" can hardly be automated.

"conventional bonded heatsink"	**"printed heatsink"**
Fabrication of punching tools	not applicable
Punching of the metal foils in heatsink tools	not applicable
Bonding of accurate bonding foil to punched shapes	not applicable
Positioning and bonding of heatsinks on the pcb	not applicable
Mechanical pretreatment of the heatsink metallic surface	not applicable
Fabrication of screens for printing protective coat onto heatsink	Fabrication of screens for printing heatsink paste, that constitutes the heatsink
Printing of the protective coat (as a rule, solder resist two times)	Direct printing of the heatsink onto the pcb (if necessary more than once, see Item 7)
Curing of the protective coat (if necessary after each print)	Curing of the heatsink

4. Safety recommendations

→ Please read the corresponding material safety data sheet where you will find detailed specifications of safety precautions, environmental protection, waste disposal, storage, handling, transport as well as other characteristics.

→ When using chemicals, the common precautions should be carefully noted.

→ Please read our **Technical Information sheet TI 15/3 "Protective measures when using chemicals including lacquers, casting compounds, thinners, cleaning agents".** On our report manual CD and on our website, technical information sheets can be accessed in the "Service" section.

5. Characteristics

	HSP 2740	**HSP 2741**
Colour/appearance	black	black
Solids content	100 % by weight	100 % by weight
Viscosity* at 20 °C [68 °F] ISO 3219	28 000 ± 3 000 mPas	28 000 ± 3 000 mPas
Density at 20 °C [68 °F] ISO 2811-1	2.00 ± 0.05 g/cm³	2.05 ± 0.05 g/cm³

* measured with Haake RS 600, C 20/1°, D = 100 s^{-1}, viscosity measuring unit supplied by:
Thermo Electron (Karlsruhe) GmbH (formerly Haake-Messtechnik GmbH + Co)
Dieselstraße 4, 76227 Karlsruhe, Germany
Phone +49 (0) 721 - 40 94 - 0; Fax +49 (0) 721 - 40 94 - 300
www.thermo.com

6. Properties

The heatsink pastes **HSP 2740** and **HSP 2741** are distinguished by the following properties:

6.1 General properties

- do not contain substances listed in the RoHS directive 2002/95/EC, EU End-Of-Life Vehicle directive 2000/53/EC and WEEE directive 2002/96/EC
- solids content 100%, i.e. the achieved dry film thickness is practically identical with the wet layer thickness
- problem-free application with existing screen/stencil printing and dryer technology
- high definition and easy printability enable the representation of practically any heat dissipative areas on the printed circuit board
- high flexibility in the configuration of many different heatsink geometries as merely the corresponding screens and stencils have to be replaced
- homogeneous lacquer film, i.e. no reduction of the thermal conductivity by air inclusions
- being paste systems, they facilitate the secure filling of heat vias to increase the heat contact areas
- excellent adhesion to solder resists and various metallic substrates
- thermal class F based on DIN IEC 60 085 permits the use of **HSP 2740** and **HSP 2741** at continuous temperature loads of up to 155 °C [311 °F]
- high mechanical resistance
- very good solder bath resistance
- UL approval acc. to UL 94 for **HSP 2741** (see also Item 2 "Application”). **HSP 2740** meets the requirements acc. to UL 94
- free of halogenated flame retardants.

6.2 Physical and mechanical properties

Property	Test method	HSP 2740	HSP 2741
Solvent resistance	IPC-TM-650, 2.3.42 Isopropanol Isopropanol (75 %) / H2O (25 %) monoethanolamine deionized H2O	 passed passed passed passed	 passed passed passed passed
Solder bath resistance	IPC-SM-840E, 3.7.1/3.7.2 IPC-TM-650, 2.6.8 UL 94	passed: 20 s at 265 °C [509 °F] passed: 10 s at 288 °C [550.4 °F] 	passed: 20 s at 265 °C [509 °F] passed: 10 s at 288 °C [550.4 °F] passed: 20 s at 288 °C [550.4 °F]
Thermal class	based on DIN IEC 60 085	F = 155 °C [311 °F]	F = 155 °C [311 °F]
Glass transition temperature Tg	TMA method (thermo-mechanical analysis, expansion mode)	approx. 80 °C [176 °F]	approx. 65 °C [149 °F]
Coefficient of thermal expansion CTE	TMA method (thermo-mechanical analysis, expansion mode)	approx. 27 ppm/°C < Tg approx. 110 ppm/°C > Tg	approx. 30 ppm/°C < Tg approx. 100 ppm/°C > Tg
Heat conductivity	Based on VDE 0304 per modified heated wire method	2 W/mK	2 W/mK

6.3 Electrical properties

Property	Test method	HSP 2740	HSP 2741
Dielectric strength	VDE 0303, part 21 DIN EN 60243-1	30 kV/mm	10 kV/mm
	IPC-TM-650, 2.5.6.1	passed	passed
Surface resistance	VDE 0303, part 30 DIN IEC 60093 IPC-TM-650, 2.5.17.1	2.0 x 10^{12} Ohm	2.0 x 10^{12} Ohm
Specific volume resistivity	VDE 0303, part 30 DIN IEC 60093 IPC-TM-650, 2.5.17.1	4.9 x 10^{16} Ohm x cm	3.0 x 10^{14} Ohm x cm
Moisture and insulation resistance	IPC-SM-840E, 3.9.1	class H and T 1.0 x 10^{12} Ohm	class H and T 1.0 x 10^{9} Ohm
Comparative Tracking Index (CTI)	DIN EN 60112 on base material with CTI 250 with CTI 600	 CTI 600* CTI 600*	 CTI 600* CTI 600*
Dielectric constant ε_r	DIN 53483 1 kHz 1 MHz 1 GHz	5.8 5.2 6.5	4.4 4.2 4.1
Dielectric loss factor tan δ	DIN 53483 1 kHz 1 MHz 1 GHz	0.015 0.013 0.022	0.029 0.021 0.025

* Among others the CTI value of the coating also depends upon the tracking resistance of the base material.

6.4 Heat-conducting performance

Compared to the systems used up to now heatsink pastes are very flexible in their design. Provided the developer and pcb manufacturer work together from a very early stage of development, they open up new ways in the thermal management of electronic assemblies. The layout, the design of the heat coupler, the chosen final copper thickness, the size of the printable area as well as the optimum layer thickness of the heatsink have a substantial influence on the result (see also item 7.3 ”Advice on pcb design”). In most cases the effectiveness cannot be calculated in advance, however, in pretrials concrete values can be ascertained.

The field of application of heatsink pastes is mainly where heat dissipation by means of heat couplers to the ”back side” of the pcb is possible and heat convection in a scale of approx. 3 W/m K occur. Heatsink pastes are particularly suitable to solve thermal problems where the expenditure for metal foils is too cost-intensive or where the layout design does not allow the use of a metal foil. They can be used successfully in layouts where copper areas are integrated as heatsinks. In such cases it is possible to reduce the copper areas by more than 50 % by overprinting them with heatsink paste.

7. Processing

Since the many different permutations make it impossible to evaluate the whole spectrum (parameters, reactions with materials used, chemical processes and machines) of processes and subsequent processes in all their variations, the parameters we recommend are to be viewed as guidelines only that were determined in laboratory conditions. We advise you to determine the exact process limitations within your production environment, in particular as regards compatibility with your specific follow-up processes, in order to ensure a stable fabrication process and products of the highest possible quality.

The specified product data is based upon standard processing conditions/test conditions of the mentioned norms and must be verified observing suitable test conditions on processed printed circuit boards.

Feel free to contact our application technology department (ATD) if you have any questions or for a consultation.

Stir lightly before using

7.1 Adjustment of viscosity

The heatsink pastes **HSP 2740** and **HSP 2741** must be processed in the condition supplied.

Do not add any solvents or thinners to reduce viscosity.

7.2 Auxiliary products

We recommend the **cleaning agents R 5899, R 5821 and R 5817** as auxiliary products for the processing of the heatsink pastes **HSP 2740** and **HSP 2741**. The cleaning agent **R 5899** does not have to be marked according to German dangerous goods regulations and can be handled simply and safely. Owing to its high flash point (> 100 °C [> 212 °F]) it is especially suitable for use in screen washing equipment. The cleaning agent **R 5899** is particularly distinguished by a low vapour pressure (< 0.1 hPa at 20 °C [68 °F]) and thus is not affected by the EU-VOC regulation 1999/13/EG which judges solvents by their percentage of volatile organic compounds (VOC = volatile organic compounds).

Furthermore, the cleaning agent **R 5821** is available which, owing to its high flash point of +32 °C [89.6 °F], is also suitable for use in screen washing equipment as well as for cleaning work tools. For the manual cleaning of screens and tools we recommend our cleaning agent **R 5817** with its fast and thorough cleaning properties.

Do not use cleaning agent as a thinner or for washing hands since solvents remove the natural grease from skin.

Special technical reports for these products are available upon request. Further information regarding the content and consequences of the EU-VOC regulation can be found in our technical information **sheet TI 15/110 E ”EU-VOC regulations – Content and consequences for the PCB industry”**. On our report manual CD you will find technical reports in the "Products" section and technical information sheets in the "Service" section.

7.3 Advice on pcb design

The design should be determined in close cooperation between pcb manufacturer and assembly developer to fully utilize the performance of **HSP 2740** and **HSP 2741**: To this aim, the following notes should be observed:

- **SMD assembly**
  On account of the relatively high layer thickness of the heatsink paste of 100 – 300 µm the printing of solder paste directly next to the heatsink area should be avoided in order to ensure a perfect solder paste print.
- **Holes**
  A largest possible free space around the holes of soldered components should be aimed for, at least 0.5 mm on all sides.
- **Heat vias (heat couplers)**
  The efficiency of the heatsink paste is greatly increased by means of so-called heat vias. These vias should have a diameter of 0.6 – 0.8 mm.

7.4 Screen printing

The heatsink pastes **HSP 2740** and **HSP 2741** can be applied either by screen or stencil printing. After each print an **interim curing** of each layer is mandatory (see item 8 ”Drying/curing”).

→ Please read our **Technical Information sheets TI 15/11 ”The screen printing stencil in the pcb industry”** and **TI 15/13 ”Precleaning in the pcb fabrication process”**. On our report manual CD and on our website technical information sheets can be accessed in the ”Service” section.

→ Ensure that the surface to be coated is clean, dry and grease-/oxide-free and that copper surfaces preferably have an average surface roughness of 2 µm.

- **Filling of the heat vias**
  The better the heat vias are filled the more efficient the heat dissipation. The filling degree of the vias can be controlled by means of the squeegee pressure and printing speed (by increasing the squeegee pressure and slower printing more material is filled into the vias).

Recommended screen printing parameters

Screen fabric	Steel fabric: - 224/100 - 245/65 - 265/50
Screen printing stencil	Free spaces in the screen fabric > hole diameter (0.3 – 0.5 mm larger, depending on print format size) A high stencil build-up is not necessary because the ink should be printed into the drill holes only. As a rule it is sufficient to close the screen mesh with a thin coat of emulsion or a thin capillary film.
Printing underlay	Base material with a thickness of approx. 3 mm that was drilled with the same drill program but where the diameters of the holes are five times the size of the actual heat vias. (The printing underlay enables the filling of the holes since there is no resistance caused by air pockets under the holes.) An undergrid would also be acceptable provided it does not permit the printing substrate to spring.
Snap-off	low
Flooding	rubber squeegee 75 Shore A push stroke 70°
Printing	rubber squeegee 75 Shore A, squeegee profile 30-45° printing angle 90° As high a squeegee pressure as possible (4 bar) and as low a printing speed as possible

These printing parameters are meant for orientation purposes and, depending on the layout of the printed circuit board and aspect ratio (ratio of hole diameter to board thickness) of the plated-through holes to be filled, must be optimised and adjusted to the prevailing production conditions.

- **Print on unpopulated areas**
  A layer thickness of at least 50 µm of **HSP 2740** and 80 µm of **HSP 2741** must be applied in one pass as with thinner layers a complete curing is not guaranteed.

  The layer thickness of the print on unpopulated areas is chiefly dependent upon the screen fabric used. As a rule the achieved dry film thickness is approximately identical to the thread diameter.

Recommended screen printing parameters

Screen fabric	15-200 polyester fabric (15T per old nomenclature) with a 2 x 100 µm capillary film or for lower layer thicknesses: 18-180 polyester fabric (18T per old nomenclature) with a 2 x 80 µm capillary film
Screen tension	at least 25 N/cm or according to the screen manufacturer's instructions
Snap-off	2-3 mm
Lift	minimum
Flooding	Rubber squeegee 70 – 75 Shore A, push-stroke, sharp-edged (do not use metal shovel!) slow flood (100 mm/s)
Printing	Rubber squeegee 70 – 75 Shore A, pull-stroke, sharp-edged printing angle 75° fast print (250 mm/s)

- **Overcoat print**
  When using coarse screen fabrics a clear fabric structure is visible on the surface. If a fine planar surface is needed, e.g. because the HSP surface is to be fixed to an aluminum casing to increase the heat dissipation from the assembly, a so-called overcoat print is recommended. This print smooths out the fabric structure. A layer of at least 50 µm of **HSP 2740** and 80 µm of **HSP 2741** must be applied in one pass as a complete cure cannot be guaranteed with thinner coats.

Recommended screen printing parameters

Screen fabric	Steel fabric with a 80 µm film: - 265/50 (especially for high ink penetration but sensitive) - 245/65 (also high ink penetration but more stable)
Screen printing stencil	Reduce the free spaces in the fabric by 0.3 mm compared to the print on unpopulated areas
Flooding	Standard flooding process with metal shovel
Printing	Rubber squeegee 70 – 75 Shore A, pull-stroke, sharp-edged printing angle 75° fast print (250 mm/s)

- **Fabric choice in case of low demands on the surface structure**
  If there is no need for a fine surface structure but a high layer thickness is required (250-500 µm) the filling print can be effected by means of a 15-200 polyester fabric. The ink accumulations over the vias on account of the thick fabric are ultimately almost hidden by the high overall thickness and the coarse fabric structure.

- **Fabric choice for low layer thicknesses**
  If only a low layer thickness is required (140 – 250 µm), the use of a 245/65 steel fabric for the filling print and for printing over unpopulated areas is recommended.

8. Drying/curing

The heatsink pastes **HSP 2740** and **HSP 2741** are thermally cured under the following conditions:

45 min* at 150 °C [302 °F].

* Object holding time: The time is measured from the point when the panels reach the curing temperature.

In case of multiple prints, an **intermediate drying** of each layer of

- **30 min at 130 °C [266 °F] (HSP 2740)**
- **10 min at 130 °C [266 °F] (HSP 2741)**

should be sufficient. The last layer must be cured for 45 min at 150 °C [302 °F].

Depending on the layout and subsequent processes it may be necessary to adjust the curing parameters and apply higher coating thicknesses.

Generally **HSP 2740** and **HSP 2741** are also excellently suitable for curing in conveyorized infrared dryers. The corresponding parameters have to be determined by performing pre-trials.

9. Standard packaging

The heatsink pastes **HSP 2740** and **HSP 2741** are packed for delivery as follows:

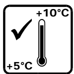
	Packaging	Selling unit
HSP 2740 HSP 2741	10 tins of 2 kg	20 kg

Partial lots of a selling unit can be ordered but will entail surcharges to cover repackaging costs.

10. Shelf life and storage conditions

Labels on containers show shelf life and storage conditions.

Shelf life: In sealed original containers at least 6 months



Optimum storage conditions are: +5 °C to +10 °C [+41 °F to +50 °F]
Protect the container from sun and other heat sources as the system is temperature sensitive.

Protect against frost

For warehousing reasons, isolated cases may occur where the shelf life upon shipment is less than the shelf life indicated in this technical report. However, it is ensured that our products have **at least** two-thirds of their shelf life remaining when they leave our company.

11. Further literature/technical documentation

In addition to the recommendations given in this technical report, we can provide technical papers and information sheets written and compiled by members of our staff. Visit our website at **http://www.peters.de** or click on the "Service" section on our report manual CD.

12. Further products for the production of pcbs

We offer a wide range of **etch resists (photoimageable, UV curing, conventional curing), plating resists, solder resists (photoimageable, UV curing, conventional curing) as well as peelable solder masks, marking inks (photoimageable, UV curing, conventional curing), carbon-conductive inks, via hole fillers (purely thermal curing), thick film fillers, plugging pastes, heatsink pastes, special strippers for solder resists and further auxiliary products for screen printing (e. g. cleaning agents, thinners).**

Special technical reports are also available for these products and can be provided on request. On our report manual CD you will find technical reports in the "Products" section.

13. Further products for the electronics/ electrical engineering industries

We boast a wide range of **conformal coatings, thick film lacquers, casting compounds, casting resins, electro pastes, insulating lacquers, impregnating varnishes, adhesive lacquers and auxiliary products for electronics.**
Special technical reports are also available for these products and can be provided on request. On our report manual CD you will find technical reports in the "Products" section.

Any questions?

We would be pleased to offer you advice and assistance in solving your problems. Free samples and technical literature are available upon request.

The above information as well as advice given by our Application Technology Department whether in verbal or written form or during product evaluations is provided to the best of our knowledge, but must be regarded as non-binding recommendations, also with respect to possible third-party proprietary rights.
The products are exclusively intended for the applications indicated in the corresponding technical data sheets.
The advisory service does not exempt you from performing your own assessments, in particular of our material safety data sheets and technical information sheets, and of our products as regards their suitability for the applications intended. The application, use and processing of our products and of the products manufactured by you based on the advice given by our Application Technology Department are beyond our control and thus entirely your responsibility. The sale of our products is effected in accordance with our current terms of sale and delivery.

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