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TR TECHNICAL REPORT

Carbon-conductive ink SD 2842 HAL

The carbon-conductive ink **SD 2842 HAL** is a 1-pack screen printing ink that, on account of selected special carbons and high-quality types of graphite, displays an excellent conductivity even after soldering. The achieved conductivities are to a large extent dependent upon the selected curing conditions (see item "Resistance in relation to curing conditions")

The carbon-conductive ink **SD 2842 HAL** is suitable for sliding contacts and enables the substitution of gold on contacts, the production of cross-over conductors (cross-over technology) as well as the creation of printed resistances. Further applications include migration protection for silver-conductive ink, electro-mechanical keyboards, foil keyboards for computers, switch contacts, low-voltage circuits, shield areas and heating elements.

Since the performance of the carbon-conductive ink **SD 2842 HAL** largely depends on the condition of the contact module we recommend to carry out extensive trials on the cycle resistance under conditions of use.

When using the carbon-conductive ink **SD 2842 HAL** as a sliding contact, it is recommended to print an especially smooth surface, to use a rounded slider and to fill up the gaps with a suitable dielectric material to compensate for any difference in height, in order to prevent the carbon-conductive ink from being damaged (for further details see Report 148 “Carbon-conductive inks – fields of application and potential for rationalisation and cost reduction”).

- black, mat
- excellent definition
- high mechanical resistance
- excellent adhesion and very smooth surface
- resistant to Hot-Air Levelling as well as to leaded and lead-free wave and reflow soldering processes, almost no change in resistance
- stable electrical resistance even after temperature and moisture stress
- very good adhesion on flexible base materials such as polyimide foils, thus also suitable for ”static flex” circuits

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The carbon-conductive ink **SD 2842 HAL** shows almost no change in resistance after soldering or Hot-Air levelling. If the transition areas between the substrate and copper are printed over with carbon-conductive ink, changes in resistance may occur under thermal stress such as multiple soldering, due to the difference in heat extension of copper and the base material.

- Owing to the high number of flux agents on the market pre-trials are mandatory.
- Protect the carbon-conductive ink by overprinting with a peelable solder resist (solder mask) if the resistance of the carbon-conductive ink changes/the resistance is insufficient or to avoid residues of fluxing agents.

Boards that have been coated with **SD 2842 HAL** may also be treated in chemical or electroplated surface finish processes such as CSN or ENiG provided they have been protected by a peelable solder mask.

For further information on suitable solder masks please see our technical report on the peelable solder masks of the series **SD 2950** and the Application Information sheet **AI 2/29** ”Selection criteria and processing advice for our peelable solder resists (solder masks) of the series SD 2950”. Basically, a subsequent protective coating can be applied without interfering with the resistance.

The **ELPEGUARD®** conformal coatings of the series **SL 1301 ECO-FLZ** and **SL 1301 ECO-BA-FLZ** as well as the thick film lacquer **TWIN-CURE® DSL 1600 E-FLZ/150** were tested as examples. Perform pre-trials when using other protective coating systems to ensure the compatibility.

Characteristics

Colour/appearance	black, mat
Solids content, ISO 3251 (1 h, 125 °C [257 °F], 1 g weighed quantity, 75 mm dish)	80 ± 4% by weight
Viscosity at 20 °C [68 °F], ISO 3219	29 000 ± 7 000 mPas
Density at 20 °C [68 °F], ISO 2811-1	1.37 ± 0.05 g/cm³

* measured with Haake RS 600, C 20/1°, D = 100 s^{-1}, viscosity measuring unit supplied by:
Thermo Fisher Scientific, Dieselstraße 4, 76227 Karlsruhe, Germany
Phone +49 721 4094-444, Fax +49 721 4094-300, www.thermo.com

Indices: SD = screen printing ink, HAL = Hot-Air Levelling

Physical and mechanical properties

Property	Test method	Result
Solder bath resistance	IPC-SM840E, 3.7.2 IPC-TM-650, 2.6.8	10 s at 265 °C [509 °F] 10 s at 288 °C [550.4 °F]
Resistance to solvents	IPC-TM-650, 2.3.42 Isopropanol Isopropanol/water Deionized water	 passed passed passed
Moisture and insulation resistance	based on IPC-SM-840 E, 3.9.1	Change of layer resistance < 25 %
Cross-cut test	DIN EN ISO 2409 On copper On FR 4	 Gt 0 Gt 0

Resistance in relation to curing conditions

Curing parameters	Test method	Result
Circulating air curing (45 min/150 °C [302 °F])	measured over parallel copper contacts *	≈ 14 Ω/☐
IR curing (at least 2 min/180 °C [356 °F])	measured over parallel copper contacts *	≈ 14–20 Ω/☐

* resistance of a square area (area: 1 cm², layer thickness: approx. 25 µm), for further details see Report 148 “Carbon-conductive inks – fields of application and potential for rationalisation and cost reduction”

In case of higher temperatures and/or longer curing times changes in resistance may occur.

Besides the physical drying process (evaporation of solvents) and the chemical reaction of binding agents, the carbon particles go through a sintering process during **IR curing.**

This temperature-induced sintering process is mainly responsible for the resulting resistance, thus a slightly differing resistance results depending upon the temperature profile and drying time. The reproducibility in case of the same processing and curing conditions is in the range of ± 2 Ohm/☐.

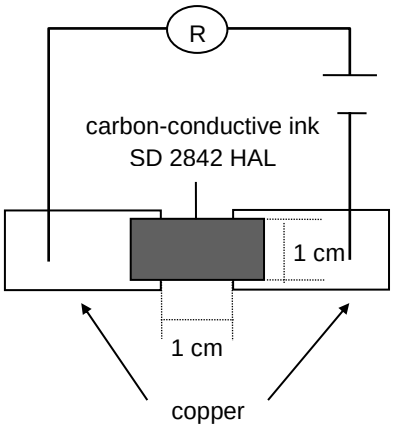

Fig. 1: Measuring principle for measuring the resistance at a coating thickness of approx. 25 µ

When measuring resistances, this measuring principle shows direct Ohm/square values and is generally valid for any square surfaces. But the edge length should not fall below approx. 0.8 cm, as otherwise influences from the screen printing process and/or contact resistances on the copper may falsify the measured values considerably.

Processing

	Please read this technical report and the publications listed below carefully before using the product. These sheets are enclosed with the first shipment of product or sample.
MSDS	The corresponding material safety data sheet contains detailed information and characteristics on safety precautions, environmental protection, transport, storage, handling and waste disposal.
TI	Technical information TI 15/3 “Protective measures when using chemicals including lacquers, casting compounds, thinners, cleaning agents”
TI	Technical information TI 15/13 ”Precleaning in the pcb fabrication process“

The carbon-conductive ink SD 2842 HAL is intended for printing on copper surfaces. An application of this carbon-conductive ink on other surfaces such as ENIG is critical.

Contamination of the substrate leads to adhesion problems of the subsequently printed carbon-conductive ink. If this causes the carbon-conductive ink to peel off we recommend the pre-cleaning of the surface, e.g. by means of the cleaning agent CME 137 supplied by KIV PCB ProfiChem GmbH or KOH, e.g. stripper Ultrastrip 218 P available from Mac Dermid Electronics Solutions.

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 if necessary while observing suitable test conditions on processed products.

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

Safety recommendations

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

→ Ensure that extractor units of workplace ventilation arrangements are positioned at solvent source level.

Adjustment of viscosity

The carbon-conductive ink **SD 2842 HAL** is adjusted in such a manner that it can normally be processed in the condition supplied.

Stir before use, see also Item “Screen printing”

If necessary, its viscosity can be reduced for processing purposes by adding the retarder **VZ 5104**.

To be thinned with retarder VZ 5104

→ Please note that by adding the retarder **VZ 5104** the solids content and thus the dry film thickness are reduced. Lower layer thicknesses show a higher resistance.

→ Therefore, perform pre-trials to determine the suitable quantity of retarder **VZ 5104** to be added.

Auxiliary products recommended

- Screen opener HP 5200
  highly active spray for dissolving dried screen printing inks from the screen; silicone- and grease-free, thus no surface defect/dewettings or smearing effects to be expected
- Cleaning agent R 5899
  for screen washing equipment, simply and safely to handle, no labelling in accordance with the German dangerous goods regulations required, extremely high flash point (> 100 °C [> 212 °F]), low vapour pressure < 0.1 hPa at 20 °C [68 °F], thus not affected by the EU-VOC regulation 1999/13/CE

- Cleaning agent R 5821
  for the cleaning of equipment and work tools, high flash point (+32 °C [89.6 °F])
- Cleaning agent R 5817
  for the manual cleaning of screens and tools

Screen printing

➔ 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

Imperatively stir before use

➔ Please consider that owing to its high thixotropy the carbon-conductive ink **SD 2842 HAL** has to be thoroughly homogenised / machine-stirred before processing which reduces the viscosity considerably. You may proceed as follows:
Slowly increase the speed of the stirrer (such as of the company Vollrad, diameter approx. 50 mm) to approx. 1900 min^{-1}.
After approx. 45 s of stirring separate all non-stirred lacquer from the sides by means of a plastic spatula (to avoid damaging the container) and homogenise it.
Let stir for another 45 s (slowly increase the speed to approx. 1900 min^{-1}).

➔ Homogenize again if the printing properties are not satisfying

The maximum lacquer temperature of 45°C must not be exceeded when stirring.

➔ **All stirred material should be processed instantly.**

During breaks and storage the thixotropy increases and the ink becomes thicker so that it may have to be stirred again.

As this is fast drying material, excessive product must not be filled back from the screen into the container for later use.

The optimum processing temperature is 18-23 °C [64.4 –73.4 °F], along with a humidity in the range of 50-70 % r. h.

Printing parameters	Standard process	Proven parameters from practical experience
Screen fabric	polyester 43-80 to 55-65 (acc. to old nomenclature 43-55 T [lines/cm]) or corresponding steel fabric	150-250 mesh steel fabric, angled at 22.5°
Screen tension	min. 25 N/cm or according to the recommendations given by the screen fabric manufacturer	
Squeegee	75-80 Shore-A hardness with angular cut	
Squeegee angle	75-80°	
Squeegee pressure	as low as possible, to avoid smearing	

A very low stencil build-up or the use of thin steel stencils, a steep squeegee angle, a sharp squeegee edge and a low squeegee pressure contribute to a high resolution.

➔ If possible, print control areas that enable a measurement of the resistance at parallel copper conductors to determine resistances and for process control.

The following **specialities** have to be observed when processing carbon-conductive ink **SD 2842 HAL**:

- When printing on thermally curing 2-pack solder resists, it should be ensured that the solder resists have previously been fully cured, otherwise changes in resistance may occur (see also Item "Curing in circulating air ovens").
- When overprinting carbon conductors/resistors with thermally curing inks (for instance 2-pack solder resists) increases in resistance may occur (see also Item "Curing in circulating air ovens").We suggest using our UV curing solder resists of the series **SD 2368 UV** or **SD 2460/201 UV-FLEX**. The flexible solder resists (Index FLEX) are to be preferred for overprinting in cross-over technology. A coating thickness of 25 - 30 µm should be applied in order to ensure perfect insulation. These coating thicknesses are achieved by employing polyester fabrics of 54-64 to 68-55 (according to old nomenclature 54 T to 68 T [lines/cm]). (UV) curing should be effected directly after printing in order to prevent the carbon-conductive ink from being penetrated by liquid solder resist components.
- When using the carbon-conductive ink **SD 2842 HAL** as migration protection, it must be ensured that the silver conductor is covered completely by the carbon-conductive ink.

Drying/Curing

The carbon-conductive ink **SD 2842 HAL** may be cured either in circulating air ovens or in IR curing units.

→ The curing conditions (temperature and time) must be observed in any case so that a reproducible final resistance/properties are achieved.

→ Do not cure the carbon-conductive ink SD 2842 HAL at the same time as other lacquer systems in the curing oven, since this may delay their curing and/or increase the resistance (see also Item ”Screen printing”).

Curing in circulating air ovens

→ Cure the carbon-conductive ink **SD 2842 HAL** in a circulating air oven under the following conditions: **45 min* at 150 °C [302 °F]**.

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

IR-curing

→ Cure the carbon-conductive ink **SD 2842 HAL** in infrared curing units for at least **2 min at 180 °C [356 °F]**.

→ Determine the optimum temperature profile of the oven for curing the carbon-conductive ink **SD 2842 HAL** by means of pre-trials.

Packaging

The packing units available are indicated in our offer which we will send you upon request.

Shelf life and storage conditions

Shelf life: In sealed original containers at least 6 months

Storage conditions: +5 °C to +10 °C [+41 °F to +50 °F]

Protect against humidity

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. Labels on containers show shelf life and storage conditions.

Disclaimer

All descriptions and images of our goods and products contained in our technical literature, catalogues, flyers, circular letters, advertisements, price lists, websites, data sheets and brochures, and in particular the information given in this literature are non-binding unless expressly stated otherwise in the Agreement. This shall also include the property rights of third parties if applicable.

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 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.

Any questions? We would be pleased to offer you advice and assistance in solving your problems. Samples and technical literature are available upon request.

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