ELPEGUARD®
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TR TECHNICAL REPORT

ELPEGUARD® thick film coatings of the series UV-LED Twin-Cure® DSL 1602 FLZ

The **ELPEGUARD®** thick film coatings of the series **UV-LED Twin-Cure®** **DSL 1602 FLZ** are used to protect and insulate electronic assemblies so that they can fulfil higher requirements regarding reliability and service life. Owing to their very good resistance against moisture and condensation an excellent protection against corrosion (such as electro corrosion and migration) is possible even under harsh climatic conditions.

- basis: copolymer of polyurethane (UR) and polyacrylate (AR)
- solvent-free
- UV LED curing at a wavelength of 395 nm, or UV curing in common UV curing units
- UV-LED Twin-Cure® DSL 1602 FLZ/400: tested by Trace Laboratories-East according to **IPC-CC-830C**
- powerful protection through electrical insulation properties directly after UV curing
- chemical cross-linking reaction in shadow zones
- excellent mechanical and chemical resistance
- UL Recognised Component: best flame class V-0 acc. to **UL 94** (UL file no. E80315)
- compliant with China standard **GB 30981-2020**
- temperature range of -65 to +130 °C [-85 to 266 °F]
- depending on the coating thickness also suitable for coating flexible circuits (“flex-to-install”, bend stress during assembly only)
- excellent edge coverage, wetting and underfilling of components (“micro-casting”), very good capillar-active behaviour, yet not suitable as underfill material for BGA’s
- excellent adhesion
- when applied in thick layers, components may be fixed to protect against vibration
- can be mechanically stripped for repair purposes (blasting method)
- possibility of touch-up and repair coatings as well as double coating

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Characteristics

	DSL 1602 FLZ/75	DSL 1602 FLZ/400
Colour/ appearance	colourless, fluorescent	colourless, fluorescent
Solids content	100 %	100 %
Viscosity* at 20 °C [68 °F], DIN EN ISO 3219	75 ± 25 mPas	400 ± 100 mPas
Density at 20 °C [68 °F], DIN EN ISO 2811-1	1.00 ± 0.05 g/cm³	1.06 ± 0.05 g/cm³

* Rotational viscometer from Thermo Fisher Scientific, C 35/1°, D = 100 s^{-1}, www.thermofisher.com

Indices: UV = UV curing, LED = for LED technology, DSL = thick film coating, FLZ = fluorescent, /400 = viscosity of 400 mPas, /75 = viscosity of 75 mPas

Physical and mechanical properties

These values are achieved after UV LED curing and 14 days‘ storage at room temperature.

Property	Test method	DSL 1602 FLZ/75	DSL 1602 FLZ/400
Thermal shock resistance	IPC-CC-830C, 3.7.2 -65 to +125 °C [-85 to 257 °F]	passed* (coating thickness ≤ 100 µm)	passed* (coating thickness ≤ 100 µm)
	1000 cycles -40 °C [-40 °F] to +125 °C [257 °F]. dwell time 30 min transfer time < 10 s	no cracks or delamination	no cracks or delamination
Adhesion	IPC-TM-650, 2.4.28.1	passed	passed
Flexibility	IPC-CC-830C, 3.5.5	passed	passed
Glass transition temperature Tg	TMA	≈ 0 °C [32 °F]	≈ 40 °C [104 °F]
Coefficient of thermal expansion (CTE)	TMA	≈ 165 ppm/°C < Tg ≈ 270 ppm/°C > Tg	≈ 140 ppm/°C < Tg ≈ 275 ppm/°C > Tg

Electrical properties

These values are achieved after UV LED curing and 14 days‘ storage at room temperature.

Property	Test method	DSL 1602 FLZ/75	DSL 1602 FLZ/400
Dielectric strength	IPC-TM-650, 2.5.6.1	≥ 40 kV/mm	≥ 50 kV/mm
	IPC-CC-830C, 3.6.1	passed	passed
Specific volume resistivity	DIN EN 62631-3-1	≥ 1.0 x 10^{14} Ohm x cm	≥ 1.0 x 10^{14} Ohm x cm
Surface resistance	DIN EN 62631-3-2	≥ 1 x 10^{13} Ohm	≥ 1 x 10^{14} Ohm
Moisture and insulation resistance	IPC-CC-830C, 3.7.1 (65 °C [149 °F]/90 % r.h.)	passed	passed
	85/85 test (3 d, 85 °C [185 °F],85 % R.H.)	≥ 1.0 x 10^{8} Ohm	≥ 3.0 x 10^{8} Ohm
Comparative Tracking Index (CTI, tracking resistance)	DIN EN 60112 on FR 4 base material with CTI 275	CTI ≥ 600	CTI ≥ 600

Property	Test method	DSL 1602 FLZ/75	DSL 1602 FLZ/400
Resistance to condensation	based on ISO 6270-2 (BIAS 12 V, 40 °C [104 °F], 100% r. H.)	≥ 1.0 x 10^9 Ohm no e-corrosion or migration	≥ 1.0 x 10^{10} Ohm no e-corrosion or migration
Permittivity ε_r	Determination with a Balanced Circular Disk Resonator	not determined	67 GHz: ≈ 2.695 78 GHz: ≈ 2.735
	VDE 0303, part 4	not determined	100 kHz: ≈ 4.0 1 MHz: ≈ 3.7 1 GHz: ≈ 3.4
Dielectric loss factor tan δ	Determination with a Balanced Circular Disk Resonator	not determined	67 GHz: ≈ 0,012 78 GHz: ≈ 0,016
	VDE 0303, part 4	not determined	100 kHz: ≈ 0.0114 1 MHz: ≈ 0.016 1 GHz: ≈ 0.0432
TI (temperature index)	DIN EN 60216 (IEC 60216) issue 2001 20 000 h 5 000 h	138 °C [280.4 F]* 156 °C [312.8 F]*	132 °C [269.6 F]* 147 °C [296.6 F]*

* can be used in a temperature range **of -65 to at least +130 °C [-85 to at least 266 °F]**. Both at the lower and upper ends of this range the performance and reliability of the material can be negatively affected in some applications. In such cases, additional pre-trials and tests are required. For determining the TI, a loss in mass of 50 % and/or 25 % of dielectric strength compared to the initial values has been fixed as a limit.

Electrical properties immediately after UV curing

After UV curing, electrically insulating properties are already present; however, they may not yet reach the values stated above. Please consider this when performing functional tests directly after UV curing where the electrical values of the thick film coatings of the series **UV-LED Twin Cure® DSL 1602 FLZ** are demanded. The final properties are only achieved after about 8-14 days.

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.
AI	Application information AI 1/2 "Processing instructions for the ELPEGUARD® thick film coatings of the series Twin-Cure®"
TI	Technical information TI 15/3 "Protective measures when using chemicals including lacquers, casting compounds, thinners, cleaning agents"

The thick film coatings of the series **UV-LED Twin-Cure® DSL 1602 FLZ** can be applied by automatic selective spray coating, by brushing or by means of dispensing.



Protect from UV light



Protect against humidity

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.

Auxiliary products recommended

- ELPESPEC® cleaning agent R 5817 and reactive thinner VR 1600
  For cleaning work place and tools we recommend our cleaning agent **R 5817.** Clean equipment with **R 5817** and then rinse with reactive thinner **VR 1600**. Please see also our application information sheet **AI 1/2**, item “Cleaning equipment”.
- ELPESPEC® cleaning agent R 5888
  water-soluble, biodegradable cleaning agent for product carriers and tools
- ELPEGUARD® Dam-and-Cure GEL 1602 FLZ-UV
  Thixotropic dam material for the application of dams around connectors, components and contact surfaces as a boundary for subsequent conformal coating with UV (LED) curable systems.

Drying/Curing

The curing process is based on two complementary chemical cross-linking mechanisms of different time lengths: UV LED curing and humidity curing.

UV LED curing with suitable lamps is mandatory. The specified final properties cannot be achieved by humidity curing alone.

UV LED curing

The **ELPEGUARD®** thick film coatings of the series **UV-LED Twin-Cure® DSL 1602 FLZ** have been developed for curing at a wavelength of 395 nm. Other wavelengths, such as 365 nm, are also possible.
Due to the rapid technological development of UV-LED curing units - particularly in the area of combination lamps, which incorporate several different wavelengths - the curing specifications should be considered as guidelines only and must be confirmed through appropriate testing of the specific curing unit.

➔ Please ensure that you use the appropriate measuring equipment for testing.

Process specification for UV curing

A total dose (energy) is required to ensure complete and high-quality cross-linking of the material. The irradiance intensity (power) to be set in mW/cm² is variable and must be adjusted to the respective process speed, including subsequent steps and the distance from the lamp.

Our recommendation for a wavelength of 395 nm:

	Measuring device	Energy density (dose)	UV irradiance (intensity)
DSL 1602 FLZ/75	LED-Cure L395 von EIT / EIT2.0 LLC	2500 – 5500 mJ/cm²	500 – 6000 mW/cm²
DSL 1602 FLZ/400	LED-Cure L395 von EIT / EIT2.0 LLC	1500 – 3000 mJ/cm²	500 – 3200 mW/cm²

Information on oxygen inhibition

Air oxygen diffuses into the incompletely cured surface and blocks the photoreactive radicals there. To counteract this sticky, incompletely cross-linked surface layer, the highest possible peak power (mW/cm²) is recommended. High power instantly creates an excess of radicals, which consume the atmospheric oxygen faster than it can diffuse in, thereby ensuring a non-sticky surface.

Oxygen inhibition affects only the upper layers (a few µm). The deeper layers are already fully cured.

There are no reported cases of overexposure - and thus damage to the cured coating layers - with UV-LED curing, due to the absence of harmful UV-C radiation in the typical wavelength range.

Through the second reaction mechanism (moisture reaction), any sticky surface that may be present continuously decreases until a non-sticky surface is achieved. Depending on the lamp's power, this can take between 0.5 and 24 hours.

→ Before packaging, check the time required for the surface to become tack-free.

UV measuring equipment

The LED-Cure L395 measuring device from EIT /EIT2.0 LLC is recommended. Upon request we will gladly provide the test report “Determination and measurement of the required curing energy for UV-LED curable protective coatings”.

→ The distance between lamp and assembly should be as low as possible.

UV curing with mercury/gallium lamps

Curing can be achieved in common UV curing units.

→ Determine the optimum energy level by performing pretrials.

The physical, mechanical and electrical properties reached after curing by means of mercury/ gallium lamps may vary from the results listed above. For further information, you may refer to our test report DA 2019-296 provided upon request.

Humidity curing

In shadow zones, the coating will cure by reacting with atmospheric humidity. Depending on the layout and assembly of the printed circuit board, this reaction is completed after 8-14 days. Only after this time the final properties are achieved.

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 +25 °C [+41 °F to +77 °F]



Protect from UV light



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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