ELPEGUARD®
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TR TECHNICAL REPORT

ELPEGUARD® thick film coatings of the series UV Twin-Cure® DSL 1600 E-FLZ

The **ELPEGUARD®** thick film coatings of the series **UV Twin-Cure® DSL 1600 E-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 powerful protection through electrical insulation properties directly after UV curing
- ELPEGUARD® Twin-Cure® **DSL 1600 E-FLZ/75** also curable with UV LEDs
- chemical cross-linking reaction in shadow zones
- complies with the standards IPC-CC-830C and MIL-I-46058C
- UL-approval according to UL 94: best flame class V-0 (UL File No. E80315)
- complies with IEC 60664-3, type 1 and 2 (UL File No. E80315)
- UL-approval of **DSL 1600 E-FLZ/75** according to UL 746E (UL file No. E80315)
- compliant with China standard GB 30981-2020
- best resistance class GX against noxious gases according to ISA 71.04-2013
- temperature range of -65 to at least +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
- halogen-free according to JPCA-ES01-2003 and IEC 61249-2-21
- high transparency and yellowing resistance
- **DSL 1600 E/500** is especially suitable for lighting electronics.

LP 250702 E-12 / 301168e_002

Characteristics

	Colour/ appearance	**Solids content**	**Viscosity* at 20 °C [68 °F]** DIN EN ISO 3219	**Density at 20 °C [68 °F]** DIN EN ISO 2811-1
DSL 1600 E-FLZ	colourless, fluorescent	100 %	2,300 ± 400 mPas	1.10 ± 0.05 g/cm³
DSL 1600 E-FLZ/75		100 %	75 ± 25 mPas	1.09 ± 0.05 g/cm³
DSL 1600 E-FLZ/150		100 %	150 ± 50 mPas	1.12 ± 0.05 g/cm³
DSL 1600 E-FLZ/500		100 %	500 ± 100 mPas	1.06 ± 0.05 g/cm³
DSL 1600 E/500	colourless	100 %	500 ± 100 mPas	1.06 ± 0.05 g/cm³

* measured with Haake RS 600, C 35/1°, D = 100 s^{-1}, or respectively, DSL 1600 E-FLZ with RS 600, C 20/1°, D = 100 s^{-1}
viscosity measuring unit supplied by Thermo Fisher Scientific, www.thermofisher.com

Indices: DSL = thick film coating, E = elastic, /75 = viscosity of 75 mPas, likewise /150 and /500, FLZ = fluorescent

Physical and mechanical properties

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

Property	**Test method**	**DSL 1600 E-FLZ**	**DSL 1600 E-FLZ/75**	**DSL 1600 E-FLZ/150**	**DSL 1600 E-FLZ/500 DSL 1600 E/500**
Thermal shock	100 cycles, –40 °C [- 40 °F] up to +110 °C [230 °F], holding time 15 min each, temperature change within 10 s (Peters test regulation LP-43.0)	passed* (layer thickness ≤ 500 µm)	passed* (layer thickness ≤ 300 µm)		
Thermal shock	IPC-CC-830C, 3.7.2 -65 to +125 °C [-85 °F to 257 °F]	passed	passed		
Adhesion	IPC-TM-650, 2.4.28.1	passed			
Flexibility	IPC-CC-830C, 3.5.5	passed			
Glass transition temperature Tg	TMA	≈ 10 °C [50 ° F]	≈ 0 °C [32 °F]	≈ 10 °C [50 °F]	≈ 10 °C [50 °F]
Coefficient of thermal expansion (CTE)	TMA < Tg TMA > Tg	≈ 100 ppm/°C ≈ 160 ppm/°C	≈ 90 ppm/°C ≈ 300 ppm/°C	≈ 80 ppm/°C ≈ 200 ppm/°C	≈ 150 ppm/°C ≈ 270 ppm/°C
Young modulus	DMA < Tg DMA > Tg	≈ 1300 MPa ≈ 100 MPa	≈ 1200 MPa ≈ 7 MPa	≈ 2000 MPa ≈ 50 MPa	≈ 1300 MPa ≈ 50 MPa
Thermal conductivity	DIN EN 821	≈ 0.2 W/mK			

* The results of the temperature shock test strongly depend on the substrate and type of components mounted on an assembly, since they exhibit vastly different coefficients of expansion. For optimum results in the temperature shock test, we recommend spray application with dry coating thicknesses below 100 µm.

Electrical properties

These values are achieved after UV curing and 14 days‘ storage at room temperature (200 µm layer thickness).

Property	Test method	DSL 1600 E-FLZ	DSL 1600 E-FLZ/75	DSL 1600 E-FLZ/150	DSL 1600 E-FLZ/500 DSL 1600 E/500
Dielectric strength	IPC-TM-650, 2.5.6.1	≥ 50 kV/mm	≥ 60 kV/mm	≥ 90 kV/mm	≥ 50 kV/mm
	IPC-CC-830C, 3.6.1	passed			
Specific volume resistivity	DIN EN 62631-3-1	≥ 7.3 x 10^{14} Ohm x cm	≥ 6.3 x 10^{11} Ohm x cm	≥ 1.5 x 10^{13} Ohm x cm	≥ 5.5 x 10^{14} Ohm x cm
Surface resistance	DIN EN 62631-3-2	≥ 2 x 10^{14} Ohm			
Moisture and insulation resistance	IPC-CC-830C, 3.7.1 (65 °C [149 °F]/90 % r.h.)	passed			
	85/85 test (3 d, 85 °C [185 °F], 85 % R.H.)	≥ 2.8 x 10^{8} Ohm	≥ 1.0 x 10^{8} Ohm	≥ 3.0 x 10^{8} Ohm	≥ 2.0 x 10^{7} Ohm
Electro migration	based on IPC-SM-840C, 3.9.2	none			
Electro corrosion	21 d, 40 °C [104 °F], 95 % r. h., 100 V DC	none			
Hydrolytic stability	IPC-CC-830C, 3.7.3	passed			
Comparative tracking index*	DIN EN 60 112, on FR 4 base material with CTI of 275	CTI ≥ 600			
Resistance to condensation	based on ISO 6270-2 (BIAS 12 V, 40 °C [104 °F], 100% r. F.)	≥ 4.0 x 10^{9} Ohm	≥ 2.0 x 10^{8} Ohm	≥ 2.0 x 10^{9} Ohm	≥ 1.3 x 10^{9} Ohm
		no electro corrosion or migration			
Salt spray test	BMW GS 95003-4	passed			
Permittivity ε_r	DIN 53483 100 kHz 1 MHz 1 GHz	≈ 3.2 ≈ 3.0 ≈ 2.3	≈ 4.7 ≈ 3.9 ≈ 2.5	≈ 3.1 ≈ 3.2 ≈ 2.5	≈ 4.8 ≈ 4.5 ≈ 3.8
Dielectric loss factor tan δ	DIN 53483 100 kHz 1 MHz 1 GHz	≈ 0.055 ≈ 0.056 ≈ 0.055	≈ 0.14 ≈ 0.12 ≈ 0.09	≈ 0.035 ≈ 0.044 ≈ 0.043	≈ 0.0196 ≈ 0.0277 ≈ 0.0422
TI (temperature index)**	DIN EN 60216 (IEC 60216) issue 2001 20 000 h (5 000 h)***	≥ 130 °C (≥ 150 °C)	≥ 125 °C (≥ 145 °C)	≥ 125 °C (≥ 145 °C)	≥ 130 °C (≥ 150 °C)

* Tracking resistance, CTI = Comparative tracking index

** can be used in a temperature range of -65 up to at least +130 °C [-85 up 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 these cases, additional pre-trials and tests are required. Limit values for classification were a 25 % loss in mass and/or dielectric strength in comparison to the appropriate reference values.

Electrical properties immediately after 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 Twin-Cure®** 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 1/1 "Processing instructions for ELPEGUARD® conformal coatings (thin film coatings)"
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 Twin-Cure® DSL 1600 E-FLZ** can be applied by automatic selective coating units, 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

- 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".
- 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 curing and humidity curing.

UV curing / UV LED curing

Curing can be effected in standard UV curing units.

➔ Cure the **ELPEGUARD®** thick film coatings of the series **UV Twin-Cure®** by applying the following UV radiation energy (given for a pure mercury lamp):

DSL 1600 E-FLZ **DSL 1600 E-FLZ/75** **DSL 1600 E-FLZ/150**	3000 ± 500 mJ/cm²
DSL 1600 E-FLZ/500 **DSL 1600 E/500**	4000 ± 500 mJ/cm²

DSL 1600 E-FLZ/75 can also be cured in UV LED curing systems with a suitable system configuration. Carry out preliminary tests to determine the optimum curing parameters. Positive experience and test reports are available. For further details, please contact our Application Technology Department (ATA).

UV curing with suitable UV lamps is mandatory. The mechanical properties are not fully achieved with pure humidity curing.

The UV cured assemblies can already be packed or encapsulated 1-3 h after UV curing.

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 bis +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.

Lackwerke Peters GmbH & Co. KG
Hooghe Weg 13, 47906 Kempen, Germany
Internet: www.peters.de
E-Mail: peters@peters.de
Phone +49 2152 2009-0
Fax +49 2152 2009-70

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