

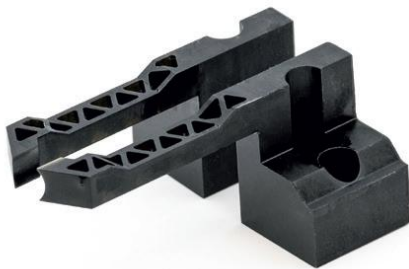


Processing Guide

High Performance 4-2800 VP-ESD

ESD material with excellent processability and low viscosity

ALTANA Cubic Ink® ESD materials are designed to meet the customer's ESD requirements. Thanks to their low viscosity a very good processability is given. The tough yet customizable range of properties of these materials makes them a good choice for a broad range of applications.



Materials can be used in



Tooling



Medical
Applications



Transportation

Performance Indicators

Volume Resistivity	$1.8 \times 10^7 \Omega\text{cm}$
HDT B	94 °C
Elongation at Break	4%
Chemical Resistance	Very Good

Preparation

Printing

Washing

Post-Curing



LCD, DLP, mSLA

2 min Water or Cleaner 400

Cure with UV / Thermal

Preparation

Safety Guideline

High Performance 4-2800 VP-ESD is a chemical formulation in the liquid state and has to be treated as such until it is fully cured. Please use personal lab protection equipment such as appropriate gloves, goggles and lab coat. Wash contaminated body parts and equipment directly after occurrence and change contaminated gloves immediately. Do not consume the resin.

Danger



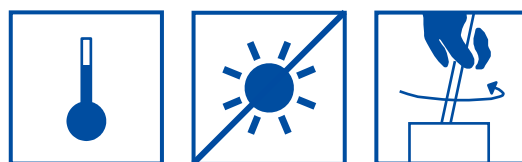
The information given in this document do not constitute a legally binding SDS, which will be provided at purchase.

Storage and Preparation

Please make sure the resin is stored between at 21 - 28 °C.

Please make sure the resin is not exposed to light.

Please stir resin thoroughly prior to use and before each printing job.



Printing

Print Settings

High Performance 4-2800 VP-ESD Black printed part properties may vary with printer, print settings, object orientation, part geometry and post-processing. The shown recommendations of printer and print settings are based on Cubic Ink's experiments and experience and do not include all possible processes and feasibility of the material (Table 1 - 3). The processor is welcome to explore the workflow regarding printer and print settings since High Performance 4-2800 VP-ESD Black is compatible with a broad range of LCD, DLP and mSLA. Nevertheless, Cubic Ink supports and customizes the processing guidelines together with their partners. If not stated otherwise specimens and objects are printed vertically.

Printing

General Curing Parameters

In Table 1 different curing characteristics are presented. The necessary critical energy as well as the penetration of depth indicate the reactivity and curing in depth abilities of the liquid resin. Please note, that **it is recommended to print layer thicknesses with 50 µm**. Please contact us for further information

Table 1: Curing Parameters measured at Cubic Ink for High Performance 4-2800 VP-ESD Black.

Measurement	Black
<u>405 nm, 8 mW/cm²:</u>	
E_c [mJ/cm²]	2.73
D_p [mm]	0.10
Thickness after 1 s of exposure [mm]	0.12
Thickness after 5 s of exposure [mm]	0.28
<u>385 nm, 11 mW/cm²:</u>	
E_c [mJ/cm²]	3.49
D_p [mm]	0.07
Thickness after 1 s of exposure [mm]	0.09
Thickness after 5 s of exposure [mm]	0.21
x-y-Compensation [%]	0.2 ¹
z-Compensation [mm]	0.3 ¹
Printable overhangs [°]	up to 20 ¹
Minimal wall thickness unsupported [mm]	0.4 ¹
Minimum pin thickness [mm]	0.5 ¹
Minimum hole thickness vertical [mm]	1.0 ¹

¹Measured with samples printed and cured via Phrozen Sonic Mighty 8K (LCD 405 nm, 2 mW/cm², 50 µm) and 60 min Formlabs Form Cure L (LED 405 nm) at 80 °C; For more details, please contact us.

Printing

Print Settings

Table 2: Suggested curing times depending on wavelength, color, printing thickness and intensity of light source for High Performance 4-2800 VP-ESD Black.

Wavelength	Color	Layer thickness [μm]	11 mW/cm ²	8 mW/cm ²	5 mW/cm ²	2 mW/cm ²
385 nm	Black	50	0.7 s	0.9 s	1.4 s	3.6 s
	Black	100	1.1 s	1.5 s	2.4 s	6.0 s
405 nm	Black	50	-	0.6 s	1.0 s	2.4 s
	Black	100	-	1.0 s	1.7 s	4.2 s

High Performance 4-2800 VP-ESD Black was tested on several printers such as

Prusa SL1S Speed (LCD, 405 nm, 2 mW/cm²), Phrozen 8K Mighty (LCD, 405 nm, 2 mW/cm²), Phrozen 8K Mega S (LCD, 405 nm, 3 – 5.6 mW/cm²), Asiga Pro 4K80/ Max 2 (DLP, 385 nm, 2 - 11 mW/cm²), Formlabs Form 4 (LCD, 405 nm, 2 - 11 mW/cm²), RapidShape D30+ (DLP, 385 nm, 3 mW/cm²). For more information, please contact us.

Table 3: Examples of print settings at Cubic Ink for High Performance 4-2800 VP-ESD Black.

Printing system	Color	Layer thickness [μm]	Exposure time bottom layer [s]	Exposure time default layer [s]
Prusa SL1S Speed (LCD, 405 nm, 2 mW/cm ²)	Black	50	30.0	8.0 – 16.0
Phrozen 8k Mighty (LCD, 405 nm, 2 mW/cm ²)	Black	50	25.0	4.0 – 10.0

Washing

Removing & Washing

- Washing with distilled water, Cleaner 400 or IPA for 2 min. Increasing washing time up to 3 min directly increases the drying time significantly.
- Ultrasonic bath or adequate mixing equipment is beneficial
- Rinse with water or IPA shortly is possible

Cleaning

- Treatment with compressed air optional
- Use sponges to clean holes and cavities

Drying

- Let dry at ambient conditions for at least 120 min
- To accelerate the process: Dry for 60 min at 50 °C

Post-Curing

High Performance 4-2800 VP-ESD Black needs to be post-cured to reach its final material properties. The post-cure used on the TDS (Version 5) contained 2 x 30 min UV-treatment via Formlabs Form Cure V1 at 80 °C (LED, 375 and 405 nm). Other examples of post-curing are shown in Table 4 to emphasize different effects of UV-curing chambers, wavelengths and intensities.

High Performance 4-2800 VP-ESD Black is post-cured via

- **Intense and homogenous UV-cure is necessary**
- Temperature in UV-chamber as high as possible (≥80 °C)
- If possible, use vacuum or nitrogen atmosphere

Table 4: UV post-processing carried out at Cubic Ink for High Performance 4-2800 VP-ESD Black (printed with 50 µm).

Post-Process	E-Modulus [GPa]	Tensile strength [MPa]	Elongation at break [%]	HDT B [°C]
IPA-Wash, 2x 30min Prusa	2.7	57	3.9	73
Cleaner 400 Wash, 2x 30min Formlabs	2.7	65	4.0	94

Prusa CW1S = LED 405 nm; Formlabs Form Cure V1 @ 80°C. Tensile testing DIN EN ISO 527-1 5A-specimens, 5 mm/min, 23 °C; HDT B DIN EN ISO 75, all specimens printed vertically.

Post-Curing

General Effects of Post-Curing

- Washing and drying:
 - The washing fluid and time of washing can influence the final material properties.
 - In some cases (e.g. using higher temperatures while post-curing) cracks can occur if not washed as recommended and not dried thoroughly.
- UV-Post-cure:
 - Higher wavelength (e.g. ≥ 405 nm) better for cure in depth, shorter wavelength (e.g. ≤ 365 nm) better for surface cure.
 - Broad spectra light sources or the combination of multiple wavelengths improve the overall curing process.
 - The higher the intensity of a light source, the shorter the time in the curing chamber.
 - Part orientation in the chosen UV-chamber is crucial. Most chambers focus the LED-spots in the middle of the volume. Placing flat objects on the bottom may cause nearly no or less irradiation by light. Curing time may need to be adjusted depending on the geometry of the part.
- UV Post-cure with vacuum or nitrogen atmosphere:
 - Better for surface cure. Decrease of time in UV-chamber.
 - Less stickiness.
- UV-Post-Cure with simultaneously temperatures above 60 °C:
 - Good for cure in depth and surface cure. Decrease of time in UV-chamber.
 - Not that much depending on the color and geometry of the part, the effect of temperature influences the homogeneity of curing.
- Additional thermal post-cure after finished UV-cure:
 - Good for final cure in depth and surface cure.
 - Recommended temperature varies between 80 - 130 °C for 1 – 5 hours for most materials, between 130 - 190 °C for 0,5 – 5 hours for very high temperature resistant materials.

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