EXTEM™ RH1017UCL-1000 RESIN DATASHEET OPTICAL PROPERTIES AND MODELING PARAMETERS

All ULTEM™ and EXTEM™ resins, when produced, have some variability in color which can affect percent transmission within a final product. Currently reported values are for average lots of resin and are subject to change.

OPTICAL PROPERTIES	TYPICAL VALUES	UNITS
Refractive Index, n_d	1.665	
Abbe Number	18.1	
Density	1.35	g / cm^3
External Transmission, 850 nm, 1 mm (ASTM D1003)	87	%
Refractive Index, 850 nm	1.639	
dn/dT, 850 nm (T = 30 - 120°C)	-9.1×10^{-5}	$°C^{-1}$

Refractive Index Dependence with Wavelength or Temperature

- Sellmeier dispersion formula parameters are valid for a refractive index specified in wavelengths (µm) from 0.39 µm to 1.54 µm
- Temperature dependence of refractive index constants are valid for a refractive index with a temperature from 30 °C to 120 °C and a wavelength from 0.5 µm to 1.54 µm

Sellmeier Dispersion Equation for Refractive Index

$$n^2 - 1 = \frac{B_1\lambda^2}{\lambda^2 - C_1} + \frac{B_2\lambda^2}{\lambda^2 - C_2} + \frac{B_3\lambda^2}{\lambda^2 - C_3}$$

Constants of Sellmeier Dispersion# Formula	
B_1	0.13379
B_2	0.70131
B_3	0.79756
C_1	-0.16107
C_2	0.03777
C_3	0.03777

Temperature Dependence of Refractive Index

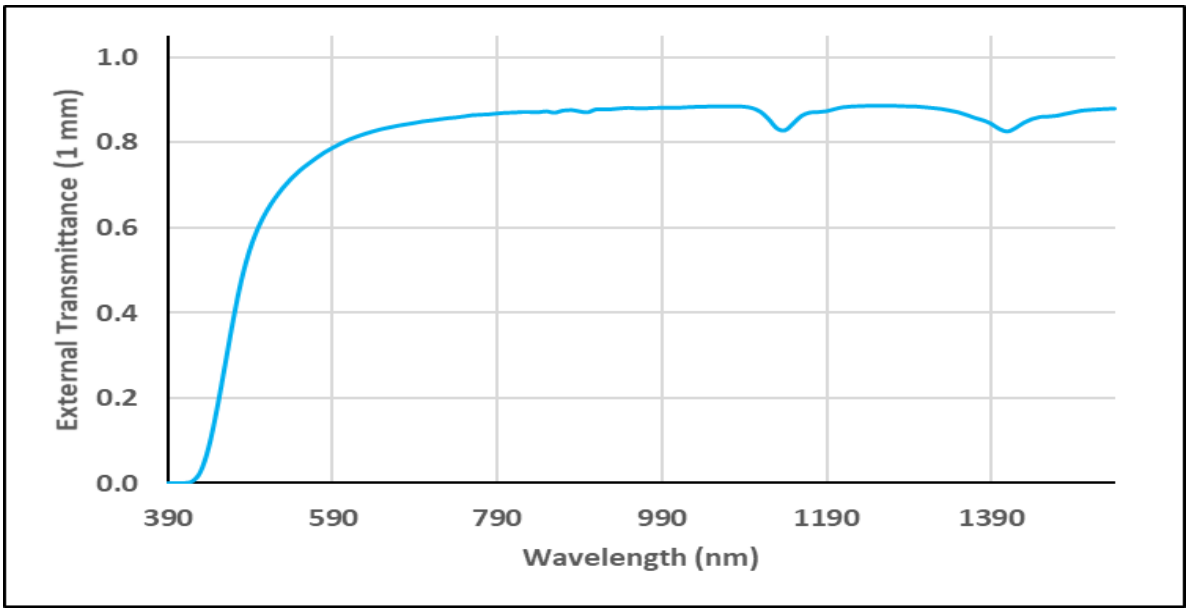
$$\Delta n_{abs} = \frac{n^2 - 1}{2n}\left[D_0\Delta T + D_1\Delta T^2 + D_2\Delta T^3 + \frac{E_0\Delta T + E_1\Delta T^2}{\lambda^2 - \lambda_{tk}^2}\right]$$

Constants* of Dispersion dn/dT	
D_o	$-1.53 \cdot 10^{-4}$
D_1	$-5.16 \cdot 10^{-7}$
D_2	$-4.97 \cdot 10^{-11}$
E_o	$-5.80 \cdot 10^{-6}$
E_1	$9.84 \cdot 10^{-8}$
λ_{tk}	0.00

EXTEM™ RH1017UCL-1000 RESIN DATASHEET OPTICAL TRANSMISSION

All ULTEM™ and EXTEM™ resins have color variability which can affect percent transmission. Reported values are representative for current resin performance.

- External transmittance of RH1017UCL-1000 resin was measured using molded optical plaques at 1 mm thickness according to ASTM D1003
- Internal transmittance values are also provided for optical modeling software

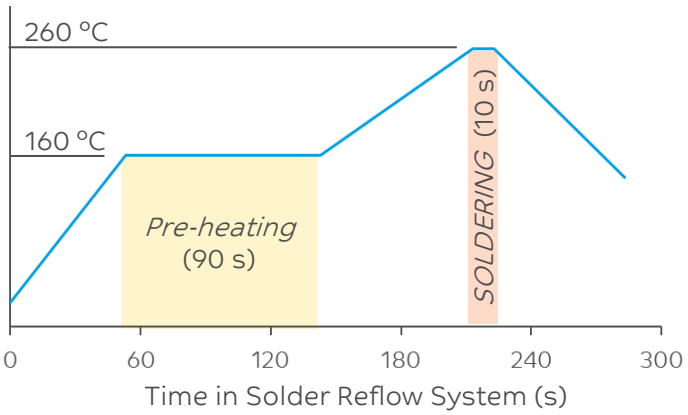


Internal Transmittance at 1 mm Thickness (t)							
λ (nm)	t = 1 mm	λ (nm)	t = 1 mm	λ (nm)	t = 1 mm	λ (nm)	t = 1 mm
390	0.00	660	0.94	900	0.99	1200	0.99
400	0.00	700	0.96	920	0.99	1250	0.99
410	0.00	740	0.97	940	0.99	1300	0.99
420	0.01	780	0.98	960	0.99	1350	0.98
460	0.32	800	0.98	980	0.99	1400	0.93
500	0.68	820	0.98	1000	0.99	1450	0.96
540	0.81	840	0.98	1050	0.99	1500	0.98
580	0.88	860	0.99	1100	0.99	1520	0.98
620	0.92	880	0.99	1150	0.95	1540	0.99

EXTEM™ RH1017UCL-1000 RESIN ENVIRONMENTAL AND ASSEMBLY FACTORS

EXTEM™ RH1017UCL resins can produce parts with infrared (IR) transparency and dimensional stability through JEDEC-compliant solder reflow assembly processes.

High dimensional stability can be achieved due to a high glass transition temperature of 280 °C, beyond the 260 °C peak reflow temperature commonly required for lead-free solder reflow.



LEAD FREE SOLDER REFLOW PROCESS

Lead free solder reflow testing at 240 °C to 260 °C peak temperatures evaluated EXTEM resin performance

- JEDEC STD-020A compliant reflow profile
- 3 reflow cycles on Cu-clad laminate PCB
- JEDEC failure criteria inspection*
- Moisture Sensitivity Level (MSL) requirements are part and assembly dependent

JEDEC REFLOW EVALUATION CRITERIA*

PEAK TEMP	XH1015UCL	RH1017UCL
240 °C	Pass	Pass
250 °C	Design Dependent	Pass
260 °C	NO Pass	Pass

GOOD DESIGN PRACTICES FOR MOLDED COMPONENTS

Maintaining molded component precision can be difficult if environmental conditions are left uncontrolled. Part design and handling should be reviewed so molded components meet the required dimensional tolerances in the long-term application environment.

- To measure consistent dimensions after molding, parts can be equilibrated in a controlled humidity and temperature environment, such as chambers used for ASTM/ISO conditioning test standards.
- To control dimensional stability during assembly, parts can be pre-equilibrated and removed from the controlled environment just prior to assembly. Dry bag packaging can minimize storage and transport variations and reduce environmental variability effects in long term storage.
- To control dimensional stability during in-use application, parts can be equilibrated to the average temperature and humidity conditions prior to assembly to limit environmental changes during use.
- Reports on dimensional stability through solder reflow have been tested by SABIC, please contact SABIC for EXTEM™ RH1017UCL resin for reports and study details. Studies were done in collaboration with NALUX Co. Ltd, an ultra-precision plastic molder headquartered in Japan.

* MSL data testing at MSL2 and MSL3. JEDEC STD-020A failure criteria are cracks, blisters, flatness changes caused by warping, swelling, or bulging. Bulging is defined as a change in part thickness that caused parts to no longer lay flat on the PCB laminate.

EXTEM™ RH1017UCL-1000 RESIN DATASHEET MATERIAL PROPERTIES

EXTEM™ RH1017UCL resin is a near-IR transparent thermoplastic with a glass transition temperature of 280 °C. This injection moldable resin can produce complex optical lens assemblies while maintaining dimensional stability during 260 °C peak temperature solder reflow assembly

PROPERTIES	TYPICAL VALUES	UNITS	TEST METHODS
MECHANICAL			
Tensile Modulus, 5 mm/min	2900	MPa	ISO 527
Tensile Stress, brk, Type I, 5 mm/min	75	MPa	ISO 527
Tensile Strain, brk, Type I, 5 mm/min	3	%	ISO 527
Flexural Modulus, 3.2 mm thickness	3100	MPa	ASTM D790
Flexural Strength, Yield	180	MPa	ASTM D790
IMPACT			
Izod Impact, Notch, 3.2 mm, 23°C	40	J/m	ASTM D256
Izod Impact, Unnotched, 3.2 mm, 23°C	1040	J/m	ASTM D256
Izod Impact, notched 80*10*4 +23°C	5	kJ/m²	ISO 180/1A
Izod Impact, notched 80*10*4 -30°C	4	kJ/m²	ISO 180/1U
THERMAL			
Heat Deflection Temperature 0.455 MPa, 3.2 mm, unannealed	270	°C	ASTM D648
Heat Deflection Temperature 1.82 MPa, 3.2 mm, unannealed	255	°C	ASTM D648
CTE (-20 to 150°C), flow direction	49	10^{-6}/°C	ASTM E831
CTE (-20 to 150°C), cross-flow direction	53	10^{-6}/°C	ASTM E831
Vicat Softening Temp, Rate B/50	280	°C	ASTM D 1525
PHYSICAL			
Specific Gravity	1.24		ASTM D792
Mold Shrinkage, flow, 3.2 mm	1.0 – 1.1	%	SABIC Method
Melt Flow Rate, 367°C, 6.6 kgf	10	g/ 10 min	ASTM D1238
Water Absorption, (23°C . 24 hr)	0.52	%	ASTM D570

EXTEM™ RH1017UCL-1000 RESIN DATASHEET INJECTION MOLDING CONDITIONS

Injection molding conditions supplied are for representative ISO or ASTM sized test components. Contact SABIC for recommendations when using micro molding or modified injection molding techniques such as injection compression molding.

PROPERTIES	TYPICAL VALUES	UNITS
RESIN DRYING CONDITIONS		
Drying Temperature*	175	°C
Drying Time	6 - 8	hrs
Drying Time (Cumulative)	24	hrs
Maximum Moisture Content	0.02	%
INJECTION MOLDING		
Melt Temperature	380 - 410	°C
Nozzle Temperature	375 - 405	°C
Front - Zone 3 Temperature	380 - 410	°C
Middle - Zone 2 Temperature	370 - 400	°C
Rear - Zone 1 Temperature	360 - 385	°C
Mold Temperature	160 – 200	°C
Intake (throat) temperature	70 – 100	°C
Back pressure (Plastic Pressure)	5 – 10	MPa
Screw speed (Circumferential speed)	< 0.2	m/s
Shot to Cylinder Size	40 – 70	%
Vent Depth	0.025 – 0.076	mm

SABIC Internal methods for shrinkage: Measured on ~100 mm diameter, 3.2 mm thickness disk versus molded metal dimensions
*The recommended drying temperature of 175°C is for dehumidifying dryer systems. Hot air dryer systems are not recommended if dehumidifying dryer systems are available. Hot air dryer systems at temperature of 200°C may be used provided maximum moisture content is not exceeded.