CHEMISTRY THAT MATTERS™

PRODUCT INTRODUCTION: SABIC CXT RESIN PORTFOLIO

NOVEMBER 2019

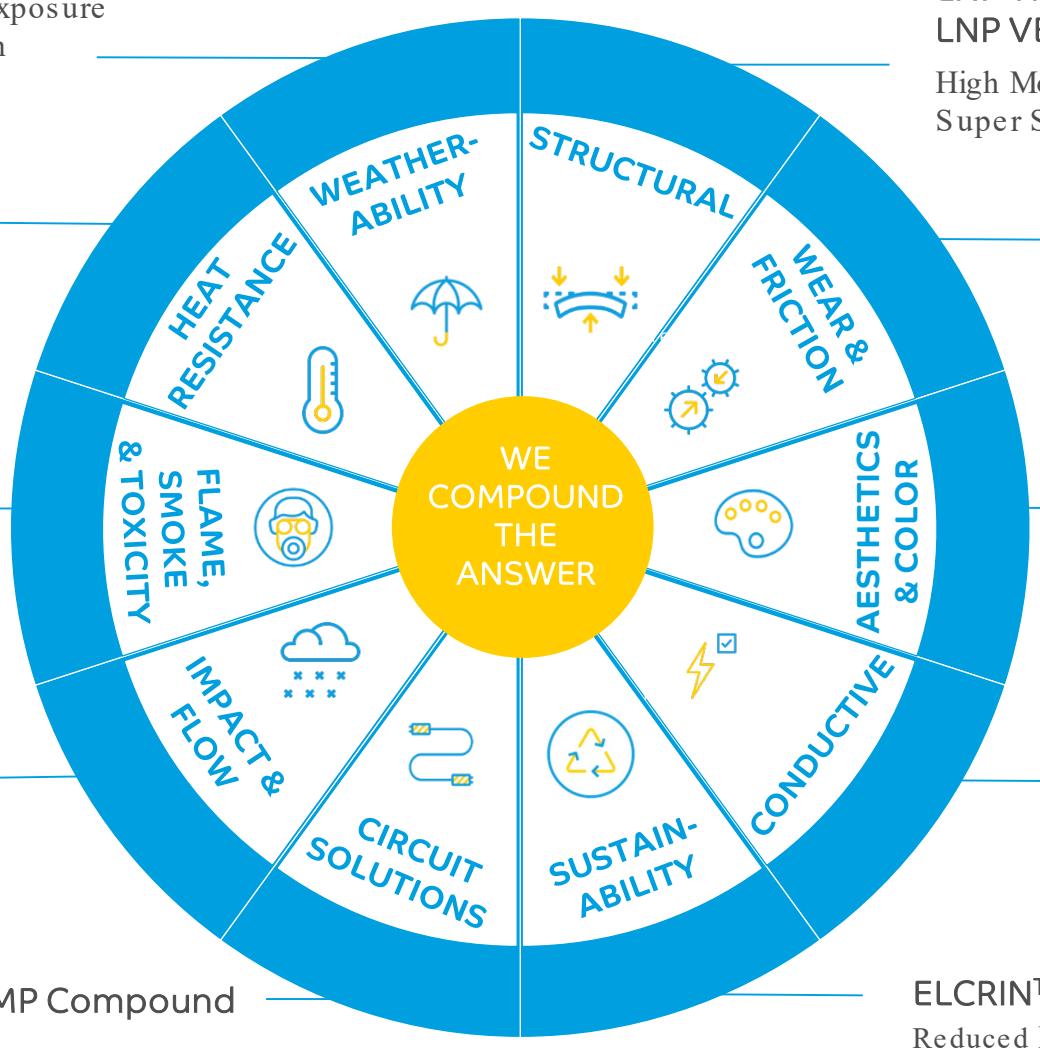
INTRODUCTION

Our Copolymers and Compound solutions

Introduction to LNP Copolymer Resins

Introduction to XHT, CXT and PPC resins

Industry trends and needs driven by Connectivity



LEXAN™ SLX Resin

Prolonged UV exposure
Paint Elimination

LEXAN XHT Resin
LEXAN CXT Resin
LEXAN PPC Resin

Excellent Processability
High Heat Resistant

LEXAN FST Resin
LEXAN CFR Resin

FAR Compliant
Transparent FR

LEXAN EXL Resin
LEXAN HFD Resin

Superior Flow
Low Temperature Impact

LNP THERMOCOMP Compound

Tunable Dielectrics
MID (Laser Direct Structuring)

LNP™ THERMOTUF™ Compound
LNP THERMOCOMP™ Compound
LNP VERTON™ Compound

High Modulus Ductile
Super Structural

LNP LUBRICOMP™ Compound
LNP LUBRILOY™ Compound

Wear Resistance
Friction Reduction

LEXAN LUX-C & FX Resin
LNP COLORCOMP™ Compound

Special colors
Transparency

LNP STAT-KON™ Compound
LNP STAT-LOY™ Compound
LNP FARADEX™ Compound
LNP KONDUIT™ Compound

Thermal Dissipation
Electrostatic Dissipation

ELCRIN™

Reduced Energy &
Carbon Footprint

WHAT ARE SABIC COPOLYMER RESINS?

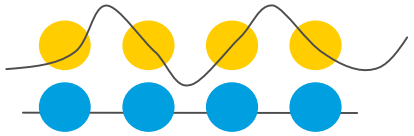
Performance →

Innovation →

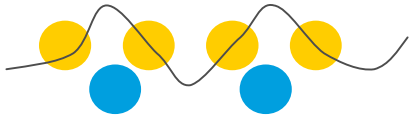
Advanced Technology
Expanded properties
New and existing markets

SABIC
Copolymer Resins

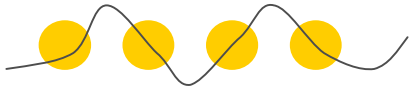
Blends



Additives



Standard PC



Standard technology
Established properties
Mature markets

INTRODUCING LEXAN™ CXT RESINS

LEXAN CXT resins are a new family of high heat polycarbonate copolymers targeted to offer a combination of:

HIGH HEAT
Potential to use in demanding secondary operations, assembly processes and usage conditions.

+

HIGH FLOW & BROAD PROCESS WINDOW
Potential for high precision molding of complex, large, thin and/or textured parts with high productivity and quality.

LOW COLOR AND HIGH TRANSMISSION
Good optical properties for part appearance and operation, with limited color shift and transmission loss after heat ageing compared to alternatives.

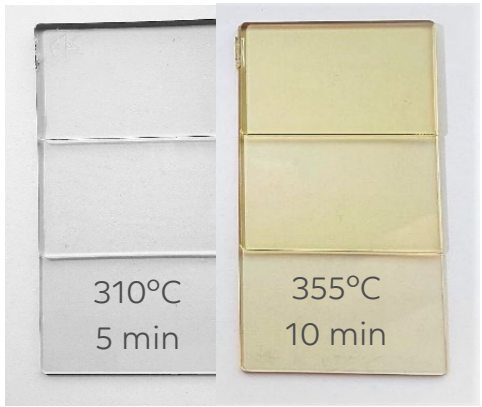
HIGH REFRACTIVE INDEX
Unique combination of high heat, crystal clarity and high refractive index, with potential for thinner part and module designs and miniaturization.

TAILORED AND FLEXIBLE PORTFOLIO
Broad portfolio setup to serve different needs and ability to formulate for additional features if needed.

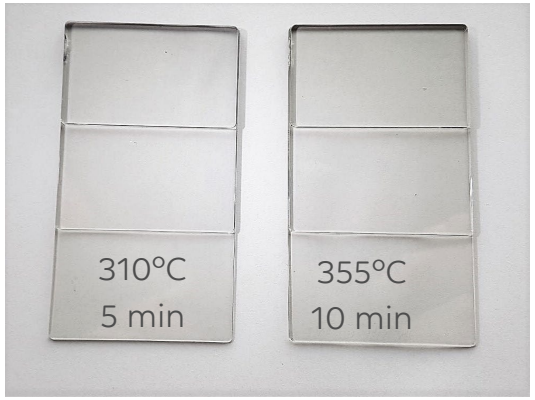
STABILITY OF OPTICAL PROPERTIES OF SELECTED SABIC XHT, LEXAN™ CXT AND LEXAN™ PPC RESINS

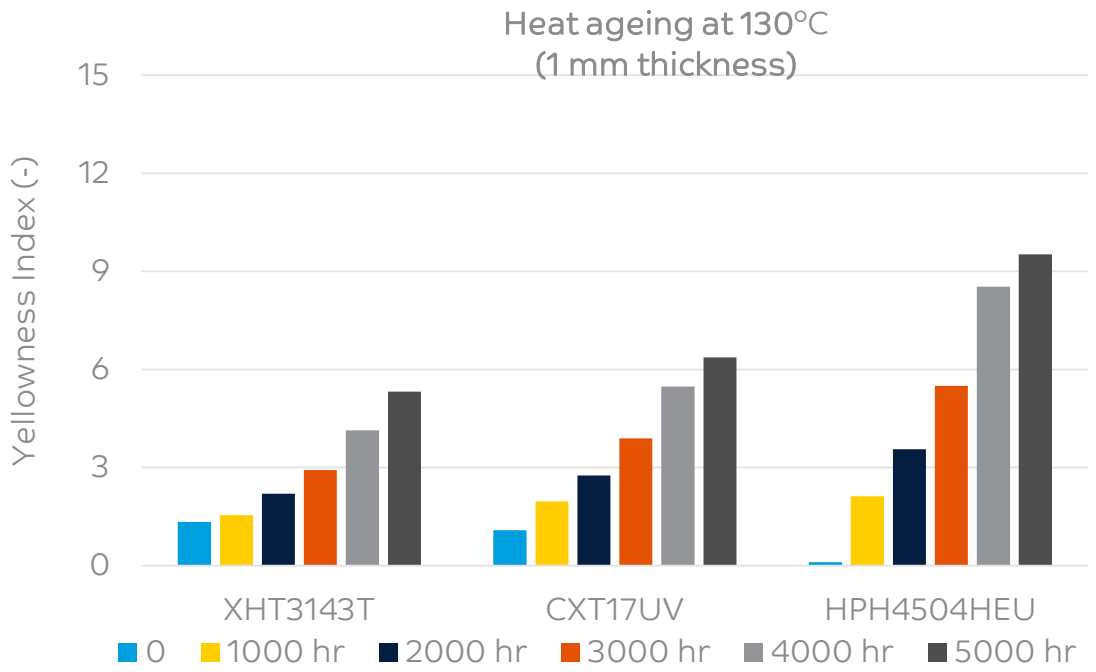
LEXAN CXT resins outperform LEXAN XHT and LEXAN PPC analogues in low color retention after molding under abusive conditions and offer excellent balance with other properties like impact, flow and heat ageing

LEXAN XHT3143T resin



LEXAN CXT17UV RESIN





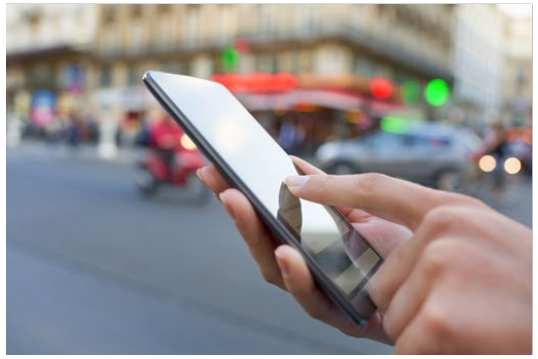
LEXAN CXT resins have lower color shifts when molded under more demanding molding conditions on melt temperature and/or residence time compared to LEXAN XHT resins

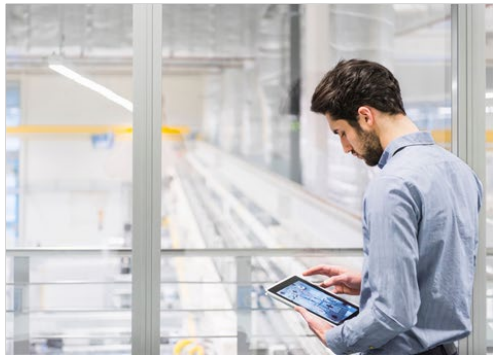
Data are indicative and intended as reference only. Customers are fully responsible for testing the performance of the SABIC material in the end application and checking whether the properties of these grades are meeting their application requirements.

TRENDS FOR ELECTRONICS

CONNECTIVITY

The electronic devices of tomorrow are trending towards improved user experience, functionality, and connectivity





Lenses in sensors, cameras and LED's will be critical components to support the increasing trend of seamless connectivity in electronic devices

Their build number will increase exponentially, requiring economy of scale and cost efficient processes for production and assembly

THERMOPLASTIC RESINS IN OPTICS

POTENTIAL BENEFITS

ECONOMY OF SCALE
Injection molding of thermoplastics allows high precision production of large build numbers of complex parts

DESIGN FREEDOM
Thermoplastics can allow complex part designs that are not possible with alternative solutions like glass or thermoset resins

INTEGRATION AND SIMPLIFICATION
Thermoplastics allow the integration of mechanical (such as fixtures) and optical features and enable design simplification

KEY CONSIDERATIONS

TEMPERATURE LIMITATIONS
The glass transition temperature of thermoplastics may limit secondary operations (like soldering) and part use conditions

DIMENSIONAL STABILITY
Dimensional changes due to temperature variation (thermal expansion) or moisture uptake may affect part or optical operation

OPTICAL PROPERTIES
Properties like transmission, refractive index, and birefringence depend on many variables (e.g. design, processing, operating conditions)

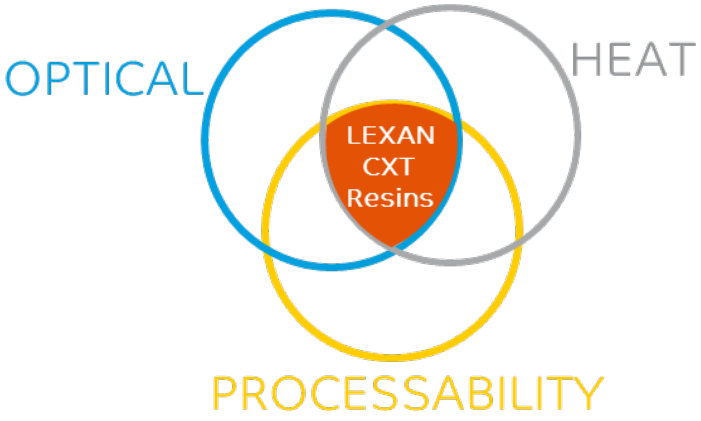
A KEY CHALLENGE FOR LENSES

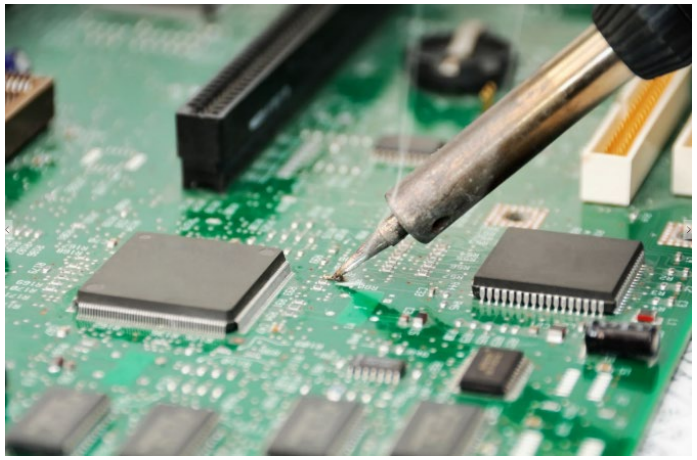
CHALLENGE

Develop a transparent and crystal clear material solution for cost efficient production and assembly of large build number of transparent lenses

Thermoplastic resins have this potential, but often do not offer sufficient heat for assembly or application (e.g. PMMA or PC resins) or have yellow to amber color (e.g. PEI or PSU resins)

In Electronics applications, an often-used assembly process is soldering of parts and modules onto printed circuit boards (PCB's)





LEXAN HIGH HEAT POLYCARBONATE COPOLYMER RESIN PORTFOLIO

Comparison of LEXAN CXT, XHT and PPC copolymer resins

LEXAN CXT, XHT and PPC copolymer resin portfolios

Potential application spaces for LEXAN CXT resins

OUR HIGH HEAT POLYCARBONATE COPOLYMER RESINS

LEXAN™ XHT RESINS

Features

- High heat resistance (Tg in range of 155 to 195°C)
- Excellent processability with standard and high flow versions
- Ductile practical impact at low temperatures
- Excellent metallization capability
- Opaque and transparent colors

Potential applications

Automotive Lighting (bezels, reflectors, inner lenses)

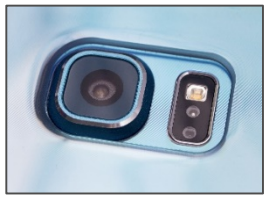

LEXAN CXT RESINS

Features

- High heat resistance (Tg 155-195°C)
- Crystal clear color and high transmission in visible and IR
- High Flow in broad processing window without discoloration
- Ductile practical impact at low temperatures
- Excellent metallization capability

Potential applications

Lenses (LED, camera and sensor), Healthcare, Automotive, Films, Appliances, Personal Safety

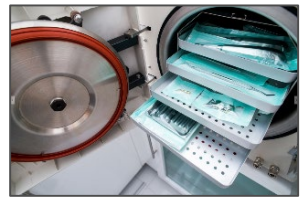
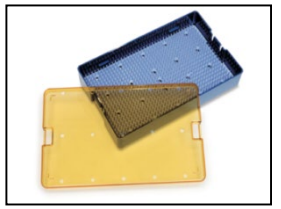
LEXAN PPC RESINS

Features

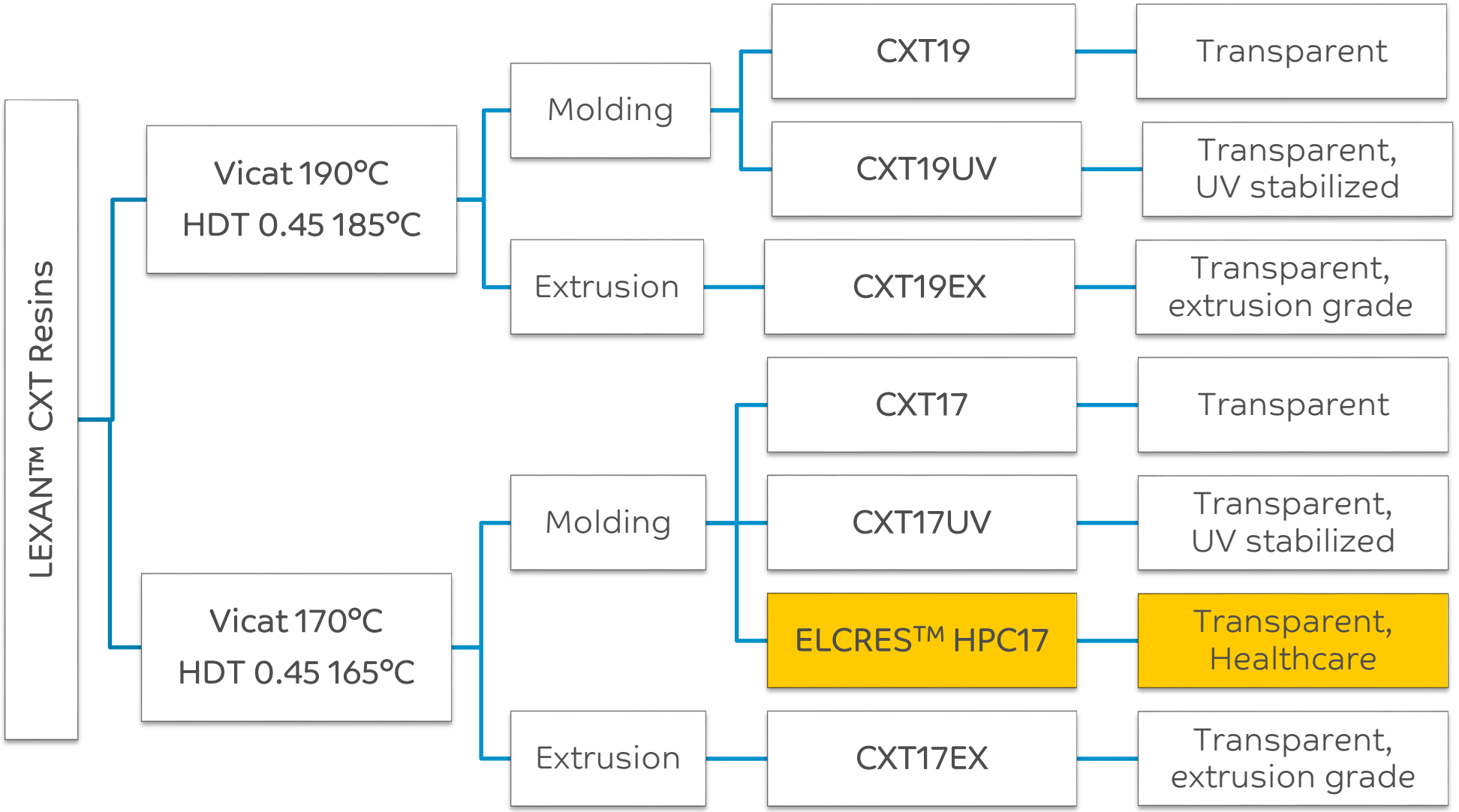
- High heat resistance (Tg 155-175°C
- Excellent notched and practical impact
- Good hydrolytic stability with impact retention after multiple autoclave sterilization cycles
- Opaque and transparent colors

Potential applications

Appliances, Automotive Lighting, Healthcare, Personal Safety

LEXAN™ CXT RESINS – PRODUCT PORTFOLIO



COMPARISON OF PHYSICAL PROPERTIES OF SELECTED LEXAN™ XHT, LEXAN CXT AND LEXAN PPC RESINS

Property	Standard	Unit	LEXAN XHT RESINS		LEXAN CXT RESINS			LEXAN PPC RESINS
			XHT3143T	XHT4143	CXT17UV	HPC17	CXT19UV	HPH4504H
Flexural Modulus	ISO 178	MPa	2500	2600	2500	2500	2550	2100
Flexural Strength	ISO 178	MPa	80	80	110	110	120	65
Tensile Modulus	ISO 527	MPa	2500	2750	2450	2450	2500	2250
Tensile Strength	ISO 527	MPa	60	65	60	60	65	65
Elongation to Break	ISO 527	%	70	> 50	> 50	> 50	> 25	> 50
Charpy Notched Impact	ISO 179	kJ/m^2	10	10	10	10	9	60
Charpy Un-notched Impact	ISO 179	kJ/m^2	NB	NB	NB	NB	NB	NB
MVR, 330°C, 2.16 kg	ISO1133	cm^3/10 min	30	24	30	30	15	12
HDT 0.45 MPa	ISO 75	°C	164	173	165	165	185	153
HDT 1.8 MPa	ISO 75	°C	152	162	152	152	170	132
Vicat B120	ISO 306	°C	170	180	172	172	190	155
Density	ISO 1183	g/cm^3	1.21	1.21	1.21	1.21	1.22	1.20
Water absorption	ISO 62	%	0.3	0.3	0.3	0.3	0.5	0.3
Shrinkage x-flow	ISO 294-4	%	0.7-0.9	0.6-0.95	0.7-0.95	0.7-0.95	0.7-1.0	0.7-0.8
CTE (-40°C to +40°C)	ISO 11359-2	10^{-4}/°C	60	60	60	60	60	60

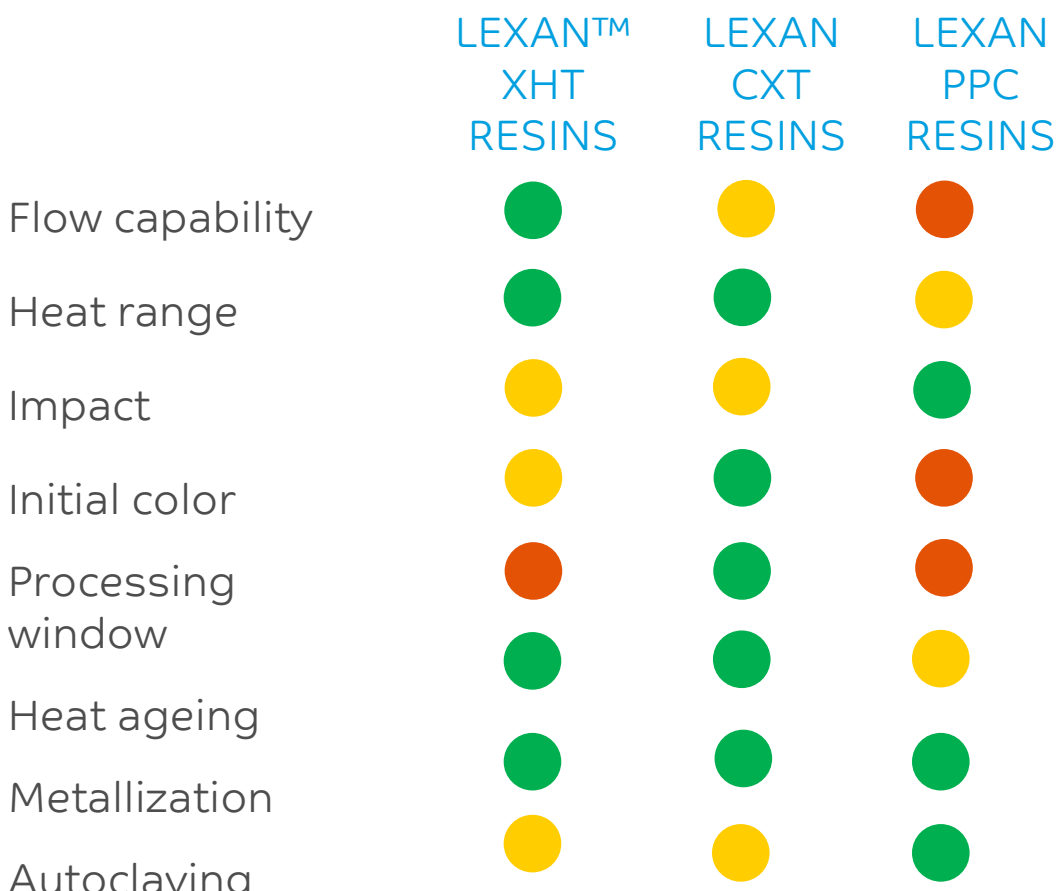
LEXAN CXT resin portfolio offers highest heat resistance amongst LEXAN transparent HH-PC resins

COMPARISON OF OPTICAL PROPERTIES OF SELECTED LEXAN™ XHT, LEXAN CXT AND LEXAN PPC RESINS

Property	Standard	Unit	LEXAN XHT RESINS		LEXAN CXT RESINS			LEXAN RESINS
			XHT3143T NA8E055T	XHT4143 NA5D003T	CXT17UV NA9H019T	HPC17 1H9A3729T	CXT19UV NA9H017T	HPH4504H 1H9D071T
Light transmittance, 1 mm	ASTM D1003	%	> 89	> 88	>89	> 89	> 88	> 87.5
Light transmittance, 2 mm	ASTM D1003	%	> 88	> 87	>88	> 88	> 87	> 85.5
Light transmittance, 3 mm	ASTM D1003	%	> 87	> 86	> 87	> 87	> 86	> 83.5
Transmission at 850 nm, 1 mm	ASTM D1003	%	> 89.5	> 89.5	> 89.5	> 89.5	> 89.5	> 89.5
Transmission at 1310 nm, 1 mm	ASTM D1003	%	> 89.5	> 89.5	> 89.5	> 89.5	> 89.5	> 89.5
Refractive index 589 nm	ISO 489	-	1.601	1.606	1.603	1.603	1.609	1.60
Abbe number	ISO 489	-	30	30	30	30	30	
dn/dT (+23°C-140°C)	ISO 489	10^{-5}/°C	-12	-12	-12	-12	-12	
Target L-value at 2.54 mm	ASTM E308-08	-	94.68*	93.56	94.69	95.18	94.37	93.32
Target a-value at 2.54 mm	D65 illuminant	-	-0.66*	-0.70	-0.29	-0.50	-0.60	0.08
Target b-value at 2.54 mm	10° observer	-	1.24*	0.04	0.90	0.64	1.23	-1.20

*Value at 3.175 mm

OVERALL COMPARISON OF OUR HIGH HEAT POLYCARBONATE COPOLYMER RESINS



LEXAN CXT resins:

When high heat is needed plus ..

- Transparency and crystal-clear color
- Limited color shift under demanding molding conditions
- Good processability in broad processing window
- Healthcare approvals with limited autoclave sterilization

LEXAN PPC resins:

When high heat is needed plus ..

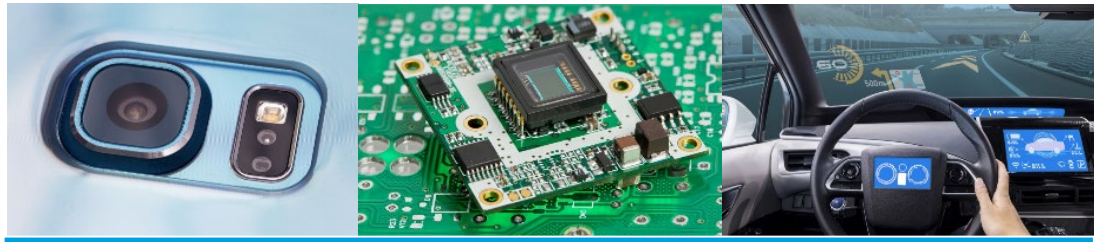
- Excellent hydrolytic stability
- Property retention after repeated autoclave sterilization
- Best-in-class impact

LEXAN XHT resins:

When high heat is needed plus ..

- Standard opaque colors and good processability
- Highest possible flow (High Flow XHTx171 portfolio)

POTENTIAL APPLICATION SPACES FOR LEXAN™ CXT RESINS



Lenses (Flash, Camera, Sensors)

LEXAN CXT resins offer high heat resistance for secondary operations (like low temperature or wave soldering), high transmission at required wavelengths (visible and/or IR) & good flow capability for high precision molding of complex, large, thin and/or textured lenses.

Films

LEXAN CXT17EX and CXT19EX resins are optimized for efficient production of films via extrusion, and offer high heat resistance (for secondary operations and/or part performance) and good optical performance (high transmission and low retardation).

Lighting covers and lenses

LEXAN CXT resins offer high heat resistance for use in demanding operation conditions without functionality loss, low color (stable during part production and lifetime), and good flow capability to allow cost-efficient part production.

Healthcare

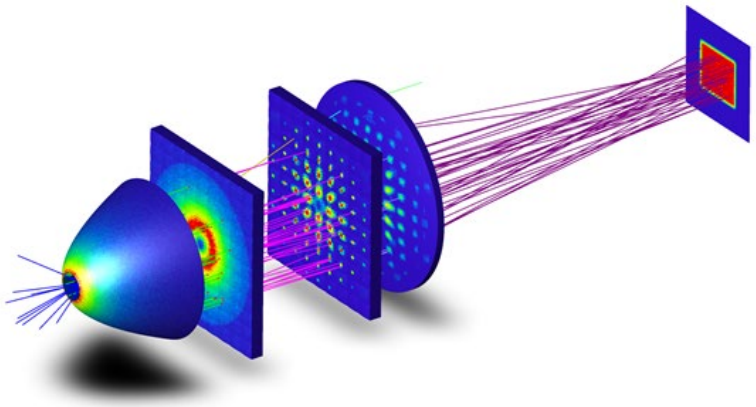
ELCRES™ HPC17 resin for Healthcare applications (FDA, Bio-C approved) offers similar benefits in high heat and low color as other SABIC ™ CXT resins to allow production of parts for Healthcare applications that require high heat resistance in part production and/or part operation.

OPTICAL AND ENGINEERING DATA AVAILABLE

Zemax OpticStudio®

Data packages ready to start design and simulation

Aiding designers in selecting the right material for their application, SABIC has added the thermo-optical resins in the materials database of the Zemax OpticStudio®, the industry-standard in software for designing optical systems.



FEATURES AND POTENTIAL BENEFITS

FEATURES AND BENEFITS OF LEXAN™ CXT RESINS

FEATURES

HIGH HEAT + OPTICAL + HIGH FLOW

BENEFITS

- Assembly via (cold) soldering without distortion
- Over-molding with second resin
- Performance retention during part life time

- Optimal light transmission
- Consistent & stable optical properties
- Design freedom for optical performance

- Enhanced freedom in tool design
- Cost & time efficient molding processes
- Lower reject rates & defects

Improved productivity and/or lower system cost while retaining quality

POTENTIAL BENEFITS OF USING LEXAN™ CXT RESINS IN DIFFERENT STEPS OF PART PRODUCTION AND OPERATION

PART PRODUCTION

- High flow capability of LEXAN CXT resins in broad processing window to provide potential benefits in cost efficiency, part design freedom, lower reject rates, cycle time reduction
- Potential for over-molding with liquid silicone resins (LSR) at higher temperatures than standard PC resins without part distortion for cycle time and system cost reduction

SECONDARY OPERATIONS

- Potential to apply surface layers (coating, ink, metallization) at higher temperatures for cycle time and system cost reduction

PART ASSEMBLY

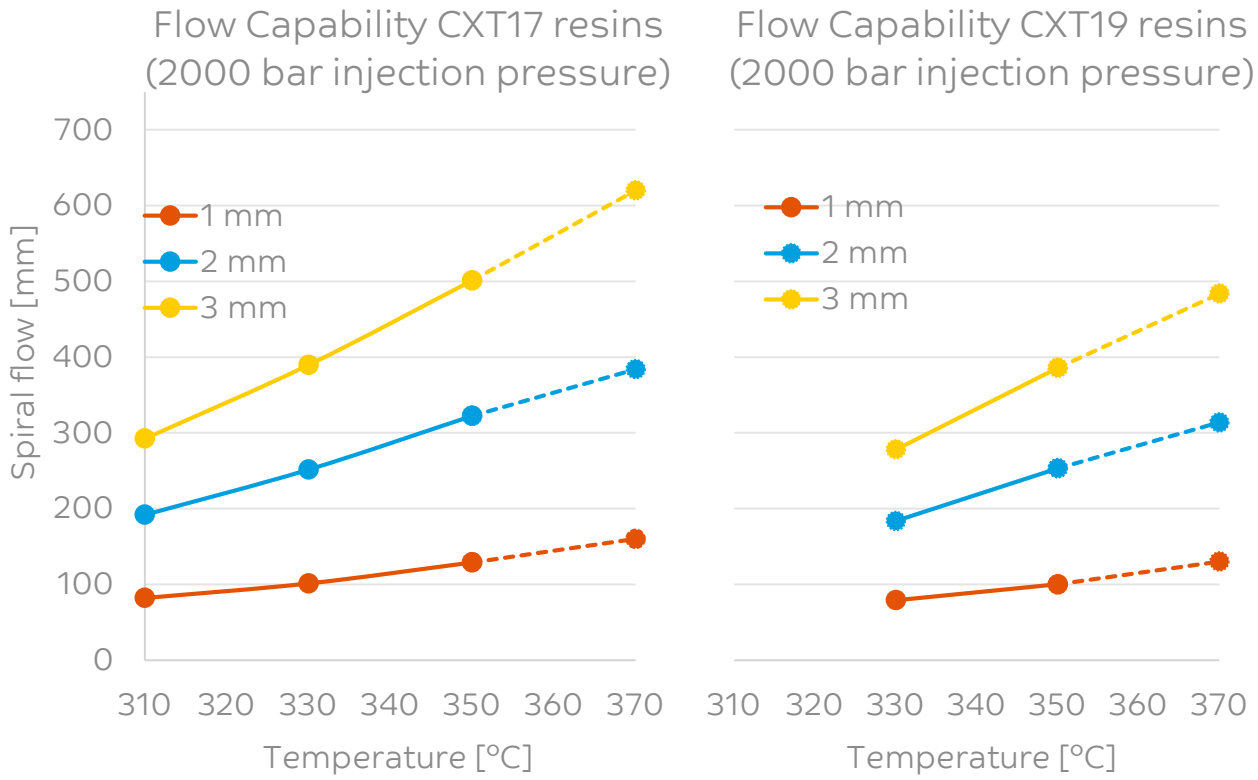
- Potential for part assembly with low temperature soldering processes without part deformation
- Potential to connect parts with UV-curing adhesives with CXT17, HPC17 and CXT19 resins

PART USE/OPERATION

- Potential for closer proximity of parts to light source with limited part deformation and/or discoloration to serve miniaturization trends
- Potential for limited autoclave sterilization cycles in medical applications with HPC17 resin

FLOW CAPABILITY OF LEXAN™ CXT RESINS

LEXAN CXT Resins can offer high practical flow in recommended processing window
High melt temperature can boost practical flow of LEXAN CXT resins in case of complex geometries, long path lengths and/or high L/T ratios.



PREPARATION

Proper drying (4-6 hours at 135°C) of LEXAN CXT resins and machine cleaning is key to minimize aesthetic defects and yield losses in molding.

MOLD TEMPERATURE

High mold temperatures close to Vicat temperature are recommended to minimize molded-in stress and to (if relevant) properly transfer textures.

RESIDENCE TIME

Long residence times (>10 min) should be avoided to prevent material degradation and excessive yellowing.

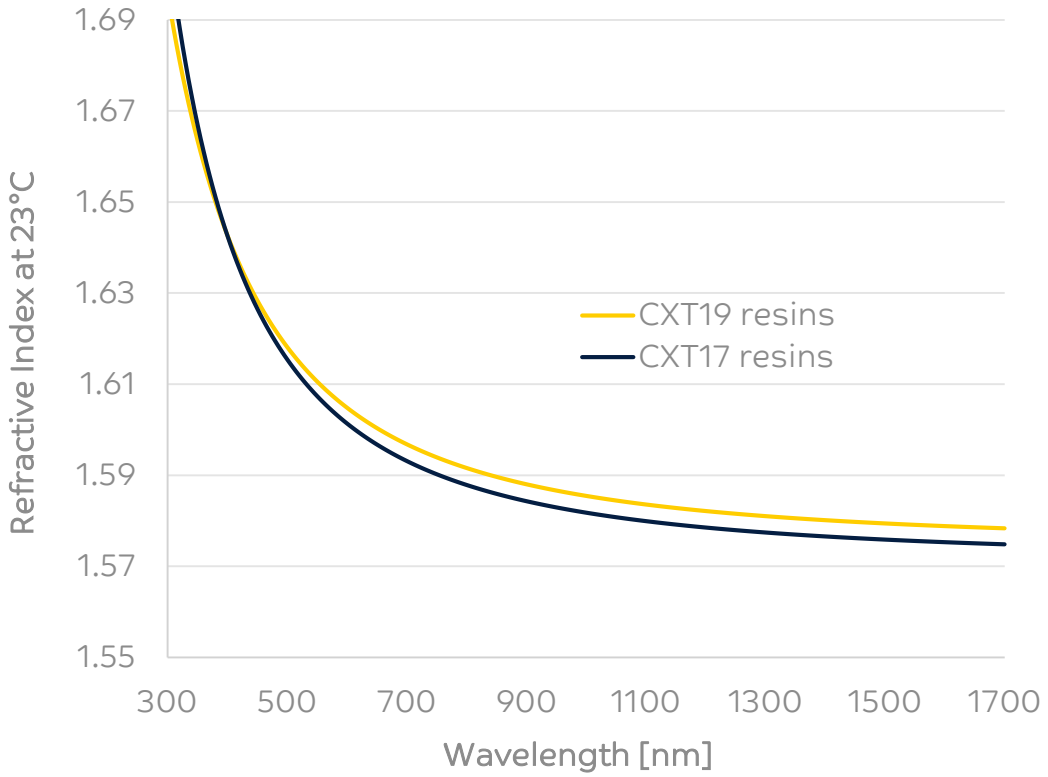
MELT TEMPERATURE

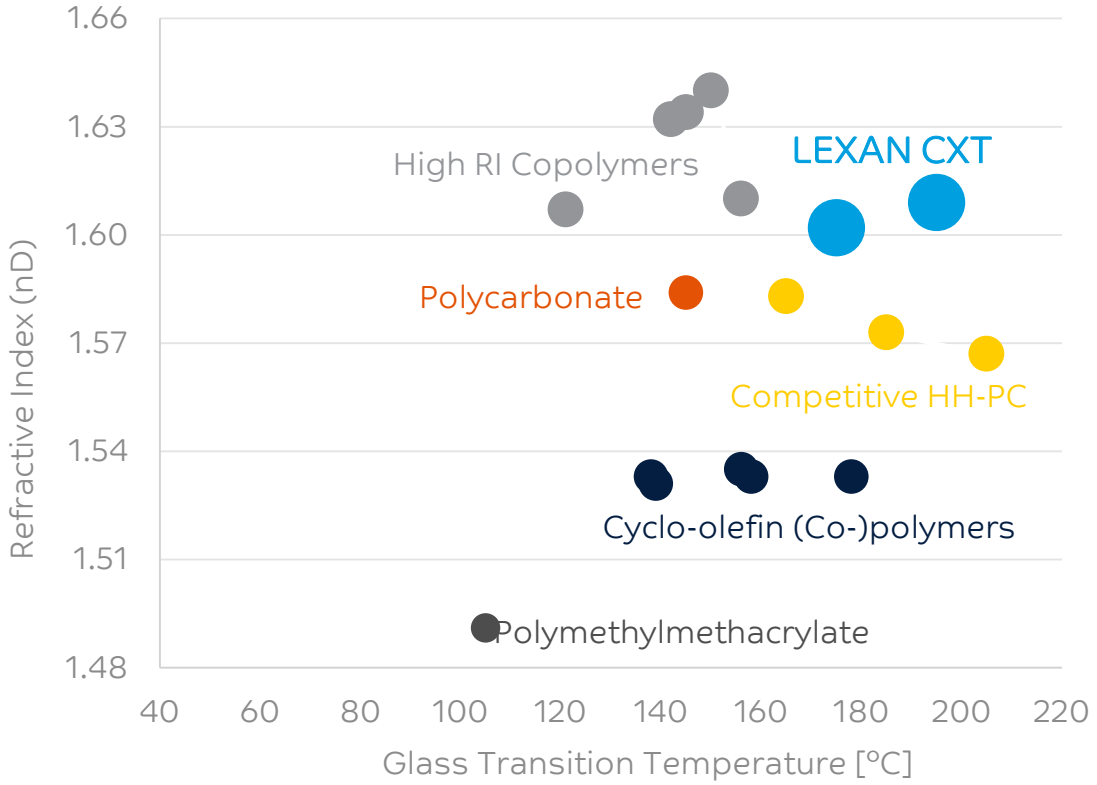
Recommended maximum melt temperature is 355°C, though higher temperatures can potentially be used under optimized machine and conditions (e.g. limited shear stresses and short cycle times).

Spiral flow performance of LEXAN CXT resins is shown within the recommended processing window (solid lines) and beyond (dotted line).

COMPARISON OF LEXAN™ CXT RESINS WITH TRANSPARENT THERMOPLASTIC RESINS

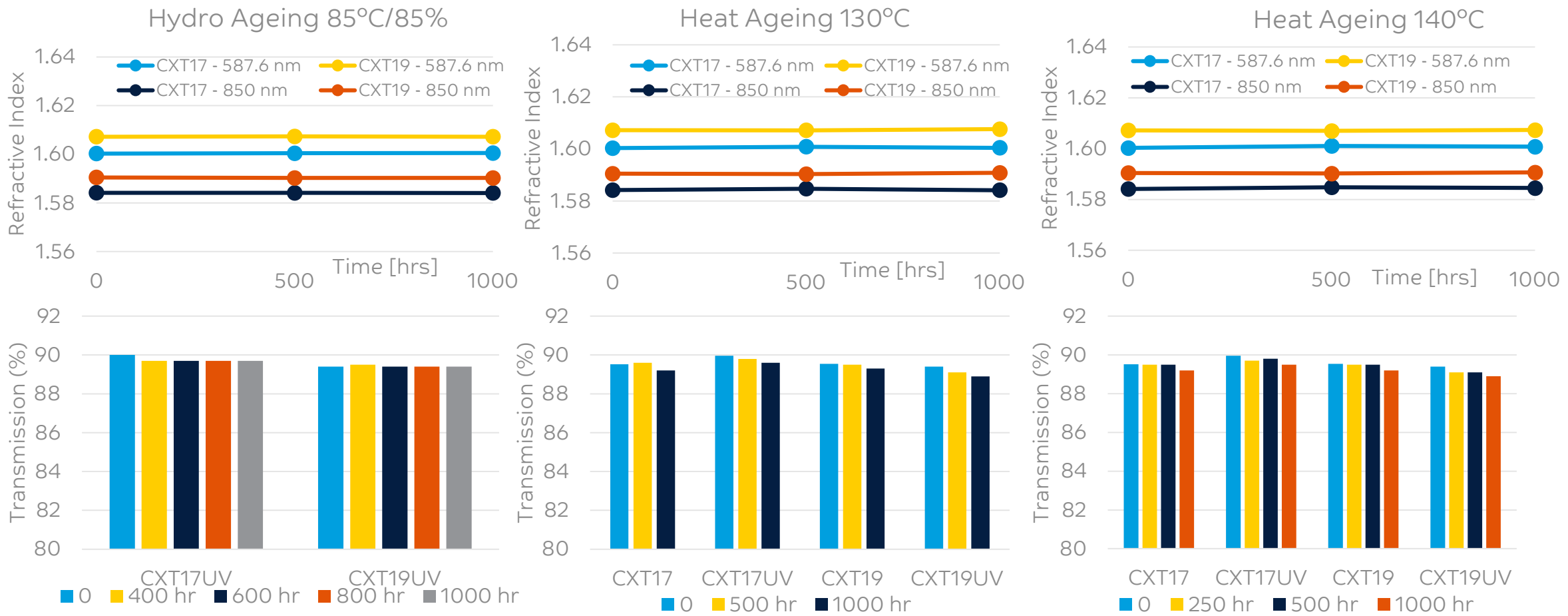
LEXAN CXT Resins can offer a unique balance of high heat and high refractive index amongst crystal clear thermoplastic resins. This may offer potential for thinner lens designs with associated lower weight and higher transmission





OPTICAL PROPERTY RETENTION FOR LEXAN™ CXT RESINS AFTER HEAT AND HYDRO AGEING

LEXAN CXT resins maintain optical properties well after prolonged hydro and heat ageing. This potentially extends their lifetime in parts and applications where prolonged exposure to heat and moisture is applicable



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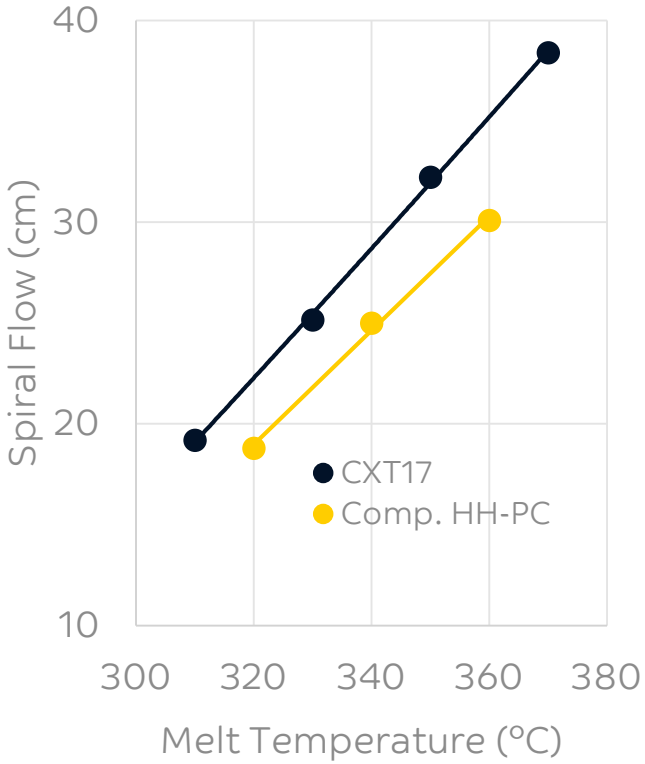
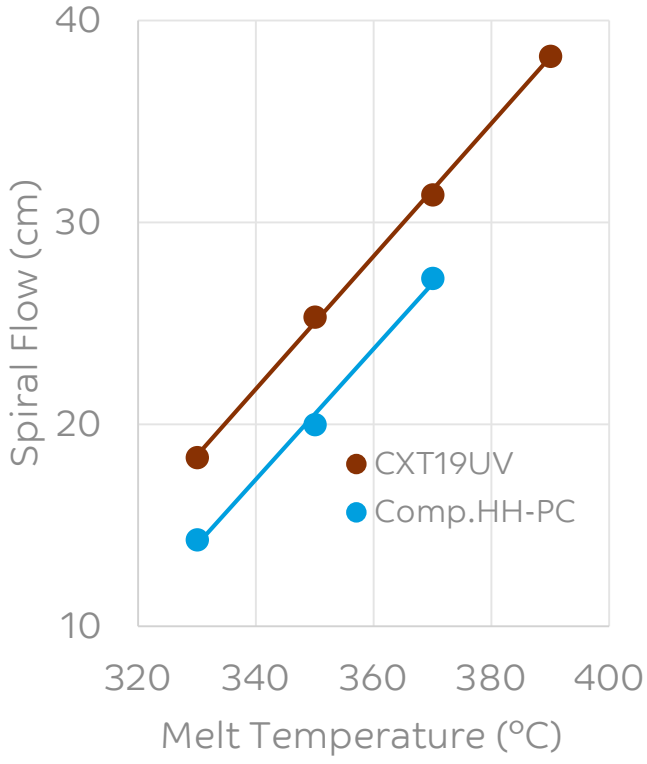
COMPARISON OF LEXAN™ CXT RESINS TO OTHER PRODUCT EQUIVALENTS HIGH HEAT POLYCARBONATE COPOLYMER RESINS

	Other product equivalents HH-PC RESINS	LEXAN CXT RESINS
Flow capability		
Impact		
Initial color		
Processing window		
Heat ageing		
Metallization		
Molded-in stress		
Hydro & Weathering		
High refractive index		

LEXAN CXT resins offer **HIGHER PRACTICAL FLOW** at same melt temperatures when compared to other product equivalents high-heat PC resins of similar heat resistance, potentially offering benefits in productivity in injection molding



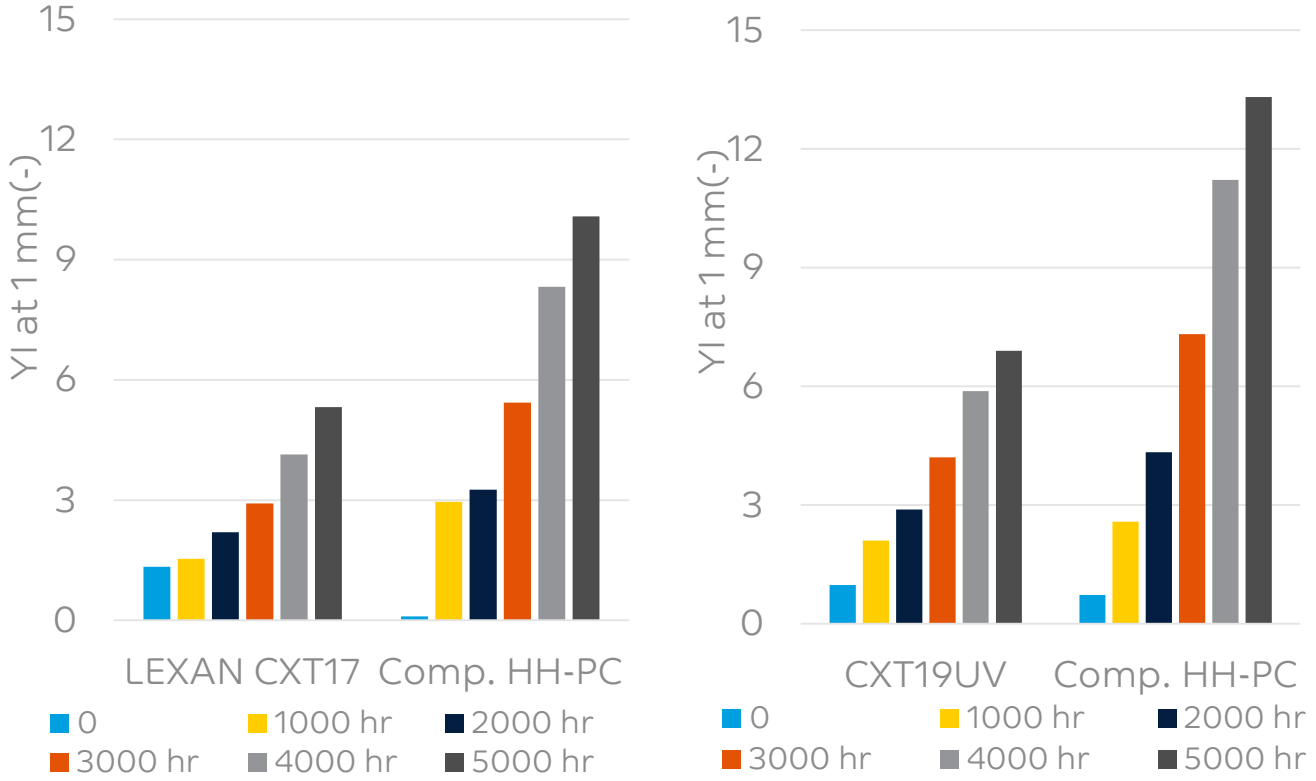


Comparative data generated for LEXAN CXT and other product equivalents HH-PC resins in SABIC labs.
Spiral flow measured at mold temperature of 130°C, 2 mm thickness, 25 cm^3/s injection speed and 2000 bar injection pressure.

COMPARISON OF LEXAN™ CXT RESINS TO OTHER PRODUCT EQUIVALENTS HIGH HEAT POLYCARBONATE COPOLYMER RESINS

	Other product equivalents HH-PC RESINS	LEXAN CXT RESINS
Flow capability		
Impact		
Initial color		
Processing window		
Heat ageing		
Metallization		
Molded-in stress		
Hydro & Weathering		
High refractive index		

LEXAN CXT resins offer **REDUCED YELLOWING** after prolonged exposure to high temperatures when compared to other product equivalents high-heat PC resins of similar heat resistance, potentially offering benefits in part lifetime and/or design freedom.

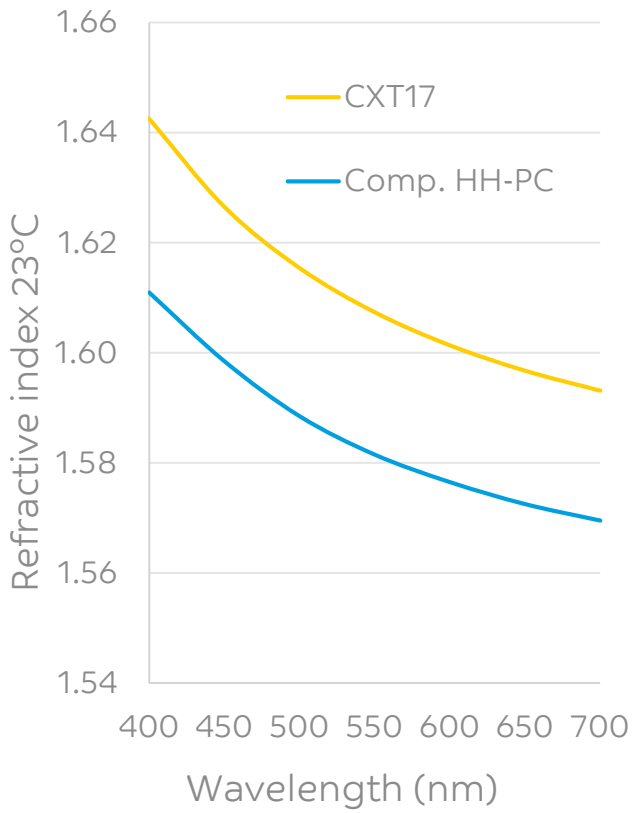


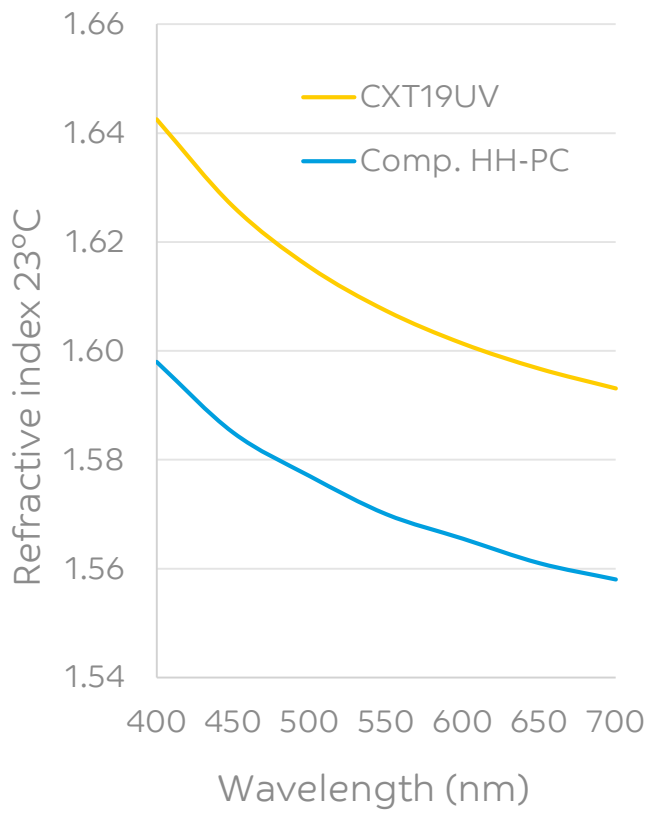
Comparative data generated for LEXAN CXT and other product equivalents HH-PC resins in SABIC labs.

COMPARISON OF LEXAN™ CXT RESINS TO OTHER PRODUCT EQUIVALENTS HIGH HEAT POLYCARBONATE COPOLYMER RESINS

	Other product equivalents HH-PC RESINS	SABIC CXT RESINS
Flow capability	🟠	🟢
Impact	🟡	🟢
Initial color	🟢	🟢
Processing window	🟢	🟢
Heat ageing	🟠	🟢
Metallization	🟢	🟢
Molded-in stress	🟠	🟡
Hydro & Weathering	🟢	🟡
High refractive index	🟡	🟢

LEXAN CXT resins offer **HIGHER REFRACTIVE INDEX** when compared to competitive high-heat PC resins of similar heat resistance, potentially offering benefits in design freedom.



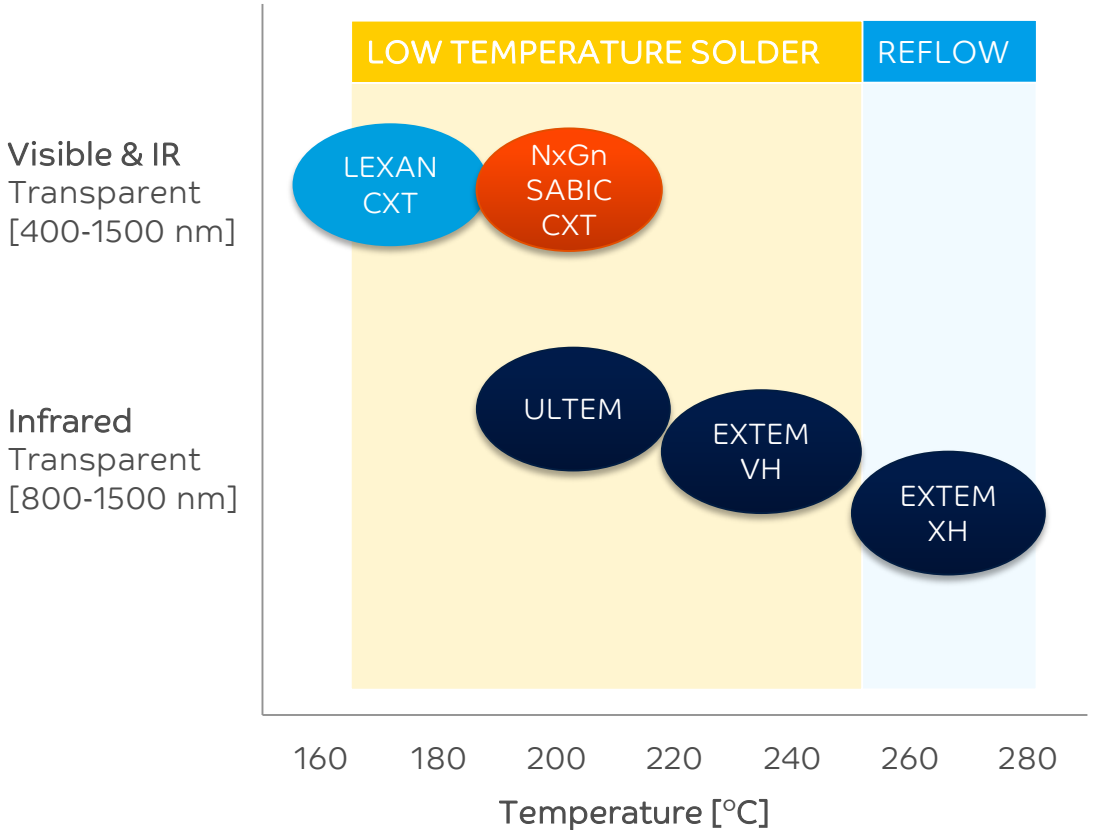


Comparative data generated for LEXAN CXT and other product equivalents HH-PC resins in SABIC labs.

LEXAN™ CXT, ULTEM™ AND EXTEM™ RESINS FOR THERMO-OPTICAL APPLICATIONS

SABIC RESIN RANGE FOR THERMO-OPTICAL APPLICATIONS

SABIC can offer a wide range of solutions for applications that use soldering for mounting of parts and modules onto PCB's. Crystal clear SABIC CXT resins for low temperature soldering, and IR transparent ULTEM™ and EXTEM™ resins for more demanding solder processes, including reflow soldering



LEXAN™ CXT resin:

- High heat (Tg up to 195°C, new development to 215°C)
- Transparent and crystal clear co-polycarbonate resin
- High flow in broad processing window

ULTEM™ resin:

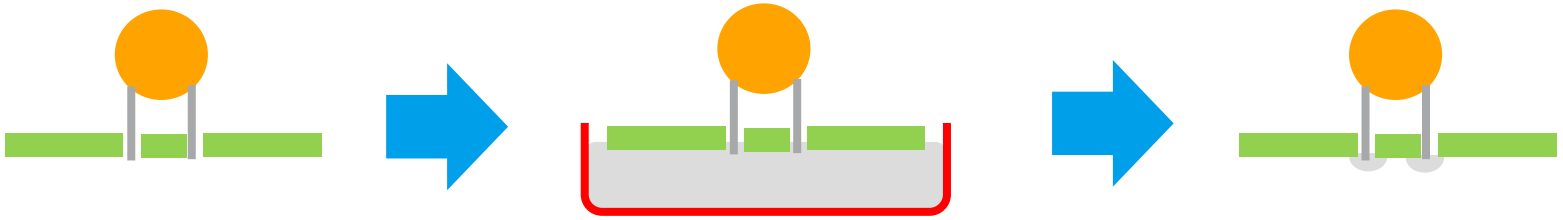
- Higher heat (Tg up to 220°C)
- IR transparent and amber-brown colored resin
- Good flow, high dimensional stability

EXTEM™ resin:

- Ultra heat (Tg up to 267°C)
- IR transparent resin
- Only (IR clear) thermoplastic resin that may withstand standard Reflow Soldering process

SOLDERING METHODS

Wave soldering



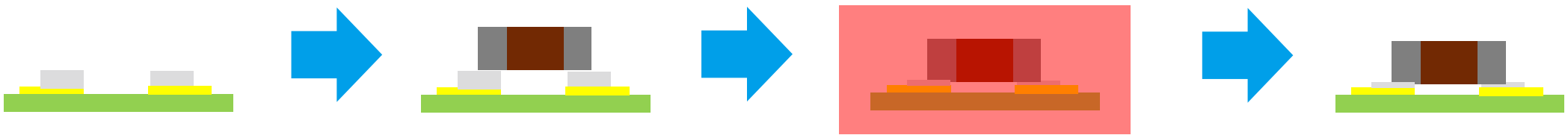
Insert electronics devices into through hole on PCB

Dip PCB into bath with molten solder

Part temperature increases up to peak temperature

Molten solder joints metal wires to PCB

Reflow soldering



Part temperature increases up to peak temp (260°C for Pb-free reflow, lower for cold reflow processes)

Print solder paste on PCB

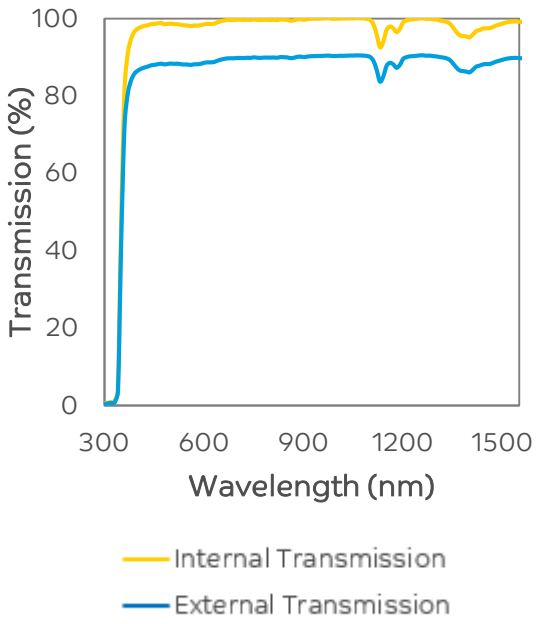
Mount electronics devices on PCB

Heat in reflow oven

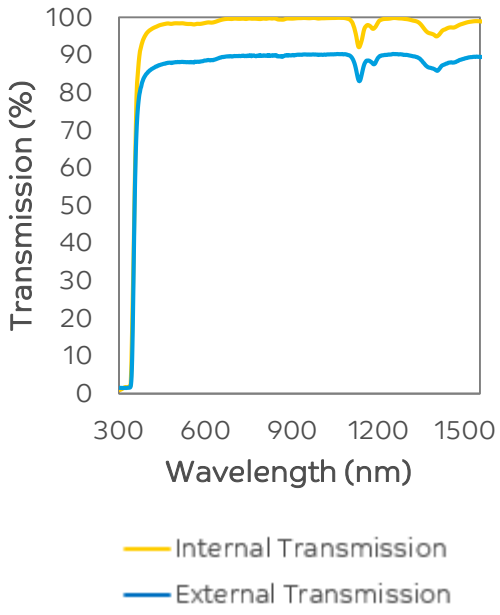
Molten solder and terminal electrode are joined

COMPARISON OF TRANSMISSION CURVES FOR LEXAN™ CXT, ULTEM™ AND EXTEM™ RESINS

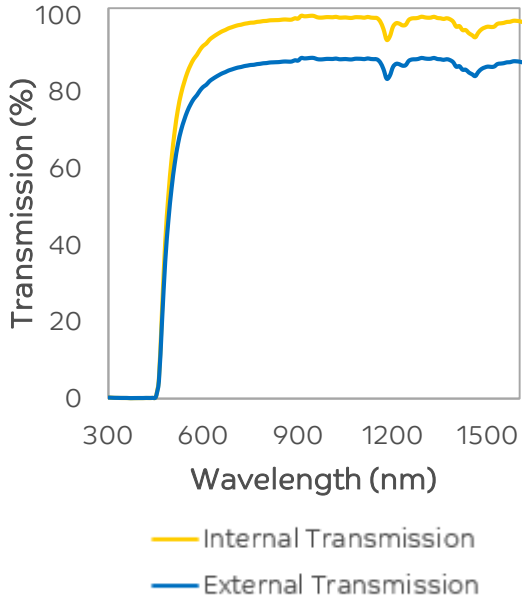
LEXAN CXT17 (Tg 175°C)



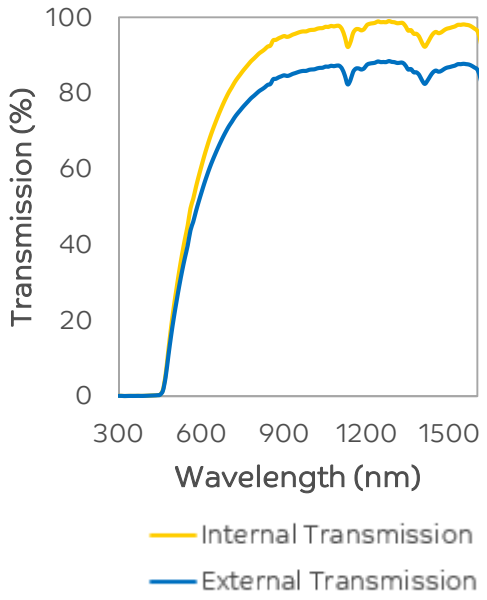
LEXAN CXT19 (Tg 195°C)



ULTEM 1010 (Tg 217°C)



EXTEM XH1015 (Tg 267°C)



- LEXAN CXT resins offer high external transmission in VIS (300-700 nm) and IR (700-1500 nm) range
- ULTEM and EXTEM resins offer high external transmission in IR (700-1500 nm) range
- Effective transmission can be increased towards internal transmission via Anti-Reflective Coatings

PHYSICAL AND OPTICAL PROPERTIES
LEXAN™ CXT RESIN, ULTEM™ RESIN AND EXTEM™ RESIN

Property	Standard	Unit	Typical PMMA resin	Typical PC resin	Typical COP resin	LEXAN CXT17 resin	LEXAN CXT19 resin	ULTEM DT1810EV resin	ULTEM 1010 resin	EXTEM XH1015 resin
Flexural Modulus	ISO 178	MPa	3100	2300	2300	2500	2550	3100	3300	2870
Flexural Strength	ISO 178	MPa	100	95	95-105	110	120	120	160	120
HDT, 0.45 MPa	ISO 75	^{o}C	95-115	135	140	165	185	190	207	250
Vicat B120	ISO 306	^{o}C	100-120	143	145	172	190	195	212	260
Density	ISO 1183	g/cm^{3}	1.16-1.19	1.2-1.25	0.95-1.01	1.21	1.22	1.28	1.27	1.31
CTE (-40 to150^{o}C)	ISO 11359	10^{-4}/^{o}C	67	60-70	60-70	60	60	60	55	50
Light transmittance at 1mm	ASTM D1003	%	> 92	> 90	> 92	>89	>88	>85	>83	>52
Light transmittance at 2mm	ASTM D1003	%	> 92	> 89	> 92	>88	>87	>83	>78	>35
Transmission, 1mm, 850nm	ASTM D1003	%	> 92	> 90	> 92	>89.5	>89.5	>88.5	>88.0	>84.5
Transmission, 1mm, 1310nm	ASTM D1003	%	> 92	> 90	> 92	>89.5	>89.5	>89	>88.5	>87.5
Refractive index (n_D, 589 nm)	ISO 489	-	1.492	1.585	1.537	1.603	1.609	1.655	1.662	1.657
Abbe number	ISO 489	-	55-57	30	56	30	30	21	21	18
dn/dT (+23^{o}C-140^{o}C)	ISO 489	10^{-5}/^{o}C	-8.5	-12 to -14	-8	-12	-12	-11	-11	-11

Unique balance of high heat, high transmission in visible and/or infrared region, and high refractive index for SABIC's thermo-optical resin portfolio vs. typical optical thermoplastic solutions

Typical optical resin data (PMMA, PC, COP) taken from supplier websites

NEW DEVELOPMENTS – ELCRES™ HPC17 RESIN

ELCRES™ HPC17 RESIN: THE CHALLENGE TO SOLVE

APPLICATIONS

Medical parts made from transparent thermoplastic resins over-molded with Liquid Silicone Resin (LSR) to create soft-touch (e.g. respiratory masks, housings, cartridges)

CUSTOMER CHALLENGE

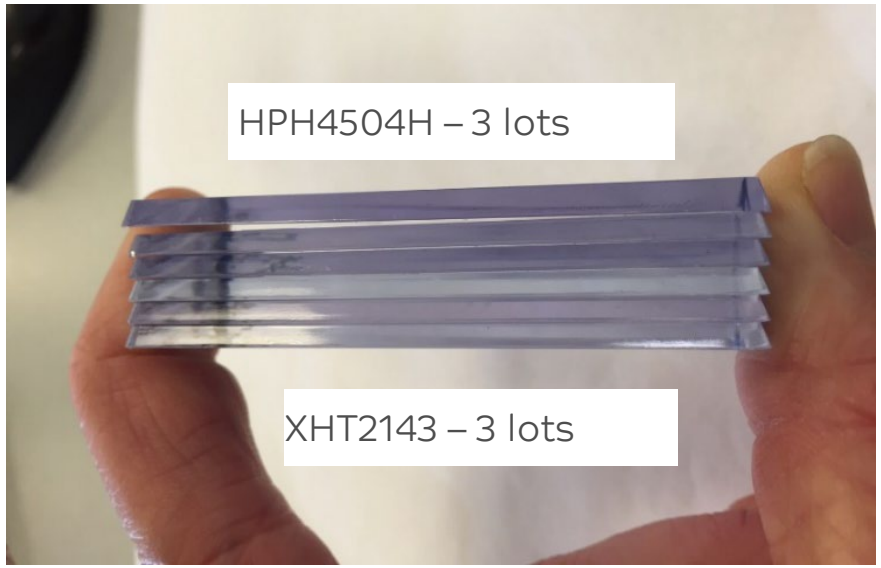
Cycle times to cure LSR resin onto standard PC parts are too long (> 2 min) for cost efficient part production due to the low cure temperature which is needed in order to prevent part deformation in over-molding step

There is a need for water-clear high heat resin solutions with necessary healthcare approvals (FDA-approved, Bio-Compatible) that allow easy processing without yellowing

ELCRES™ HPC17 RESIN: APPROACH TO DESIGN A NEW MATERIAL SOLUTION

PERFORMANCE OF EXISTING SOLUTIONS

Existing high-heat PC-Copolymer solutions from SABIC (XHT and HPH resins) are relatively blue tinted



APPROACH TOWARDS IMPROVED SOLUTION

Change composition of new SABIC CXT resin using only FDA approved additive package, without compromising color stability of CXT resins

NEW DEVELOPMENT: INTRODUCING ELCRES™ HPC17 RESIN

ELCRES HPC17 resin (experimental grade SABIC ER007513 resin) is an excellent candidate for Healthcare applications that require crystal clear transparency and high heat performance for e.g. secondary operations

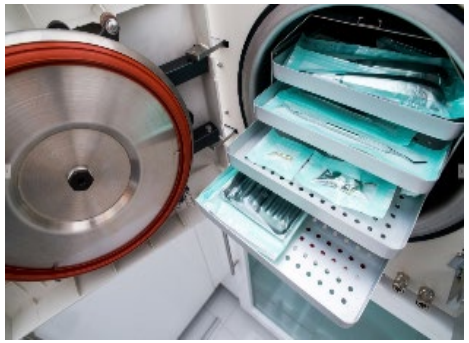
Key features of ELCRES HPC17 resin are:

- High heat with Vicat B120 of 170°C
- High Flow (MVR of 30 g/cm^3 at 330°C/2.16 kg)
- Healthcare approvals in place (FDA, Bio-Compatibility)
- Crystal clear color
- Broad processing window without discoloration
- Ability to survive limited autoclave sterilization cycles

Potential benefits for customers:

- Thin wall designs, reducing part weight
- Improved productivity and yield
- Processing benefits (melt temperature or cycle times)
- Cost and time-efficient secondary operations

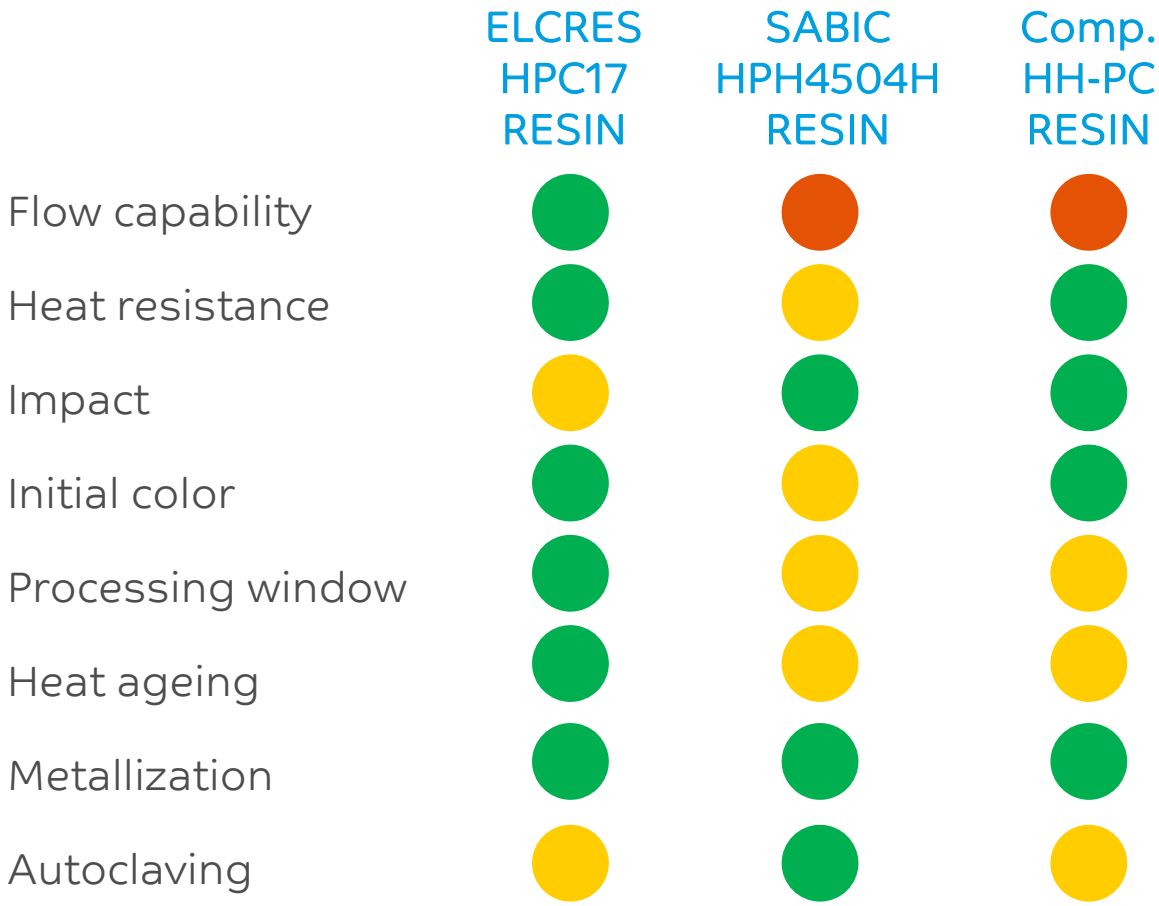
ELCRES HPC17 resin is a potential solution for applications requiring high heat and water-clear color, such as respiratory masks



SABIC HPH4504H resin is a potential solution for applications requiring multiple autoclave sterilization cycles

OVERALL COMPARISON OF ELCRES™ HPC17 RESIN AND ALTERNATIVE HIGH-HEAT POLYCARBONATE COPOLYMER RESINS FOR HEALTHCARE

ELCRES HPC17 resin (experimental grade SABIC ER007513 resin) offers a differentiated performance compared to SABIC HPH4504H resin with its crystal clear transparency, high heat resistance and excellent flow capability.



Potential SABIC High-heat Polycarbonate Copolymer solutions for Healthcare applications:

ELCRES HPC17 resin:

When high heat is needed plus ..

- Transparency and crystal-clear color
- Low color shift under demanding molding conditions
- Good processability in broad processing window
- Ability to survive limited autoclave sterilization

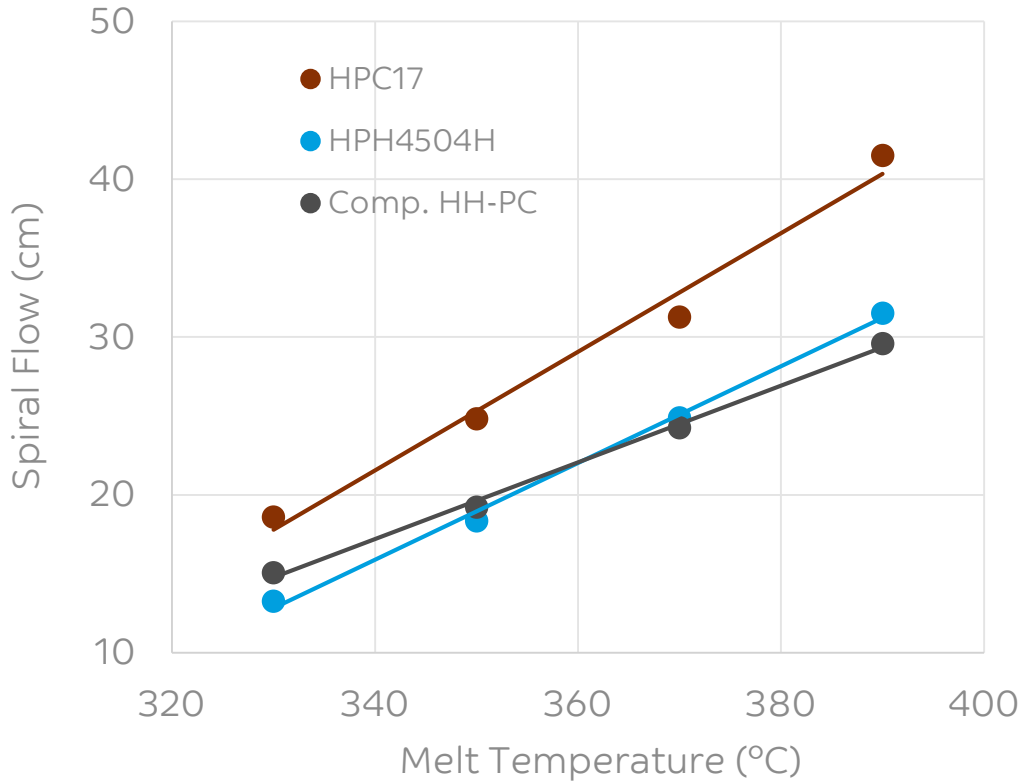
SABIC HPH4504H resin:

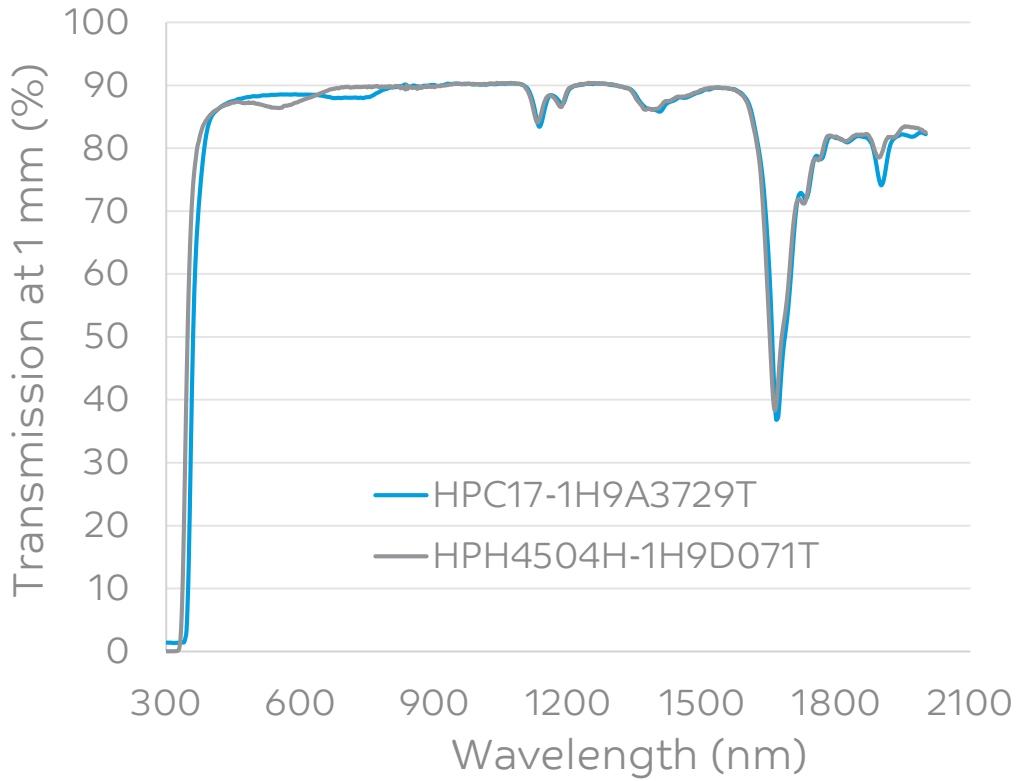
When high heat is needed plus ..

- Stability vs extensive autoclave sterilization cycles
- Best-in-class impact

FLOW CAPABILITY OF ELCRES™ HPC17 RESIN COMPARED TO OTHER HEALTHCARE APPROVED HIGH-HEAT PC COPOLYMER RESINS

ELCRES HPC17 resin has excellent flow capability compared to alternative high-heat polycarbonate copolymer resins, offering potential benefits to produce complex geometries, long path lengths and/or high L/T ratios with low levels of molded-in stress.





Comparative data generated for ELCRES HPC17 and other product equivalents HH-PC resins in SABIC labs.
Spiral flow measured at mold temperature of 130°C, 2 mm thickness, 25 cm^3/s injection speed and 2000 bar injection pressure.

DATASHEET PROPERTIES OF ELCRES™ HPC17 RESIN COMPARED TO OTHER HEALTHCARE APPROVED HIGH-HEAT PC COPOLYMER RESINS

Property	Standard	Unit	ELCRES HPC17 resin	LEXAN™ HPH4504H resin	Comp. HH-PC resin
Tensile Modulus	ISO 527	MPa	2450	2250	2400
Tensile Strength	ISO 527	MPa	60	65	70
Elongation to Break	ISO 527	%	> 50	> 50	> 50
Charpy Notched Impact	ISO 179	kJ/m^2	10	60	60
Charpy Un-notched Impact	ISO 179	kJ/m^2	NB	NB	NB
MVR, 330°C, 2.16 kg	ISO1133	cm^3/10 min	30	12	17
HDT 0.45 MPa	ISO 75	°C	165	153	160
HDT 1.8 MPa	ISO 75	°C	152	132	148
Vicat B120	ISO 306	°C	172	155	170
Density	ISO 1183	g/cm^3	1.21	1.20	1.17
Water absorption	ISO 62	%	0.3	0.3	0.3
CTE (-40°C to +150°C)	ISO11359-2	10^{-4}/°C	60	60	65
Light transmission 1 mm	ASTM D1002	%	> 90	> 88	> 90
Refractive index D-line	ISO 489	-	1.603	1.60	1.578

ELCRES HPC17 resin offers differentiated balance of flow, heat and optical properties vs alternative HH-PC resins

CHEMICAL RESISTANCE OF ELCRES™ HPC17 AND LEXAN CXT19 RESINS AGAINST TYPICAL HEALTHCARE CLEANING AGENTS

1% strain at room temperature for 7 days. Yield stress (s_y) and elongation to break (e_b) retention per ASTM D638 PRODUCT	Exposure time (days)	SANI-CLOTH Bleach σ_y ε_b	SANI-CLOTH HB σ_y ε_b	SANI-CLOTH AF 3 σ_y ε_b	SANI-CLOTH plus σ_y ε_b	Diversey Oxivir® TB σ_y ε_b	Trichlorosocynuric Acid σ_y ε_b	Cavicide 1 σ_y ε_b	SANI-CLOTH prime σ_y ε_b	Virex® II 256 σ_y ε_b	Virex® TB σ_y ε_b	CIDEX® OPA Solution σ_y ε_b	Betadine σ_y ε_b	IPA (70%) σ_y ε_b	Ethanol σ_y ε_b
XYLEX HX8300HP	7	● ■	● ■	■ ■	● ■	● ●	● ●	▲ ■	● ■	● ■	■ ■				
ELCRES HPC17	7	■ ■	● ●	■ ■	■ ■	■ ■	● ●	● ●	● ■	■ ■	■ ■	■ ■	● ■	● ●	● ■
SABIC EXL9330	7	● ●	▲ ■	■ ■	● ●	● ●	● ●	■ ■	● ●	● ■	■ ■	● ■	● ●	● ▲	● ●
SABIC CXT19	7	● ●	■ ▲	● ●	● ●	● ●	● ■	● ▲	● ●	■ ■	■ ■	● ●	● ■	● ●	● ■

ELCRES™ HPC17 performs quite similar to typical XYLEX grades in property retention after chemical exposure, but proper cleaning agent selection is critical for part longevity

Color rating	Yield stress (YS) Retention (%)	Elongation at break (EB) retention (%)
Compatible	> 90	80 – 139
Marginal	80 – 89	65 – 79
Not compatible	< 79	< 64 or > 140

Data are indicative and intended as reference only. Customers are fully responsible for testing the performance of the SABIC material in the end application and checking whether the properties of these grades are meeting their application requirements.

AUTOCLAVE STERILIZATION OF HIGH HEAT POLYCARBONATE COPOLYMER RESINS

AUTOCLAVE STERILIZATION

Sterilization with saturated steam under pressure to prevent infections by micro-organisms in hospital environment.

ELCRES™ HPC17 resin can maintain impact properties after limited numbers of cycles, similar to other product equivalents HH-PC resins, and is a potential candidate for single-use applications and/or with limited sterilization cycles.

HPH4504H resin outperforms both HPC17 and competitive HH-PC resins, and is a potential solution for transparent application requiring extensive autoclave sterilization cycles.

Property	ELCRES HPC17 resin	LEXAN™ HPH4504H resin	Comp. HH-PC resin
Autoclaving at 121°C			
Optical retention*	> 150	> 150	> 150
Impact retention*	< 50	> 150	< 50
Autoclaving at 134°C			
Optical retention*	> 150	> 150	> 150
Impact retention*	< 5	> 150	< 5

**Performance is measured based on number of cycles (30 min at 121°C or 20 min at 134°C) at given sterilization temperature without significant loss in optical (transmission, color) or impact properties. Data are indicative only, and the actual number of cycles depends on design, actual sterilization conditions and pass/fail criteria.*

ECLRES™ HPC17 RESIN REGULATORY DATA

COMPLIANCE WITH:

- Biocompatibility assessed (according to ISO 10993 or USP Class VI): Data available via Type I or Type II letters
- Food contact compliance according FDA and/or EU Reg. No. 10/2011
- FDA Drug Master File and/or Device Master File listing
  (letter of authorization provided as needed)
- Subject to formula lock and stringent management of change process. SABIC healthcare materials are being manufactured under GMP conditions (No.2023/2006 (Commission Regulation EC, 22 December 2006) or FDA 21CFR174.5)).

SABIC does not support applications which remain implanted beyond 29 days and does not support the use of its materials in medical applications intended for temporary or permanent implementation in the human body.

CONCLUSION AND CONTACT DETAILS

CONCLUSION: FEATURES AND POTENTIAL BENEFITS OF LEXAN™ CXT RESINS

FEATURES

HIGH HEAT + OPTICAL + HIGH FLOW

POTENTIAL BENEFITS

Assembly via (cold) soldering without distortion

Over-molding with second resin

Performance retention during part life time

Optimal light transmission

Consistent & stable optical properties

Design freedom for optical performance

Enhanced freedom in tool design

Cost & time efficient molding processes

Lower reject rates & defects

Improved productivity and/or lower system cost while retaining quality

CONTACT DETAILS: LNP™ COMPOUNDS & SABIC COPOLYMER SOLUTIONS

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OPTICAL CONSTANTS FOR LEXAN™ CXT RESINS

OPTICAL CONSTANTS FOR LEXAN™ CXT17 RESIN NOW ALSO AVAILABLE IN ZEMAX® OPTICAL DESIGN SOFTWARE

Refractive Index
n_d = 1.603
Abbe Number
ν_d = 27.5
Density
1.21 g/cm^3
$\Delta P_{g,F}$
-0.0342
CTE
6.5E-05 1/°C (-30 to 70 °C)

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	0.59903
B_2	0.17495
B_3	0.69642
C_1	0.020734
C_2	0.021135
C_3	0.02162

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	$-2.20\cdot10^{-4}$
D_1	$7.51\cdot10^{-7}$
D_2	$-5.60\cdot10^{-9}$
E_o	$-7.32\cdot10^{-5}$
E_1	$9.69\cdot10^{-7}$
λ_{tk}	0.00

Internal Transmittance

λ (nm)	t = 1 mm	λ (nm)	t = 1 mm
300	0.00	900	1.00
340	0.04	920	1.00
380	0.95	940	1.00
420	0.98	960	1.00
460	0.99	980	1.00
500	0.99	1000	1.00
540	0.98	1050	1.00
580	0.98	1100	1.00
620	0.99	1150	0.97
660	1.00	1200	0.99
700	1.00	1250	1.00
740	1.00	1300	1.00
780	1.00	1350	0.98
800	1.00	1400	0.95
820	1.00	1450	0.97
840	1.00	1500	0.99
860	0.99	1550	0.99
880	1.00	1600	0.97

ERCRES CXT17 Resin is a High Heat Polycarbonate Copolymer Resin with Vicat of 170°C and crystal clear transparency. This resin is optimized to have a broad processing window with limited yellowing. It is available in limited transparent colors.

*These constants are valid for a temperature range from 23 °C to 140 °C and from 0.5 to 1.7 µm.
Dispersion formula return a valid refractive index between 0.4 and 1.7 µm.

OPTICAL CONSTANTS FOR LEXAN™ CXT19 RESIN NOW ALSO AVAILABLE IN ZEMAX® OPTICAL DESIGN SOFTWARE

Refractive Index
n_d = 1.609
Abbe Number
v_d = 29.2
Density
1.22 g/cm^3
$\Delta P_{g,F}$
-0.0723
CTE
6.5E-05 1/°C (-30 to 70 °C)

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	0.83301
B_2	0.67356
B_3	-0.024393
C_1	0.021325
C_2	0.022028
C_3	0.07076

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	$-1.94\cdot10^{-4}$
D_1	$3.87\cdot10^{-7}$
D_2	$3.98\cdot10^{-9}$
E_o	$7.46\cdot10^{-5}$
E_1	$-1.59\cdot10^{-6}$
λ_{tk}	0.00

Internal Transmittance

λ (nm)	t = 1 mm	λ (nm)	t = 1 mm
300	0.00	900	1.00
340	0.02	920	1.00
380	0.93	940	1.00
420	0.97	960	1.00
460	0.98	980	1.00
500	0.98	1000	1.00
540	0.98	1050	1.00
580	0.98	1100	0.99
620	0.99	1150	0.97
660	1.00	1200	0.99
700	1.00	1250	1.00
740	1.00	1300	1.00
780	1.00	1350	0.98
800	1.00	1400	0.95
820	1.00	1450	0.97
840	1.00	1500	0.99
860	0.99	1550	0.99
880	1.00	1600	0.96

SABIC CXT19 Resin is a High Heat Polycarbonate Copolymer Resin with Vicat of 170°C and crystal clear transparency. This resin is optimized to have a broad processing window with limited yellowing. It is available in limited transparent colors.

*These constants are valid for a temperature range from 23 °C to 140 °C and from 0.5 to 1.7 µm.

Dispersion formula return a valid refractive index between 0.4 and 1.7 µm.

PHYSICAL PROPERTIES OF COMMERCIAL LEXAN™ CXT RESINS

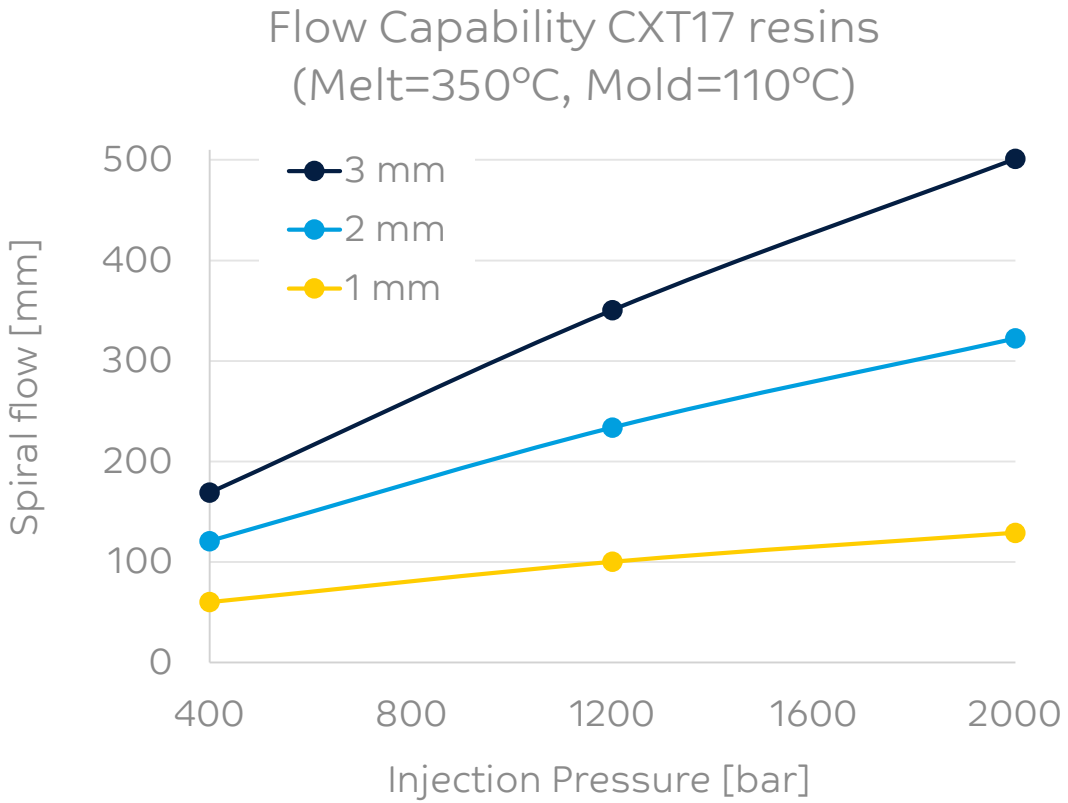
DATASHEET PROPERTIES OF COMMERCIAL LEXAN™ CXT RESINS

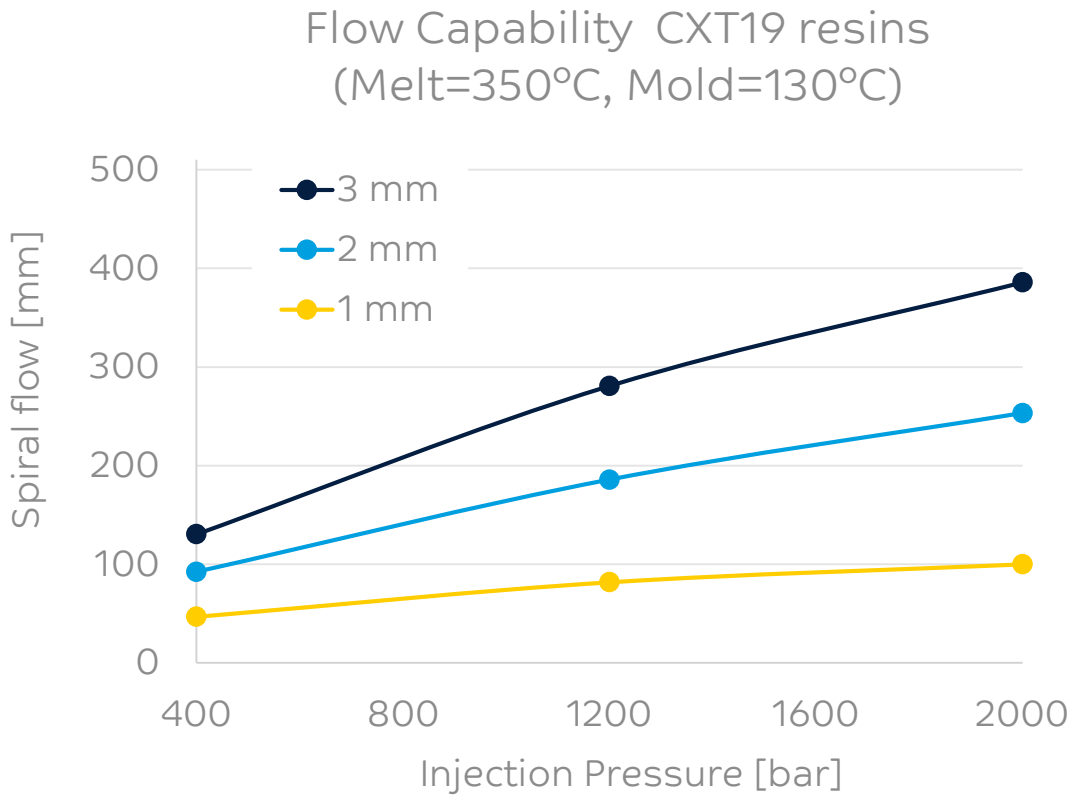
Property	Standard	Unit	LEXAN CXT17 NA9H011T	LEXAN CXT17UV NA9H019T	LEXAN CXT17EX NA9H011T	ELCRES™ HPC17 1H9A3729T	LEXAN CXT19 NA9H014T	LEXAN CXT19UV NA9H017T	LEXAN CXT19EX NA9H015T
Flexural Modulus	ISO 178	MPa	2500	2500	2500	2500	2550	2550	2550
Flexural Strength	ISO 178	MPa	110	110	110	110	120	120	120
Tensile Modulus	ISO 527	MPa	2450	2450	2450	2450	2500	2500	2500
Tensile Strength	ISO 527	MPa	60	60	60	60	65	65	65
Elongation to Break	ISO 527	%	> 50	> 50	> 50	> 50	> 25	> 25	> 25
Charpy Notched Impact	ISO 179	kJ/m^2	10	10	10	10	9	9	9
Charpy Un-notched Impact	ISO 179	kJ/m^2	NB	NB	NB	NB	NB	NB	NB
MVR, 330°C, 2.16 kg	ISO1133	cm^3/10 min	30	30	27	30	15	15	13
HDT 0.45 MPa	ISO 75	°C	165	165	167	165	185	185	187
Vicat B120	ISO 306	°C	172	172	174	172	190	190	192
Density	ISO 1183	g/cm^3	1.21	1.21	1.21	1.21	1.22	1.22	1.22
Water absorption	ISO 62	%	0.3	0.3	0.3	0.3	0.5	0.5	0.5
Shrinkage x-flow	ISO 294-4	%	0.7-0.95	0.7-0.95	0.7-0.95	0.7-0.95	0.7-1.0	0.7-1.0	0.7-1.0
CTE (-40°C to +150°C)	ISO 11359-2	10^{-4}/°C	60	60	60	60	60	60	60
Light Transmittance 1mm	ASTM D1003	%	89	89	89	89	89	89	88
Light Transmittance 2mm	ASTM D1003	%	88	88	88	88	88	88	86
Light Transmittance 3mm	ASTM D1003	%	87	87	87	87	87	86	84
Refractive index (D-line)	ISO489	-	1.603	1.603	1.603	1.603	1.609	1.609	1.609
Abbe number	ISO489	-	30	30	30	30	30	30	30

More extensive property profile for all grades can be found in the respective datasheets on www.sabic.com

FLOW CAPABILITY OF LEXAN™ CXT RESINS – SPIRAL FLOW

LEXAN CXT Resins can offer high practical flow in recommended processing window
Potential to fill large, complex, thin and/or textured parts within machine limitations

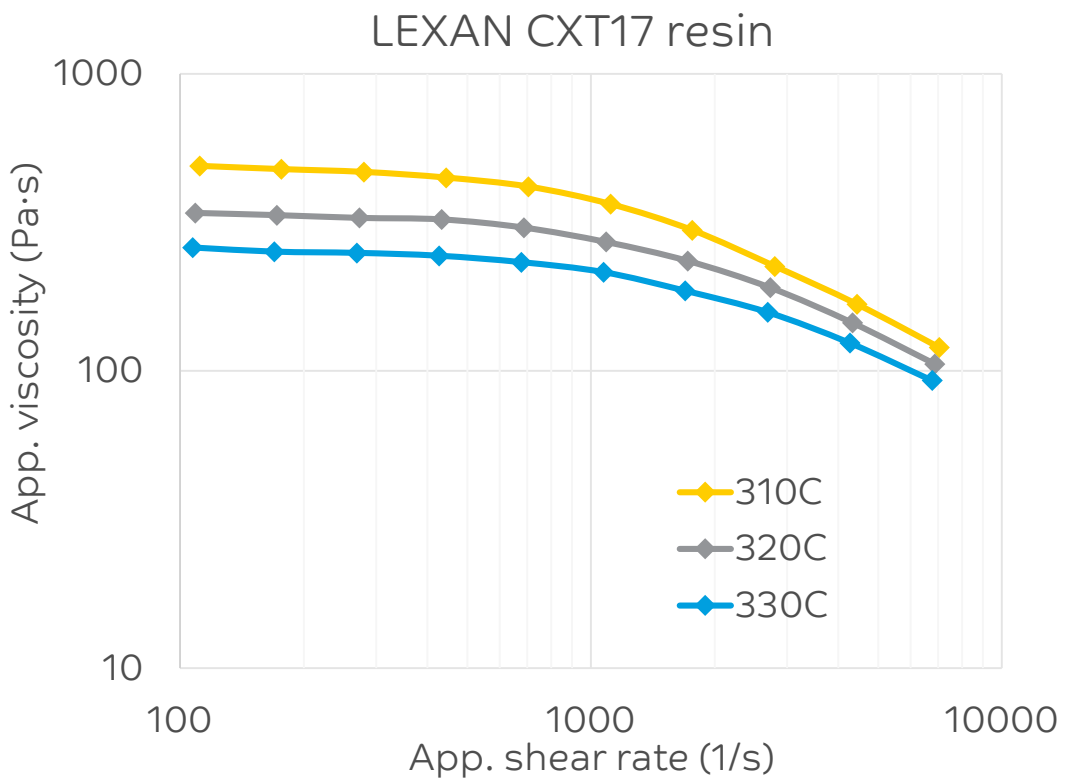


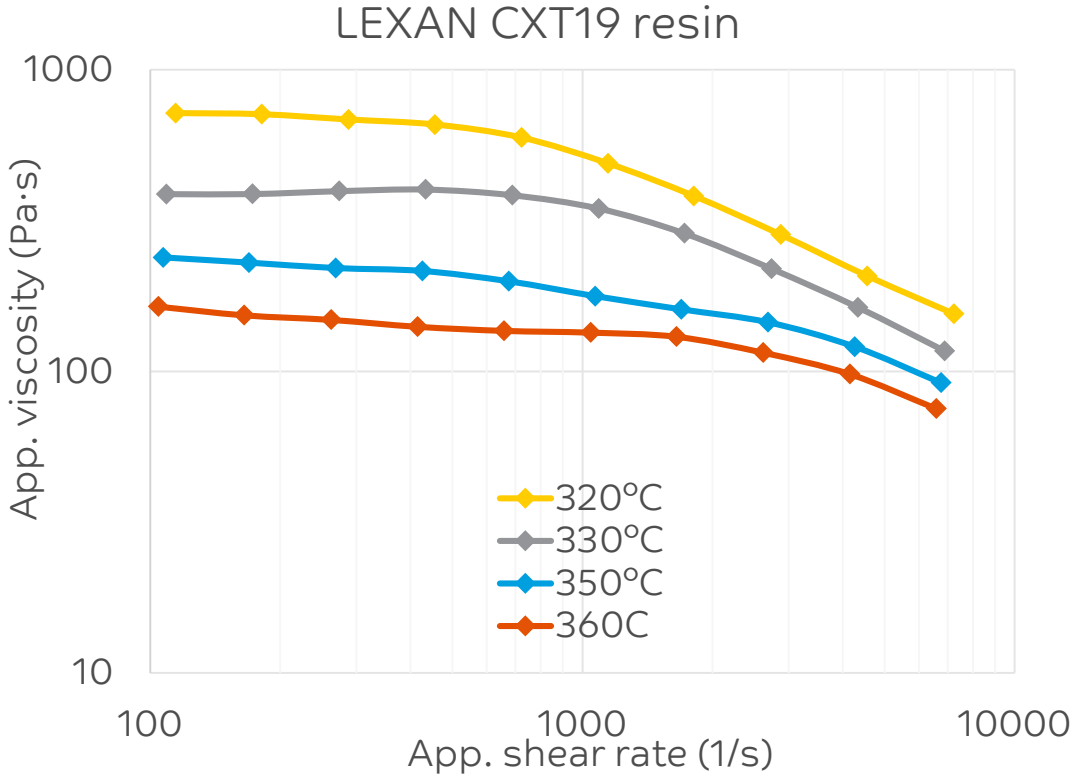


Spiral flow properties for LEXAN CXT17UV and ELCRES™ HPC17 resins are comparable to LEXAN CXT17 resin
Spiral flow properties for LEXAN CXT19UV resin are comparable to LEXAN CXT19 resin

FLOW CAPABILITY OF LEXAN™ CXT RESINS – MELT VISCOSITY

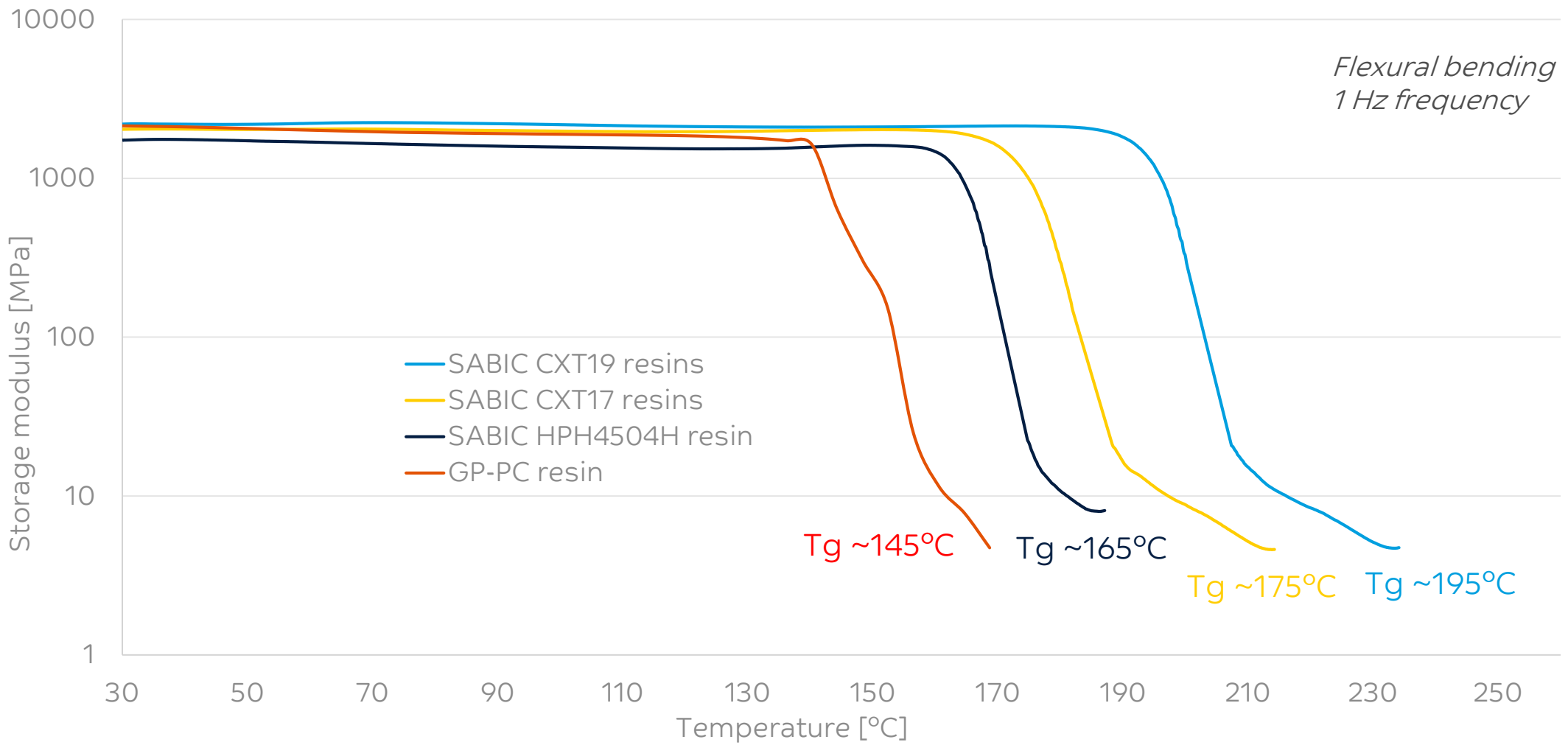
LEXAN CXT Resins can offer high practical flow in recommended processing window
Potential to fill large, complex, thin and/or textured parts within machine limitations





Melt viscosity curves for LEXAN CXT17UV and ELCRES HPC17 resins are comparable to LEXAN CXT17 resin
Melt viscosity curves for LEXAN CXT19UV resin are comparable to LEXAN CXT19 resin

DMA CURVES FOR LEXAN™ CXT RESINS



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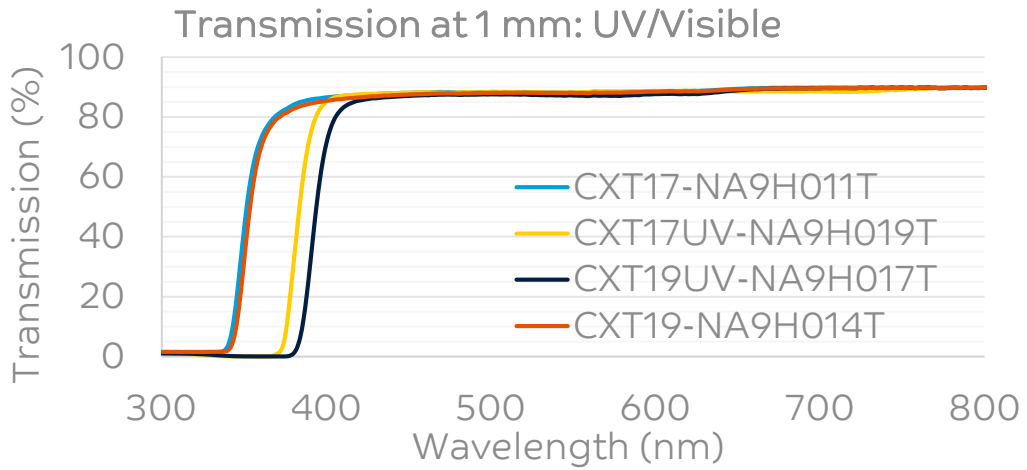
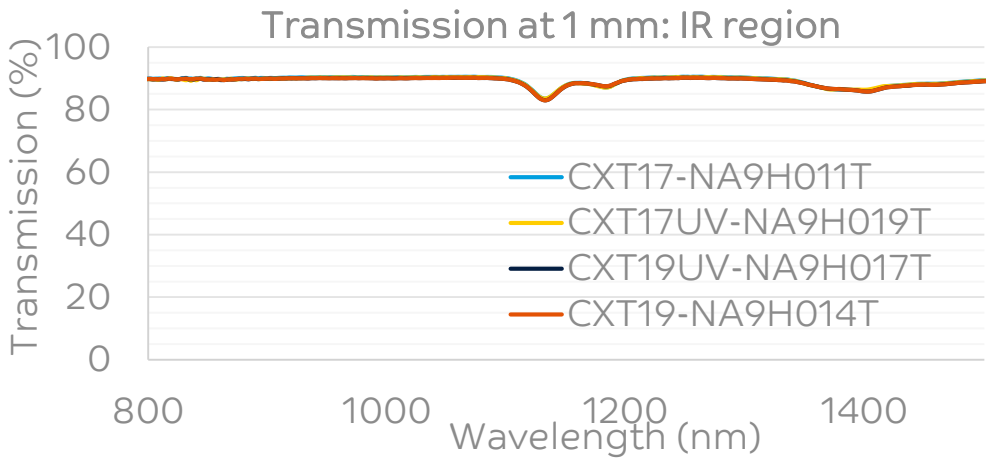
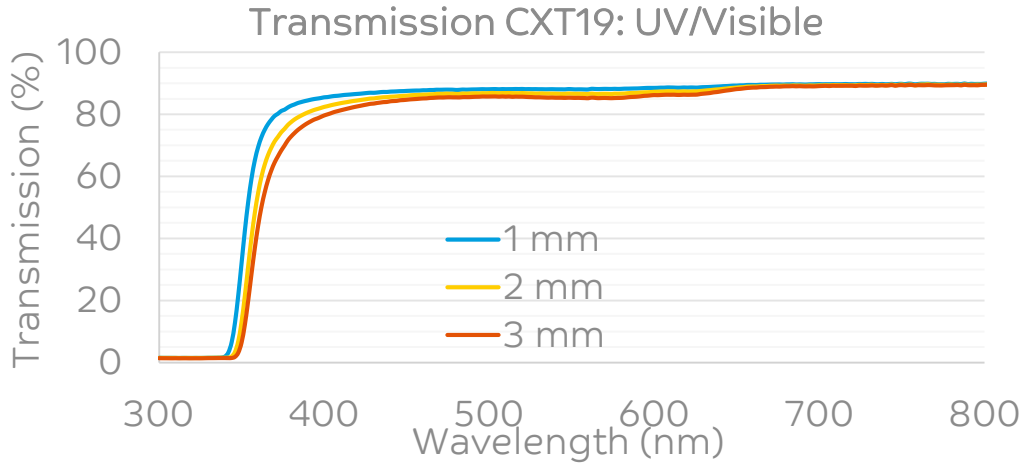
INITIAL OPTICAL PROPERTIES OF LEXAN™ CXT RESINS

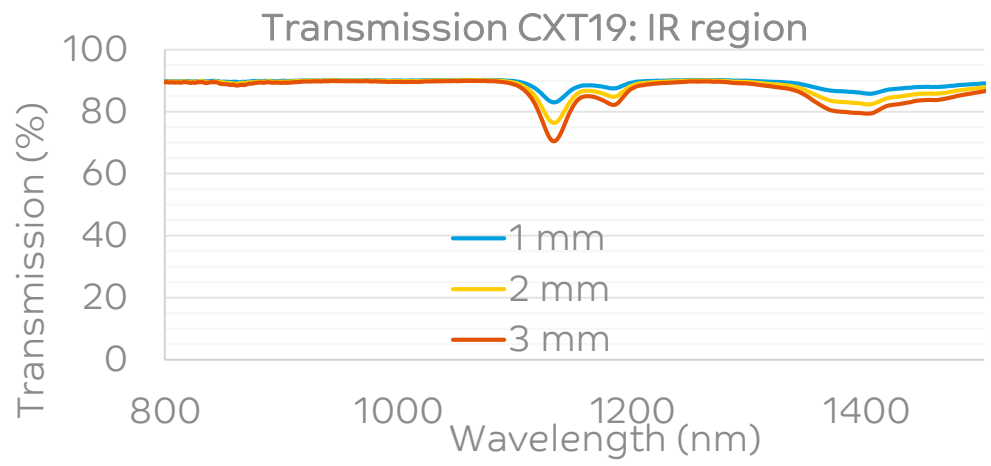
TRANSMISSION CURVES FOR LEXAN™ CXT RESINS

LEXAN CXT Resins can offer high transmission for different grades and thicknesses

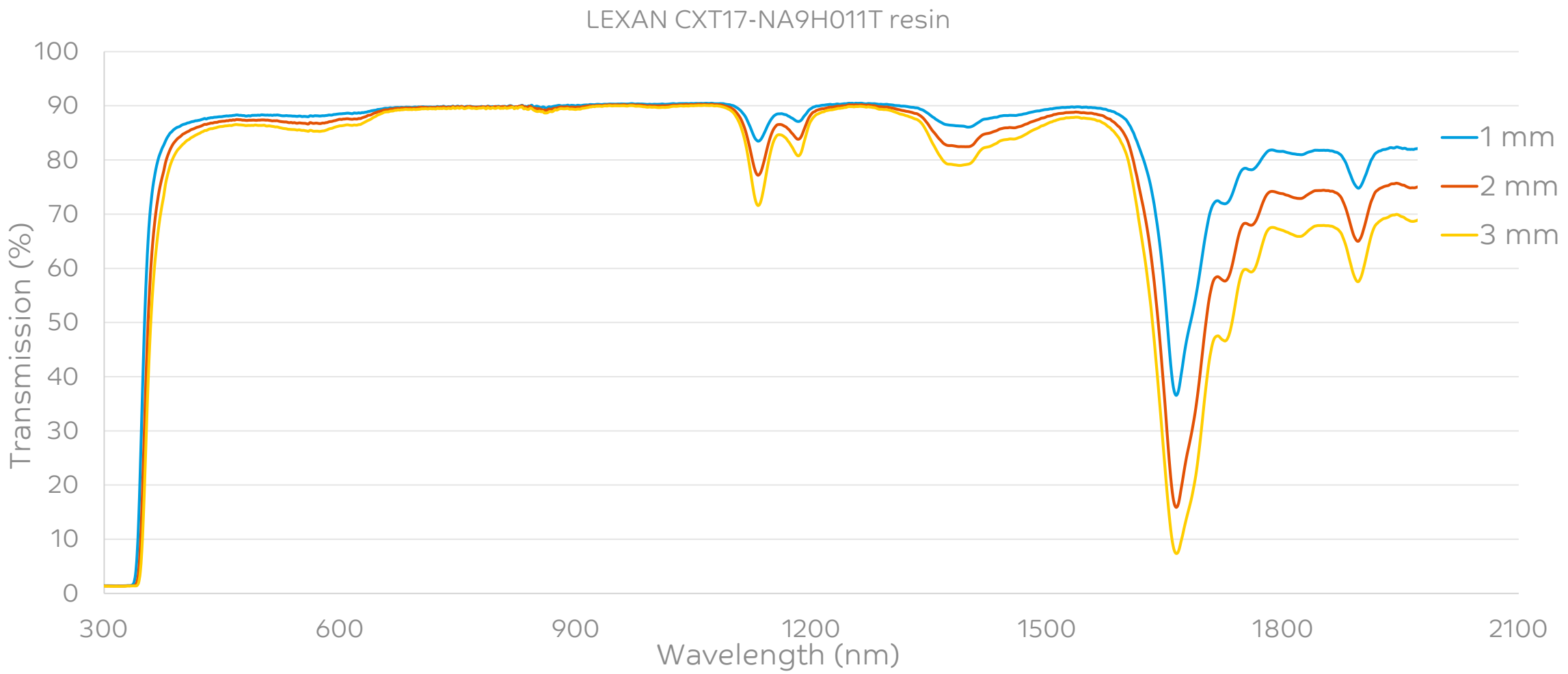




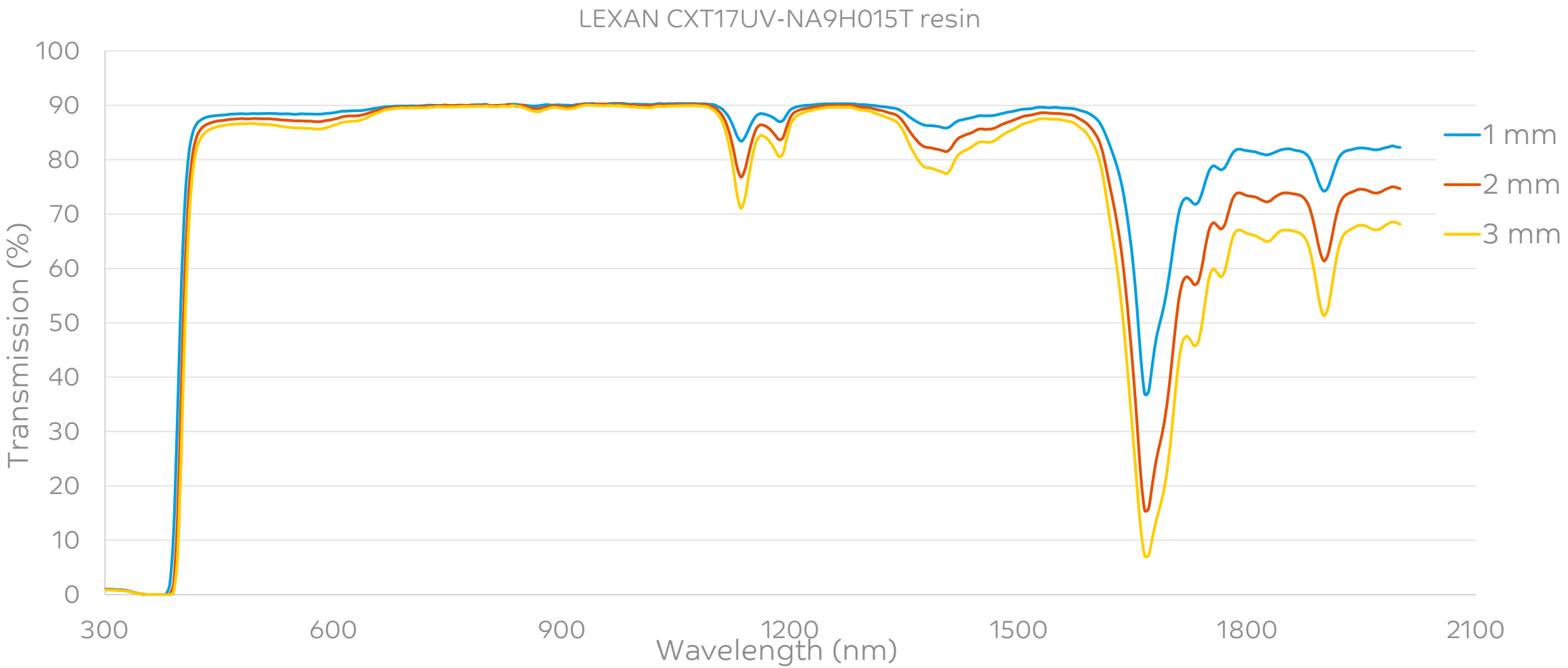




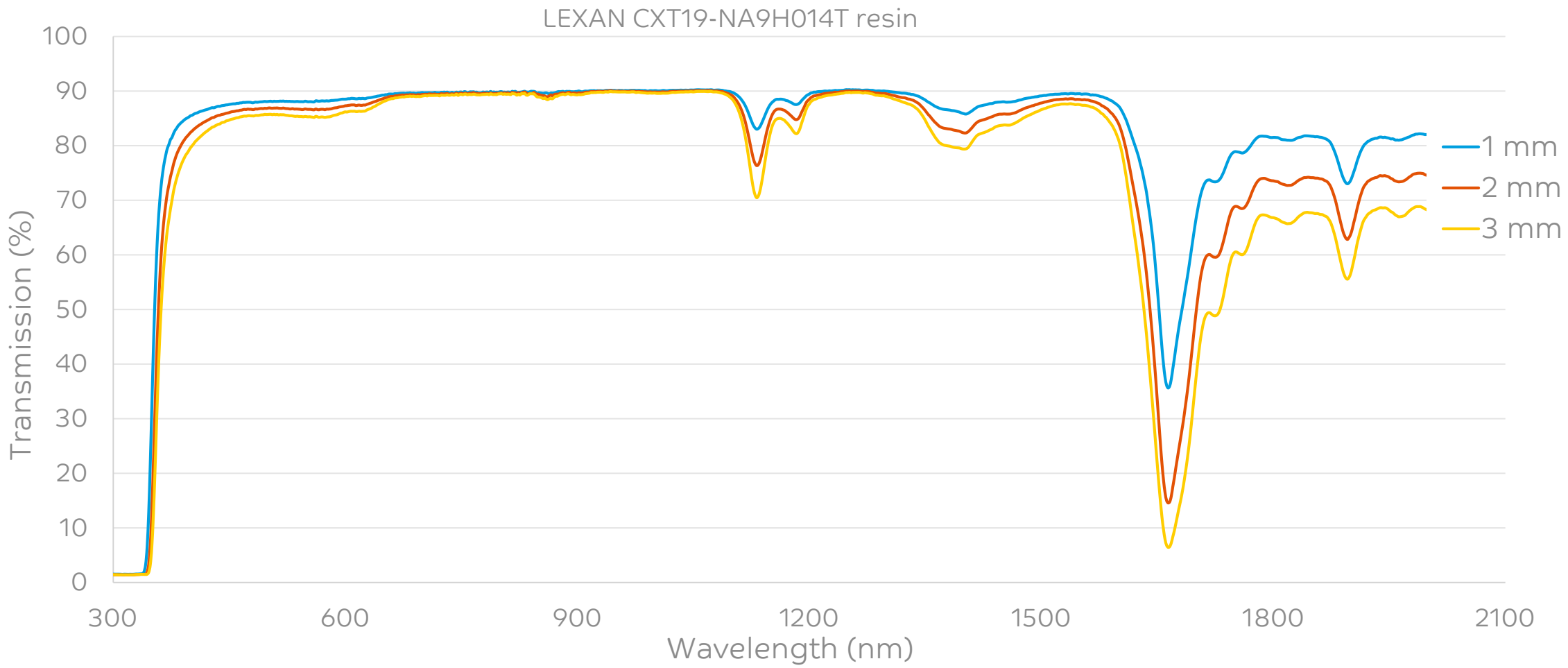
TRANSMISSION CURVES FOR LEXAN™ CXT17 RESIN



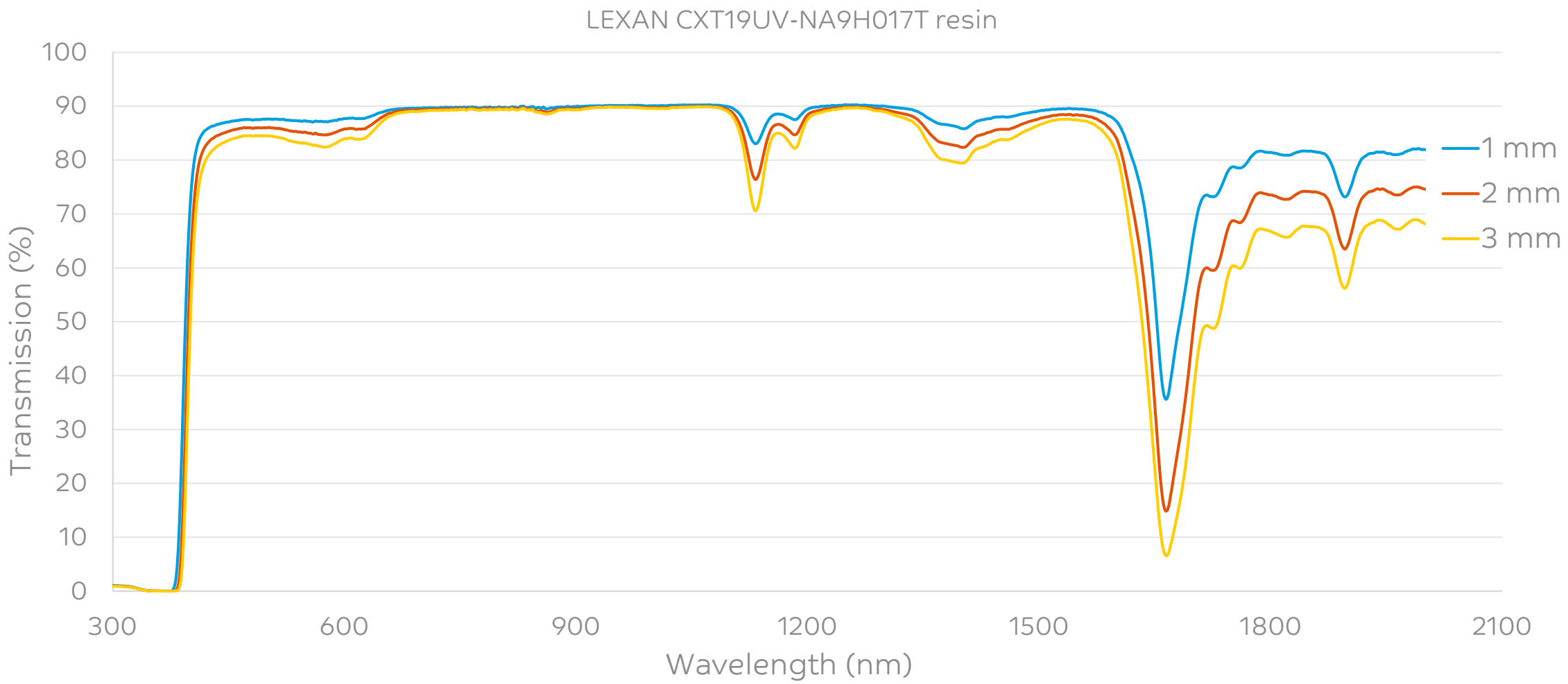
TRANSMISSION CURVES FOR LEXAN™ CXT17UV RESIN



TRANSMISSION CURVES FOR LEXAN™ CXT19 RESIN



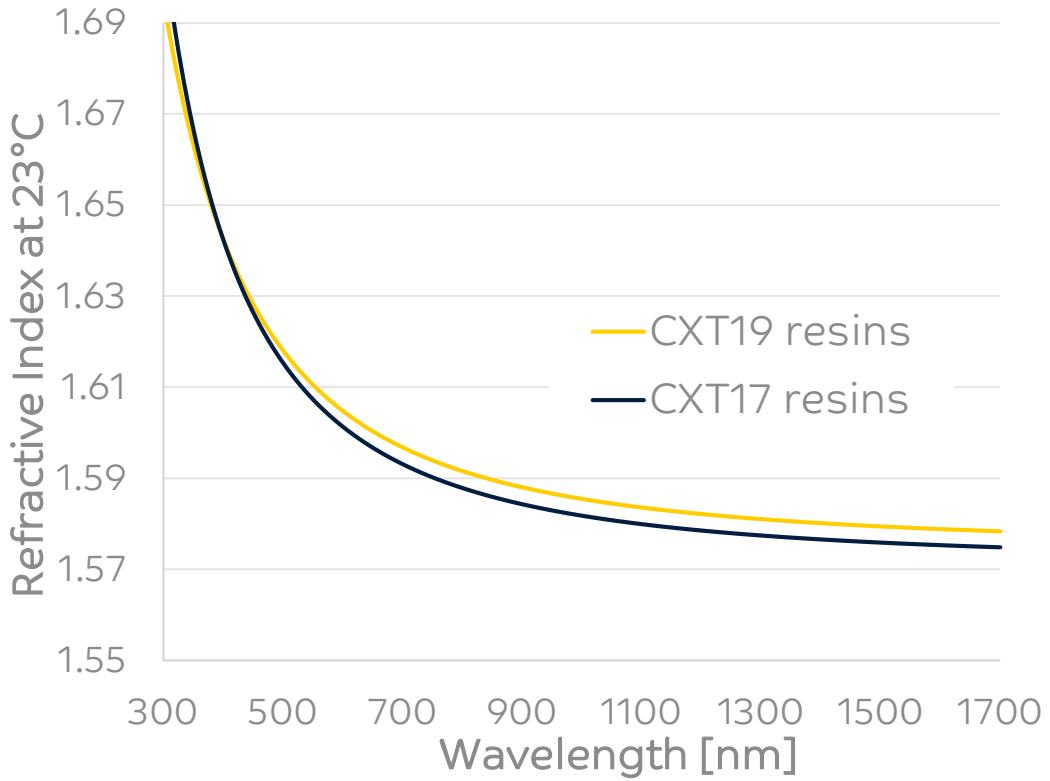
TRANSMISSION CURVES FOR LEXAN™ CXT19UV RESIN



REFRACTIVE INDEX AS FUNCTION OF WAVELENGTH

LEXAN™ CXT Resins have a high refractive index and a low Abbe number

Potential for enhanced design freedom into thinner, more efficient and lighter lenses



Wavelength	LEXAN CXT17 resins	LEXAN CXT19 resins
F-line (486 nm)	1.618	1.624
D-line (589 nm)	1.603	1.609
C-line (656 nm)	1.596	1.603
850 nm	1.586	1.592
940 nm	1.583	1.587
1310 nm	1.577	1.583
1550 nm	1.576	1.580
Abbe number	30	30

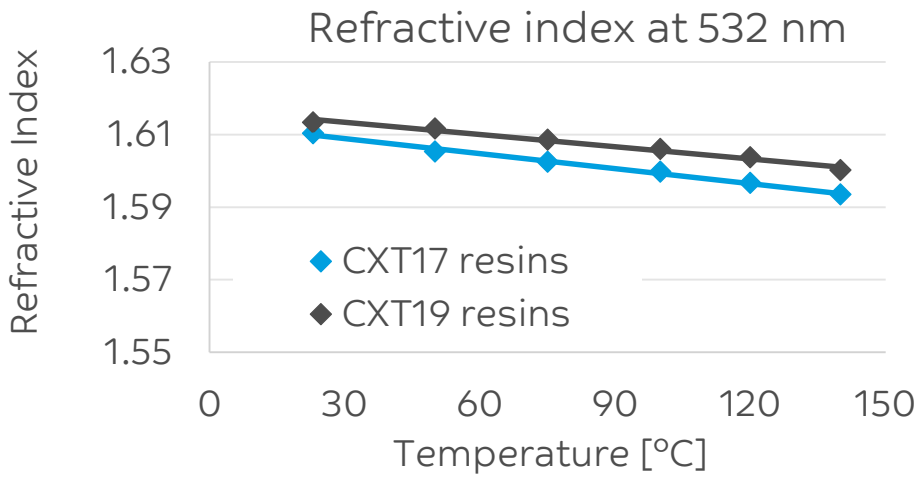
REFRACTIVE INDEX AS FUNCTION OF TEMPERATURE

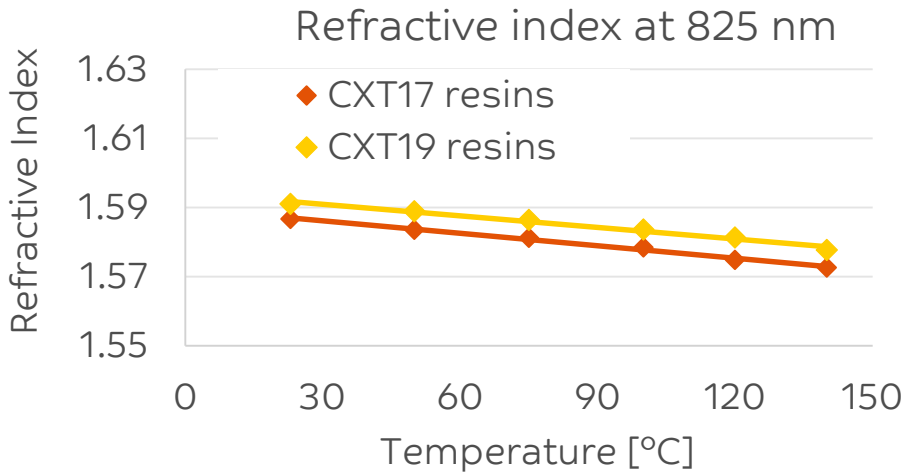
LEXAN™ CXT17 series

Temperature	532 nm	633 nm	825 nm	1312 nm	1552 nm
23°C	1.610	1.598	1.587	1.577	1.576
50°C	1.605	1.594	1.583	1.574	1.572
75°C	1.602	1.591	1.581	1.572	1.570
100°C	1.600	1.589	1.578	1.570	1.567
120°C	1.597	1.585	1.575	1.565	1.564
140°C	1.593	1.583	1.573	1.564	1.562

LEXAN CXT19 series

Temperature	532 nm	633 nm	825 nm	1312 nm	1552 nm
23°C	1.613	1.602	1.591	1.581	1.579
50°C	1.612	1.600	1.589	1.580	1.577
75°C	1.609	1.597	1.586	1.577	1.574
100°C	1.606	1.594	1.584	1.574	1.572
120°C	1.604	1.592	1.581	1.572	1.570
140°C	1.600	1.588	1.578	1.569	1.567

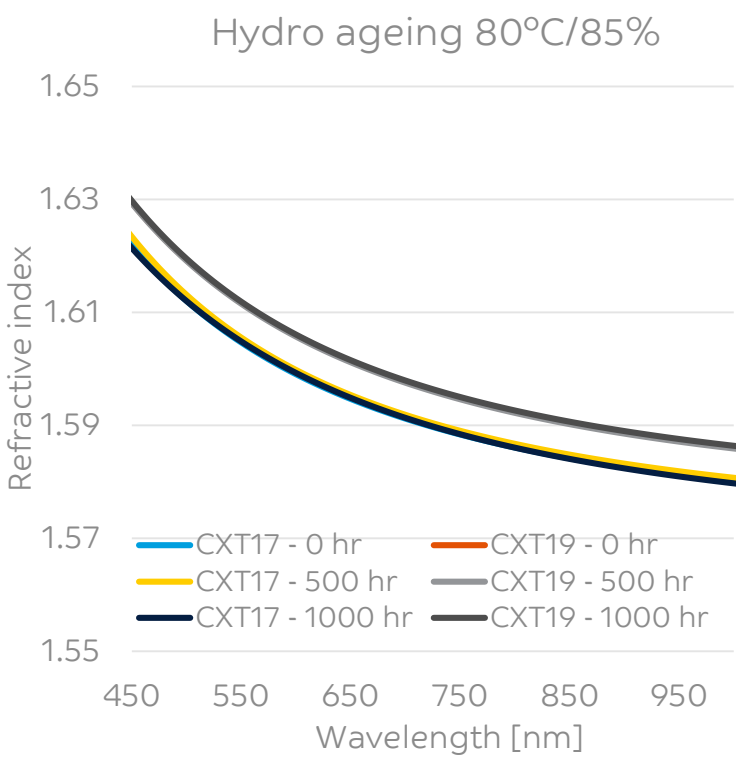


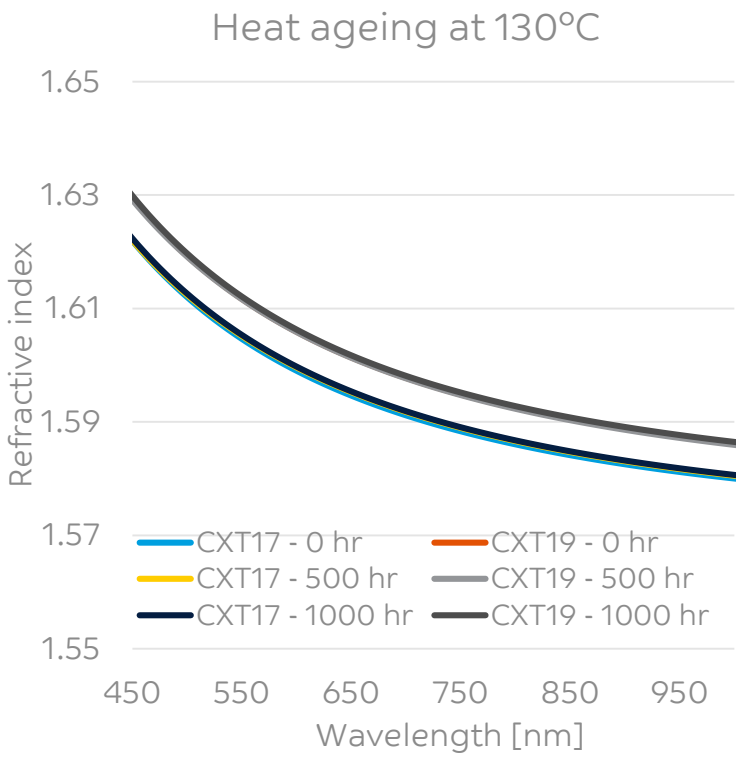


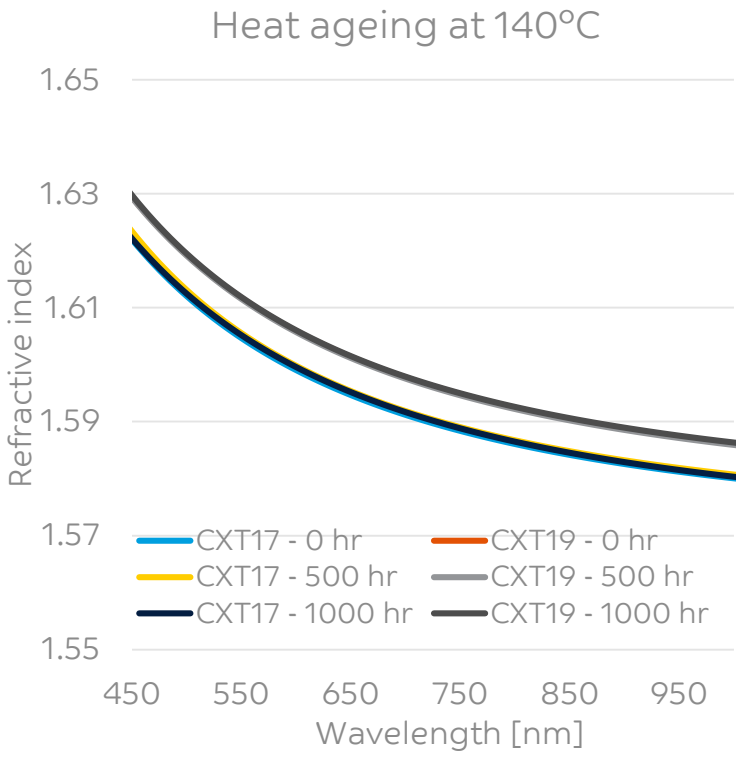
OPTICAL PROPERTY RETENTION AFTER HEAT AND HYDRO AGEING

REFRACTIVE INDEX AFTER HYDRO AND HEAT AGEING

The refractive index of LEXAN™ CXT resins is stable after prolonged heat and hydro ageing



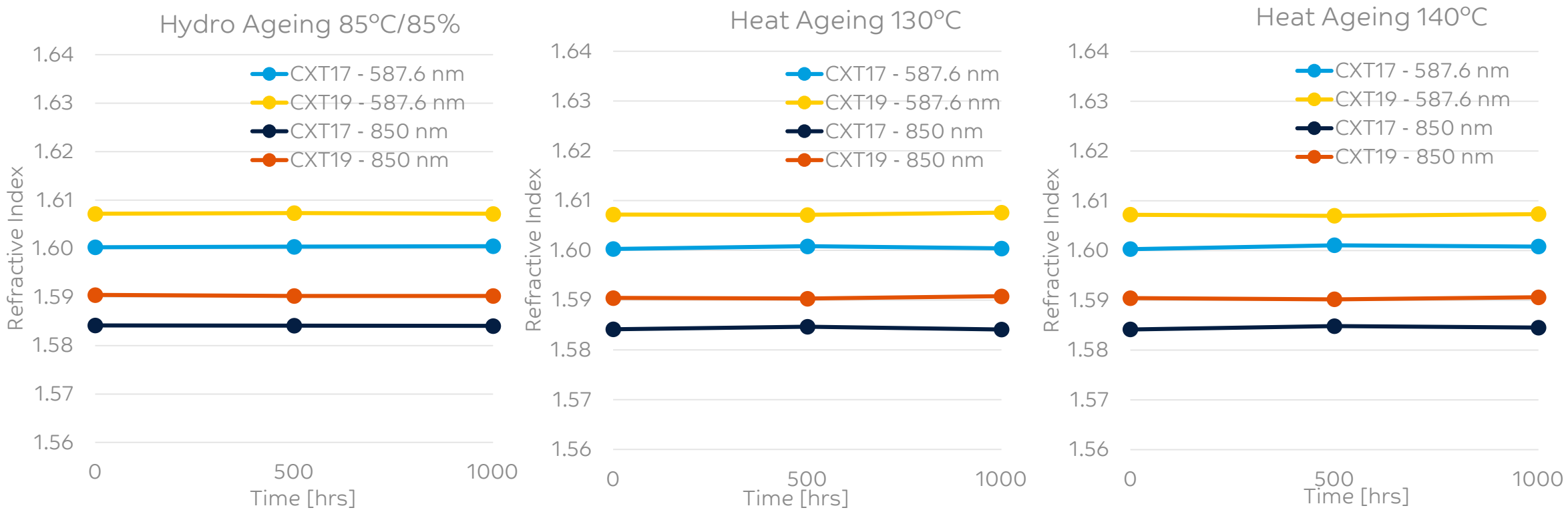




Data are indicative and intended as reference only. Customers are fully responsible for testing the performance of the SABIC material in the end application and checking whether the properties of these grades are meeting their application requirements.

REFRACTIVE INDEX AFTER HYDRO AND HEAT AGEING

The refractive index of LEXAN CXT resins is stable after prolonged heat and hydro ageing in both visible (d-line) and infrared (850 nm) wavelength range



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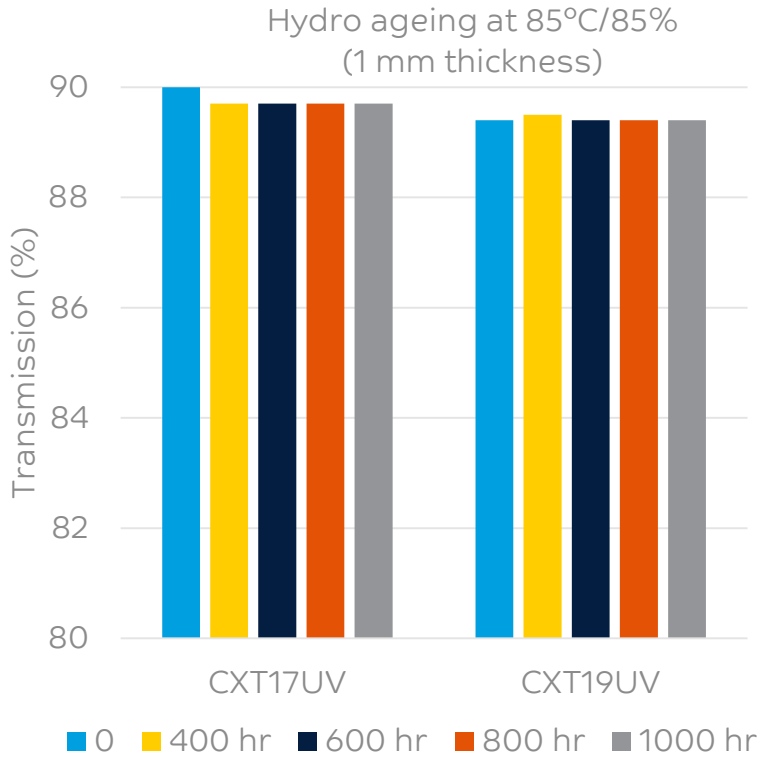
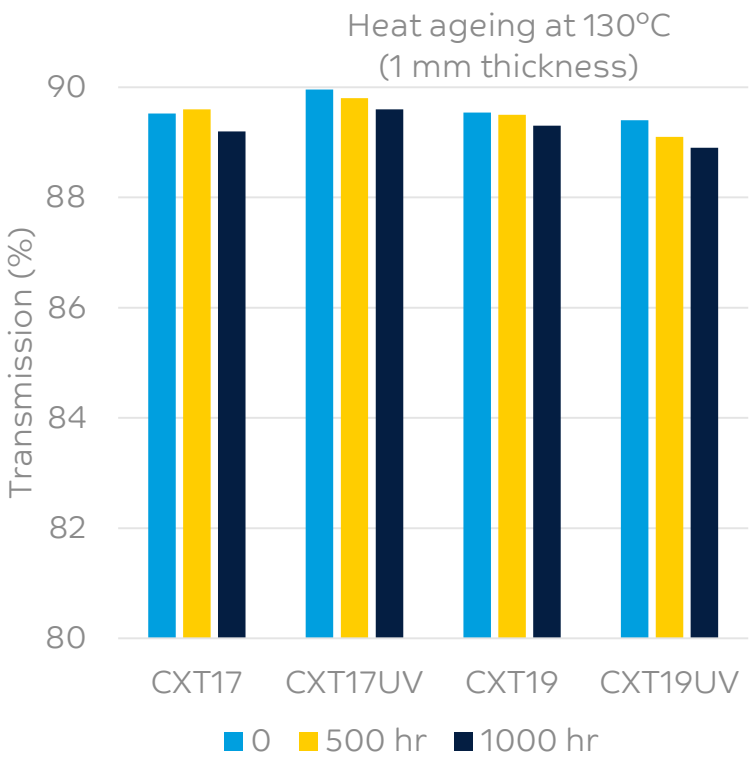
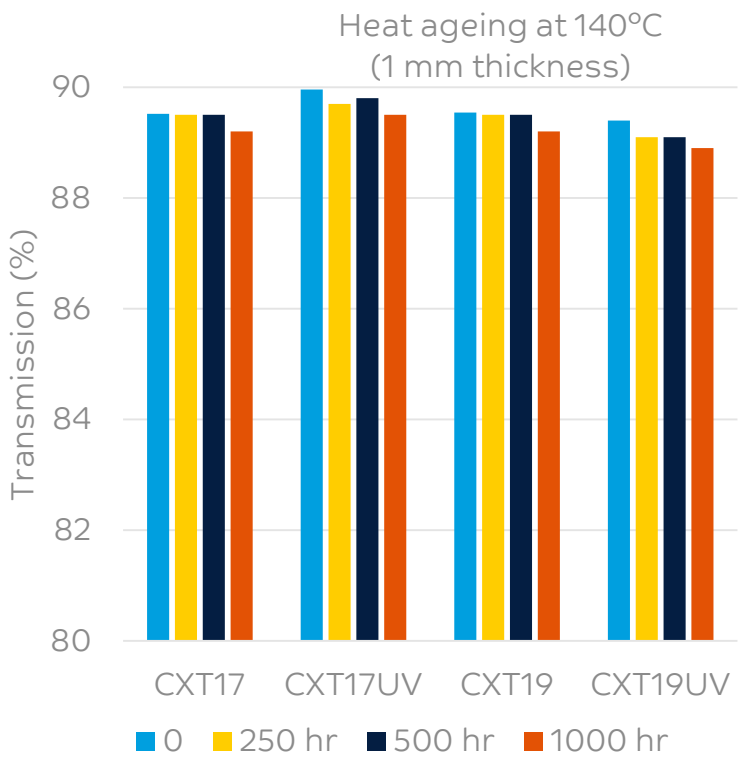
TRANSMISSION OF LEXAN™ CXT RESINS AFTER HEAT AND HYDRO AGEING

Prolonged hydro and heat ageing (up to 1000 hrs) have no or very limited effect on the transmission of LEXAN CXT17 resins.







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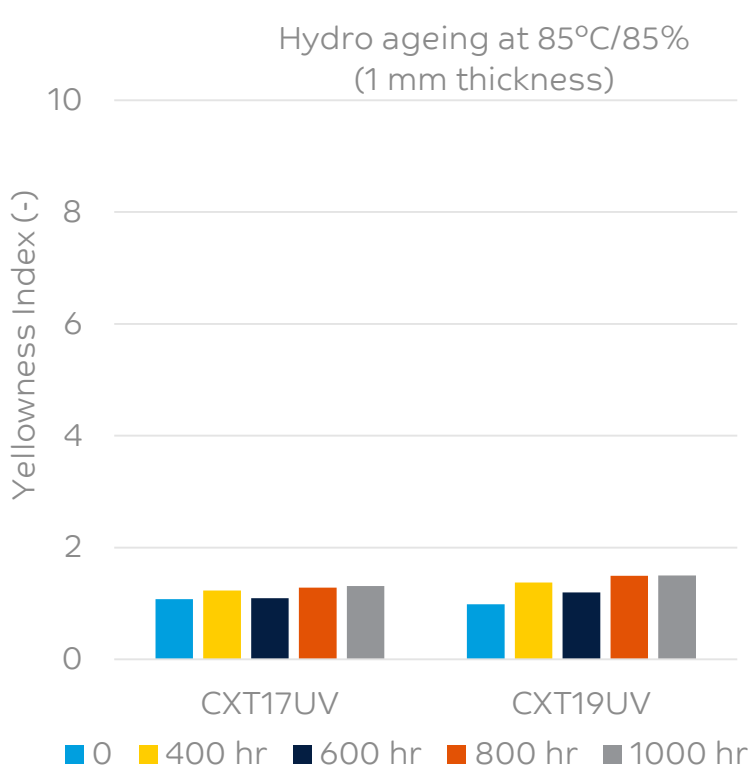
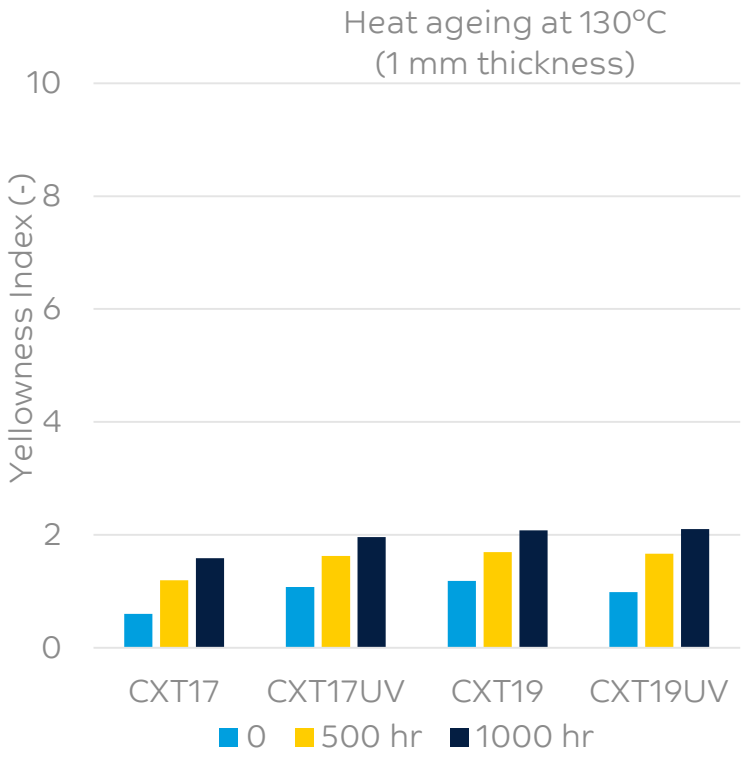
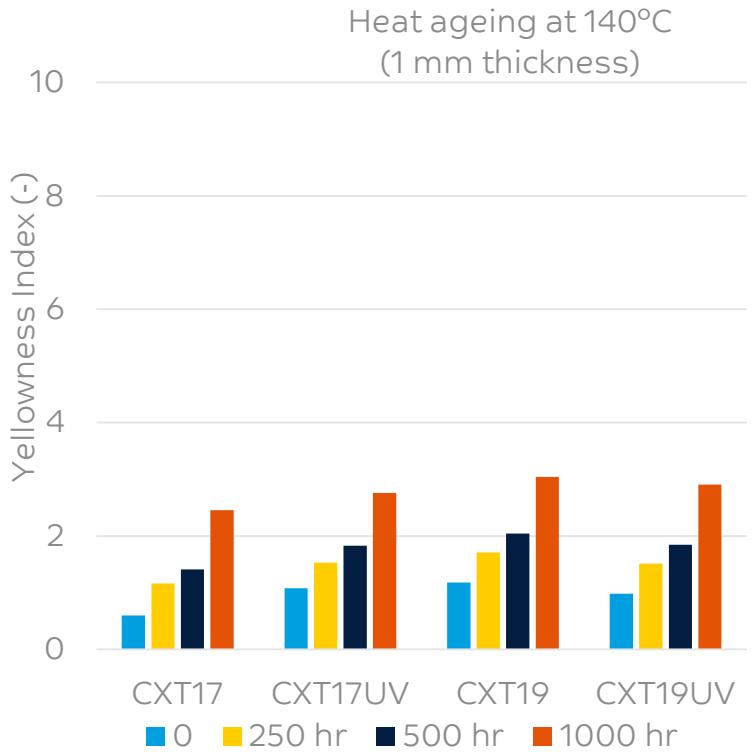
YELLOWNESS INDEX OF LEXAN™ CXT RESINS AFTER HYDRO AND HEAT AGEING

LEXAN CXT resins have excellent retention of color upon prolonged hydro or heat ageing and typically outperform alternative thermoplastic resins in low color shift.







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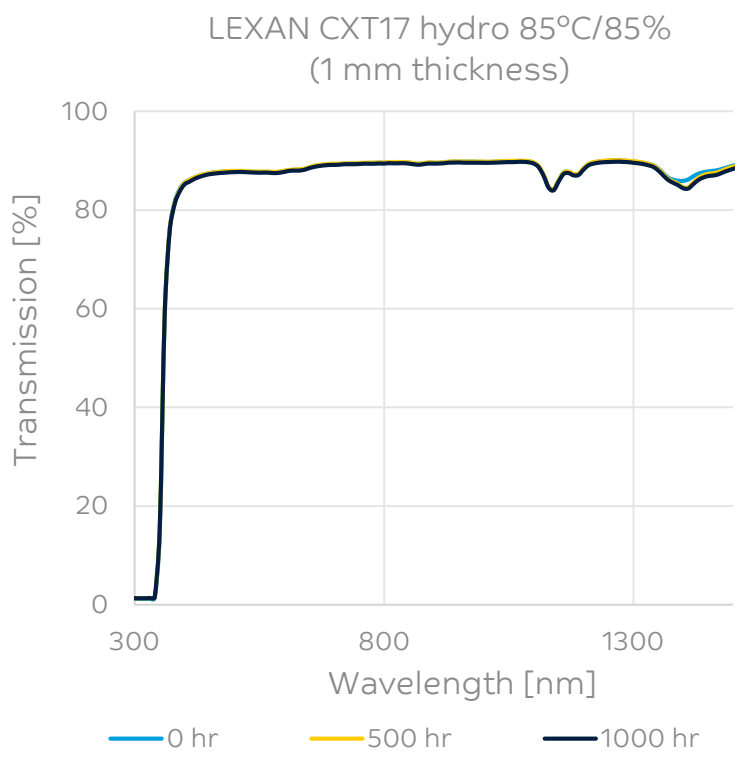
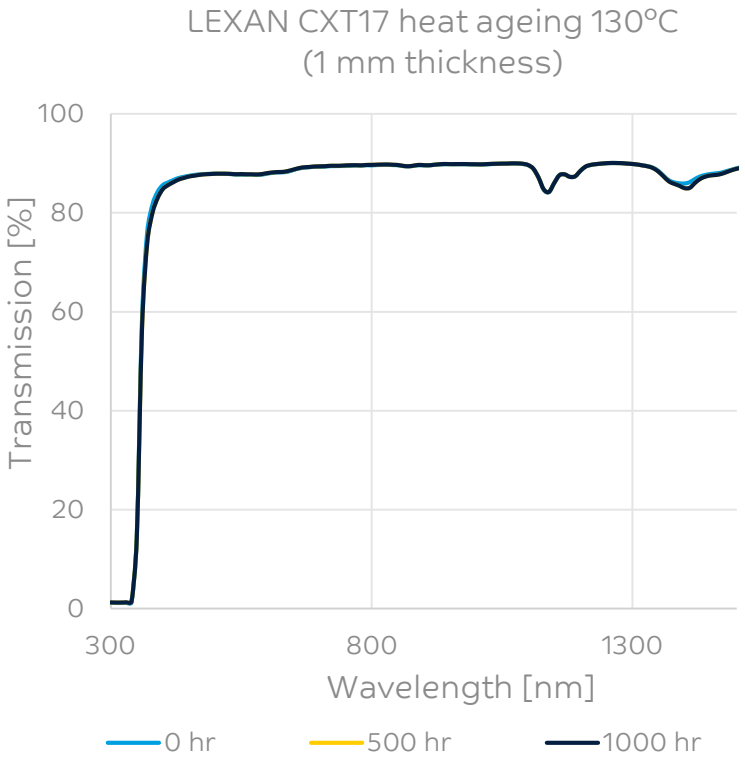
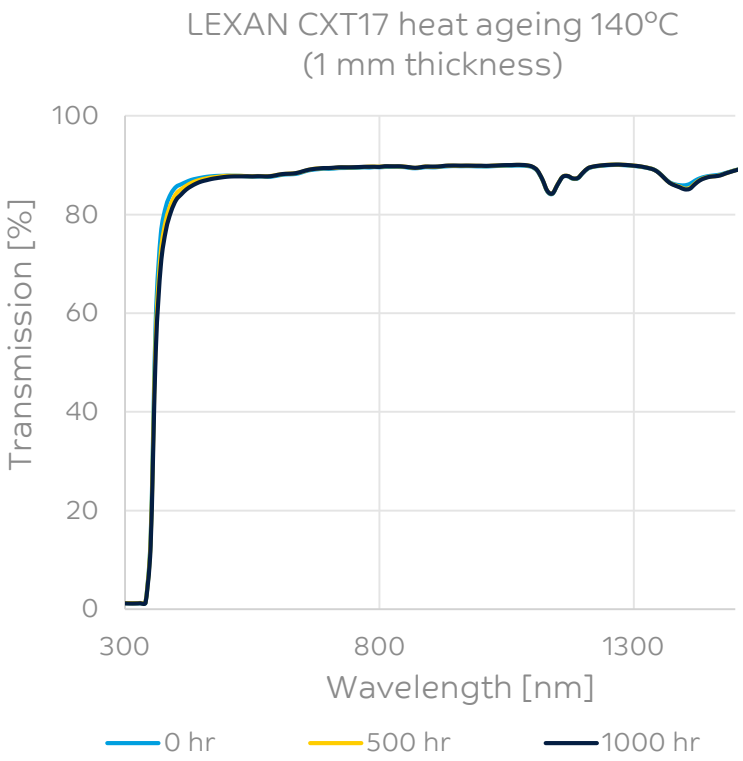
TRANSMISSION CURVES FOR LEXAN™ CXT17 RESIN BEFORE AND AFTER HYDRO AND HEAT AGEING

Prolonged hydro and heat ageing (up to 1000 hrs) have no or very limited effect on the transmission curves of LEXAN CXT17 resin.







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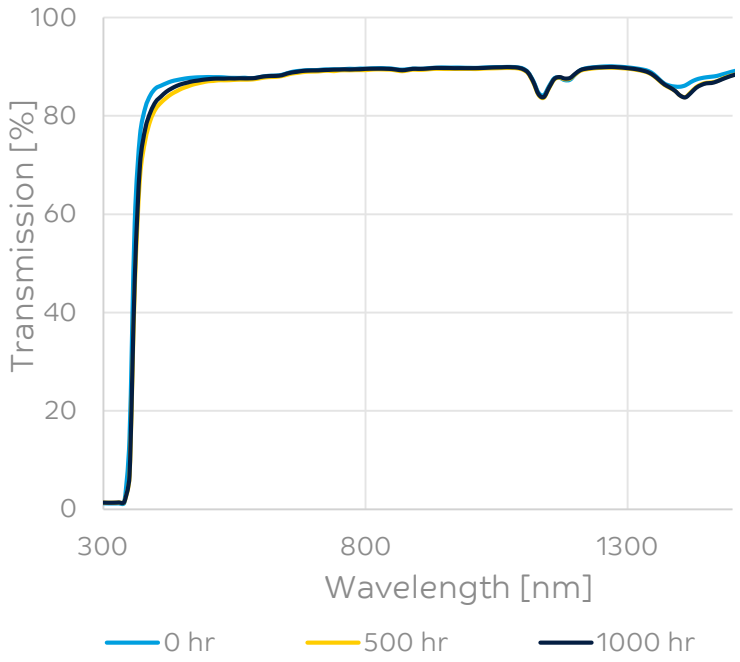
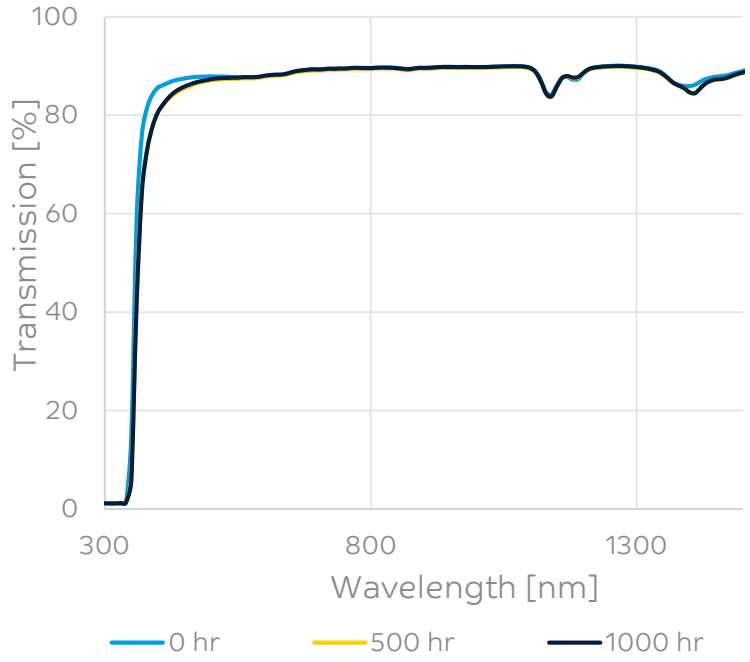
TRANSMISSION CURVES FOR LEXAN™ CXT19 RESIN BEFORE AND AFTER HYDRO AND HEAT AGEING

Prolonged hydro and heat ageing (up to 1000 hrs) have no or very limited effect on the transmission curves of LEXAN CXT19 resin.

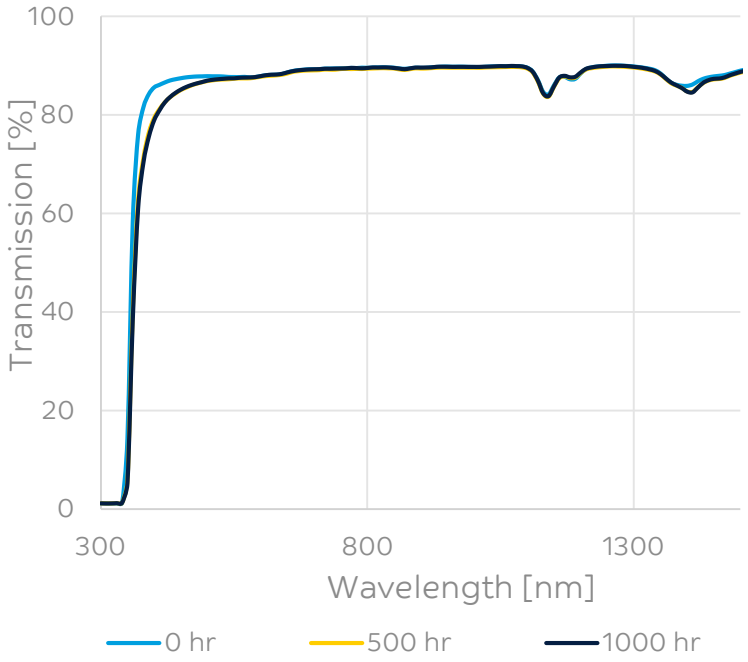
LEXAN CXT19 hydro ageing 85°C/85%
(1 mm thickness)



LEXAN CXT19 heat ageing 130°C
(1 mm thickness)



LEXAN CXT19 heat ageing 140°C
(1 mm thickness)



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