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Xenoy* High Modulus Ductile Resins

Xenoy* X4820 resin

Modulus/Stiffness & Ductility….Opposites attract in 'Nano Fibrillated' Xenoy HMD X4820 resin

We are having technical issues with the recording. A link will be posted as soon as it is available.

Sharing our futures

What is Xenoy* resin

Xenoy* Resins

- Unfilled
- Weatherable
- Extrusion/BM
- Energy Mgmt
- Filled (GF, MF, **HMD**)
- High Heat
- Specialty (IQ, FDA, Vfx, FR)

Xenoy resins: semi-crystalline blends of PC and PBT/PET resins that offer an excellent balance of chemical resistance, mechanical strength (especially at low temperature) and processability for a wide range of applications.

- **Good chemical resistance**, particularly to fuels, lubricants, solvents and cleaning fluids
- **Good impact performance**, especially at low temperature (as low as –40 ºC for some grades)
- Dimensional stability, Low moisture absorption

Additional Features:

- Weatherability, UV stability, color & gloss retention
- Heat resistance (RTI up to 140 ºC / 284 F)
- High & low gloss possible, extended color pallet & Visual*fx*
- Low fuel permeation#

 # Per CARB TP901 Permeation Test Standard

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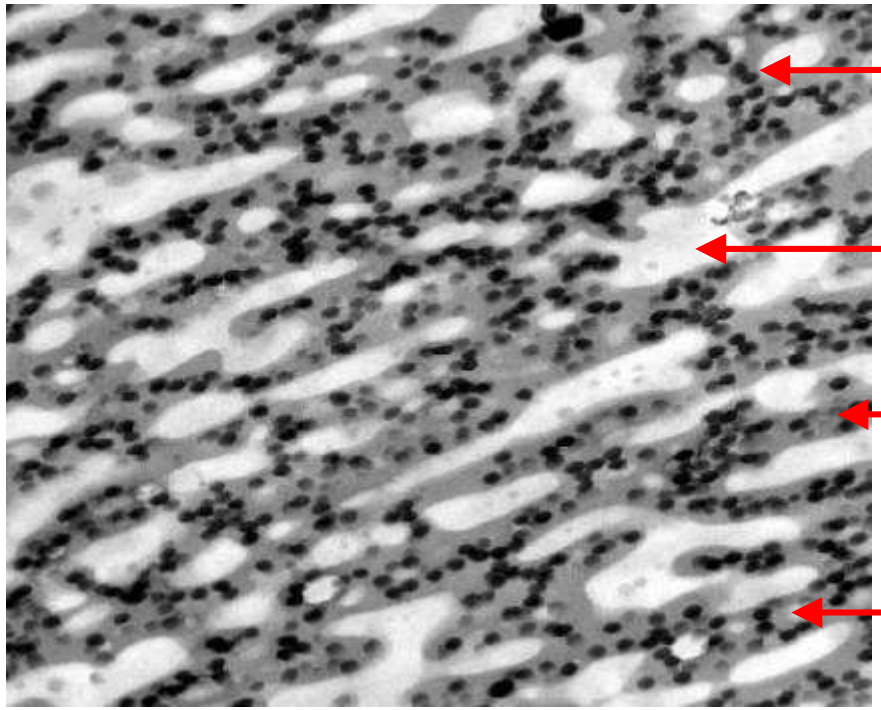
Xenoy Resin - A tough versatile thermoplastic alloy

Xenoy Technology



Partial miscibility between PEst & PC
provides blend compatibility

Polycarbonate
- Wide range of PC resins
- Copolymers

Polyester
- Wide range PEst resins
- Copolymers

Modifiers
- Impact modifiers
- Glass fibers/Mineral fillers

Additives
- UV, Hydro, Rheology…..
- Color Technology

Xenoy Resins are a family of products engineered from
SABIC – Innovative Plastics building blocks & blending expertise

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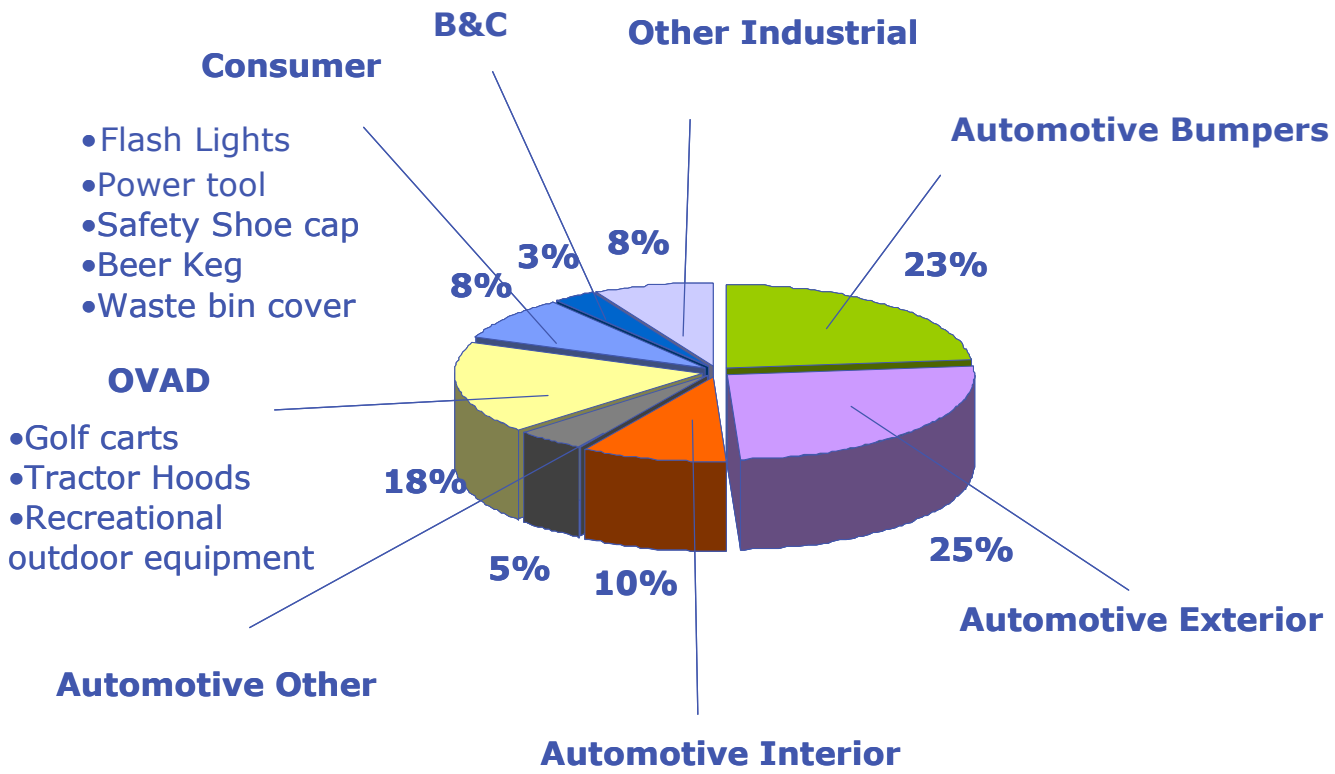
Xenoy Markets…



Versatility of **Xenoy Resin** offers unique sets of properties for various applications & markets

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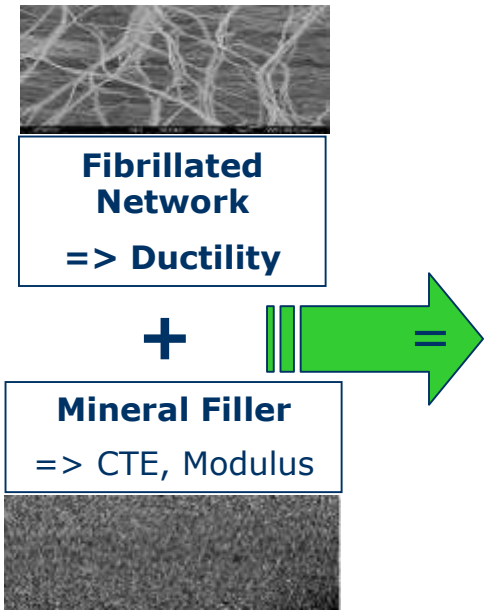
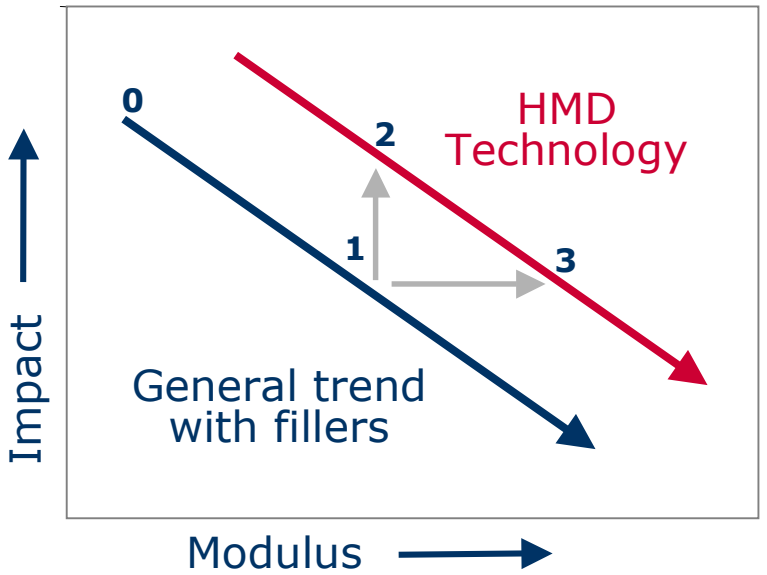
What is Xenoy HMD Resin?

Xenoy HMD technology combines a **nano-fibrillated thermoplastic network** and **state-of-the-art mineral filler technology (patent pending)** in PC/PBT or PC/PET resin….



HMD Principle



Nano-fibrillated network and mineral fillers provide outstanding balance of modulus and ductility

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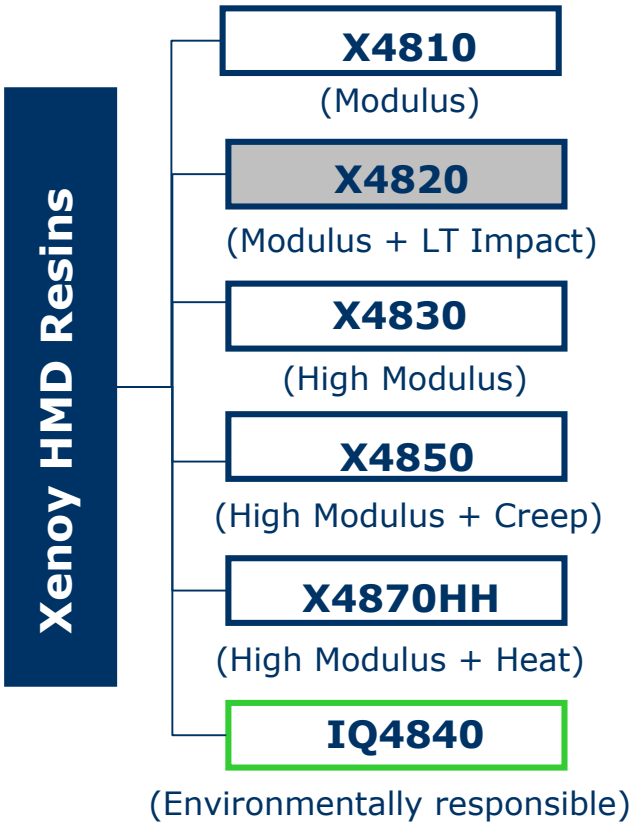
Xenoy HMD portfolio & resin features



Features

- Superior modulus / ductility balance
- Good chemical resistance
- Low CTE (down to 4.5 instead of 8)
- Excellent fatigue resistance
- Low creep
- Higher heat vs. unfilled ~ +10°C/15°F
- Good surface appearance
- Improved hydro-stability

Xenoy HMD resin portfolio offers unique set of properties for challenging applications…

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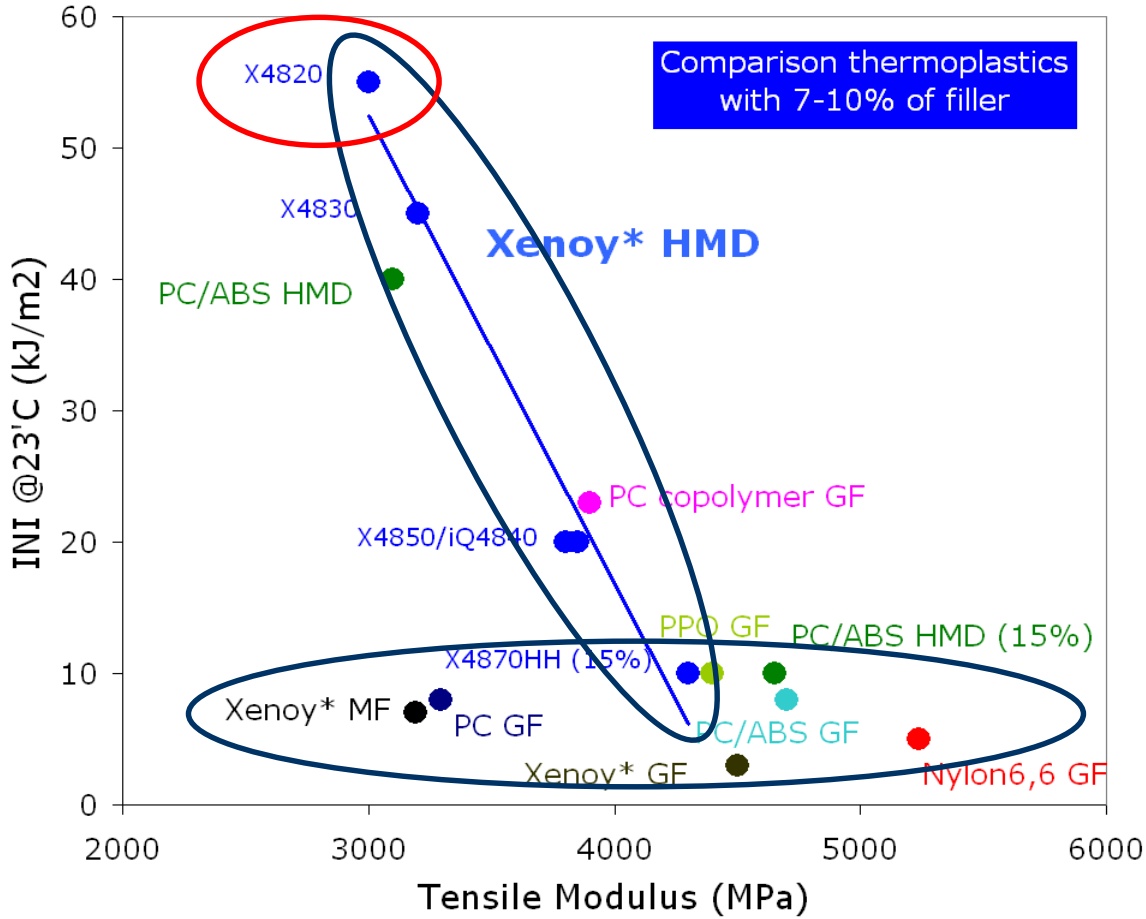
Modulus Vs Ductility



Xenoy X4820 resin : Excellent Modulus/Ductility Balance

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Xenoy X4820 resin – Features and benefits

Xenoy X4820 resin value proposition

- **Best in class modulus/impact balance** … Potential for stiffer & thinner parts – potential cost out!
- **D/B transition @ -20 deg C** … Material candidate for demanding indoor & outdoor applications.
- **Chemical resistance to grease and motor oil** … Well suited for applications in harsh environments.
- **Excellent creep & fatigue properties** … Material candidate for applications under prolonged load or repetitive stress.
- **Low coefficient of thermal expansion (CTE)** … Long term dimensional stability.
- **UL 94-HB & UL F2 rating, CTI = 2** Excellent candidate for outdoor electrical applications.
- **Good weathering performance & hydro-stability** … Property retention after UV exposure offering long term durability for outdoor applications.
- **Thermoforming & Blow Molding** … Structural material for (two layer) extruded sheet. Offers processing flexibility. **Proven regrind capability.**

Xenoy X4820 resin allows design flexibility, parts consolidation and potential for metal replacement… Offers COST OUT opportunity to OEMs!

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Datasheet comparison

DATASHEET PROPERTIES		CL100B *Unfilled*	X4810 *HMD*	X4820 *HMD*	X4830 *HMD*	iQ4840 *HMD*	X4850 *HMD*	X4870 *HMD*	X5410 *Std MF*	
MECHANICAL	Unit									*Method*
Tensile Modulus, 1 mm/min	MPa	2200	2750	3000	3200	3800	3850	4300	3200	*ISO527*
Tensile Stress, yield, 5 mm/min	MPa	55	55	52*	60	62	58	63	55	*ISO527*
Tensile Strain, break, 5 mm/min	%	75	100	100*	120	100	80	10	12	*ISO527*
Flexural Modulus, 2 mm/min	MPa	2200	2500	2850	2900	3450	3500	4000	2700	*ISO178*
Flexural Stress, yield, 2 mm/min	MPa	85	87	87	90	96	94	98	93	*ISO178*
IMPACT										
Izod Impact, notched 80*10*4 +23° C	kJ/m^2	46	50	55	45	20	20	10	7	*ISO180/1A*
Izod Impact, notched 80*10*4 +0° C	kJ/m^2		20	30	15		11			*ISO180/1A*
Izod Impact, notched 80*10*4 -30° C	kJ/m^2	21	12	15	9		7	6	7	*ISO180/1A*
THERMAL										
Vicat Softening Temp, Rate B/120	° C	129	133	134	135	128	135	139	140	*ISO306*
HDT/Bf, 0.45 MPa Flatw 80*10*4	° C	110	115		119	116	121	131	128	*ISO75/Bf*
HDT/Af, 1.8 MPa Flatw 80*10*4	° C	90	91	94	97	98	99	113	105	*ISO75/Af*
CTE, -30° C to 80° C, flow	1/° C x10^{-5}	9	8		7.2		6.3	4.8	5.8	*ISO11359-2*
PHYSICAL										
Density	g/cm^3	1.22	1.25	1.26	1.27	1.3	1.31	1.34	1.26	*ISO1183*
Mold shrinkage on Tensile bar, Flow	%	0.7-1.0	0.7-0.9	0.5-0.9	0.7-0.9	0.7-0.9	0.7-0.9	0.5-0.7	0.7-0.8	*ISO1183*

* Measured at 50 mm/min

Xenoy X4820 resin … A ductile resin with enhanced stiffness

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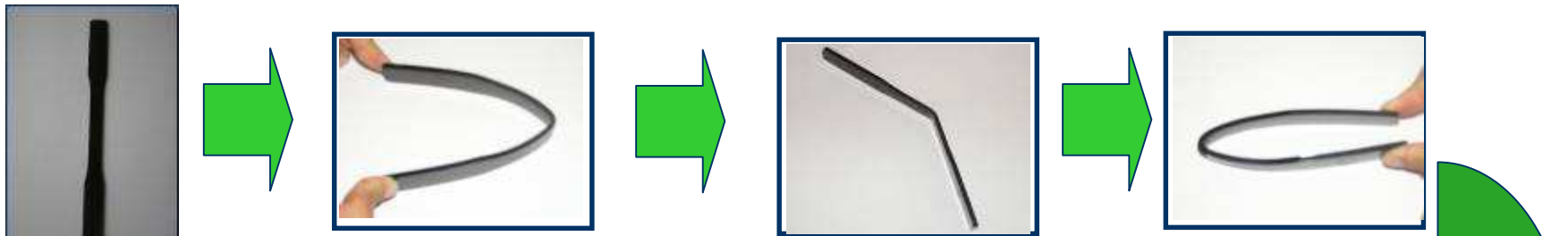
Modulus Vs Ductility - Demonstration



T'bar – Bent
In one direction

T'bar – Bent
In other direction

Xenoy X4820 resin….
Think about applications that need

- Stiffness & Ductility…
- Fatigue properties
- Processing versatility
- Hydro stability
- Thermal performance…
- Other…

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Chemical Resistance of X4820 resin

vs. non-filled Xenoy resin:

ESCR results after 5 days exposure; 23'C, 1% strain

		Windex		Motoroil		Molykote G-68		Molykote MI-60	
		YS (%)	E2B (%)	YS (%)	E2B (%)	YS (%)	E2B (%)	YS (%)	E2B (%)
5220U	Unfilled ref.	99	100			100	99	100	87
X4820	7.5 MF + HMD	96	97			97	93	100	81

vs. glass-filled PC resin:

ESCR results of 7 days exposure; 23'C, 0.5 % strain

		Formula 409		Grease		Diesel	
		YS (%)	E2B (%)	YS (%)	E2B (%)	YS (%)	E2B (%)
X4820	7.5% MF + HMD	98	101	100	99	100	100
Lexan EXL4019	9% GF	18	10	100	66	100	88
Lexan 3412R	20% GF	0	41	20	85	99	98

Grease = Permatac SF01
Formula 409 = Cleaning agent (US)
Diesel = European Diesel

retention of results

> 80%	no value = expected results based on more severe test condition
50 - 80%	
< 50%	no value = expected results based on less severe test condition

Xenoy X4820 resin : Comparable chemical resistance to Xenoy 5220U resin
Superior chemical resistance to GF PC resins

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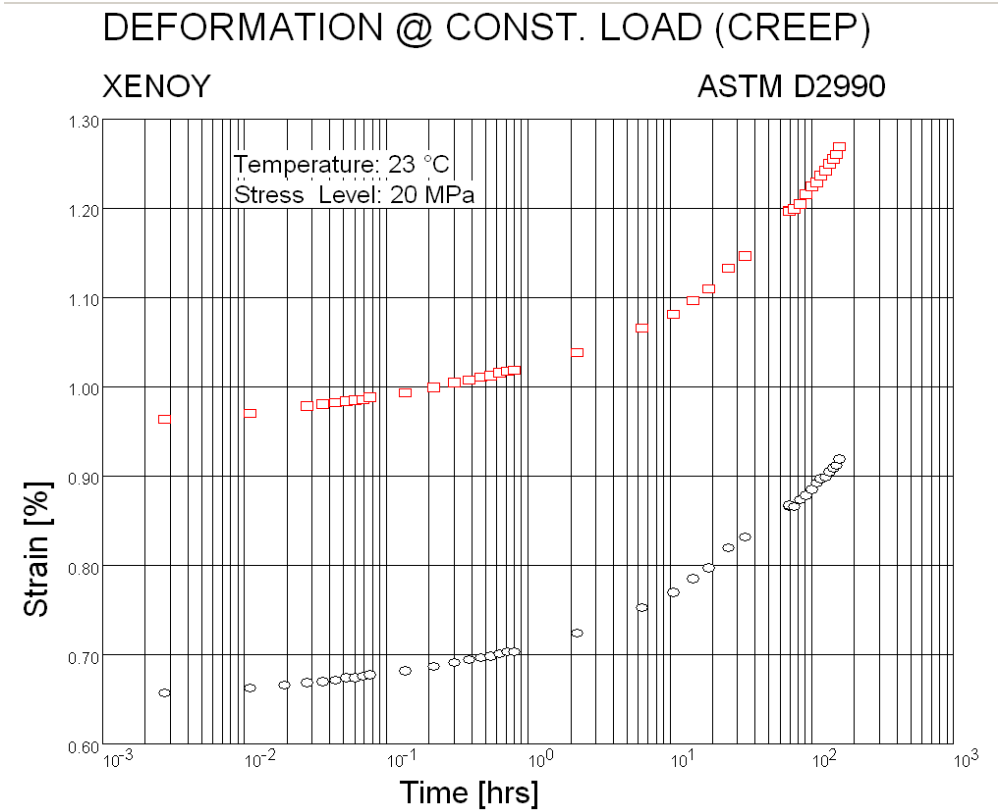
Creep performance



□ 5220U 23°C

○ X4820 23°C

Xenoy X4820 resin : Improved creep performance compared to Xenoy 5220U (Unfilled PC/Polyester) resin

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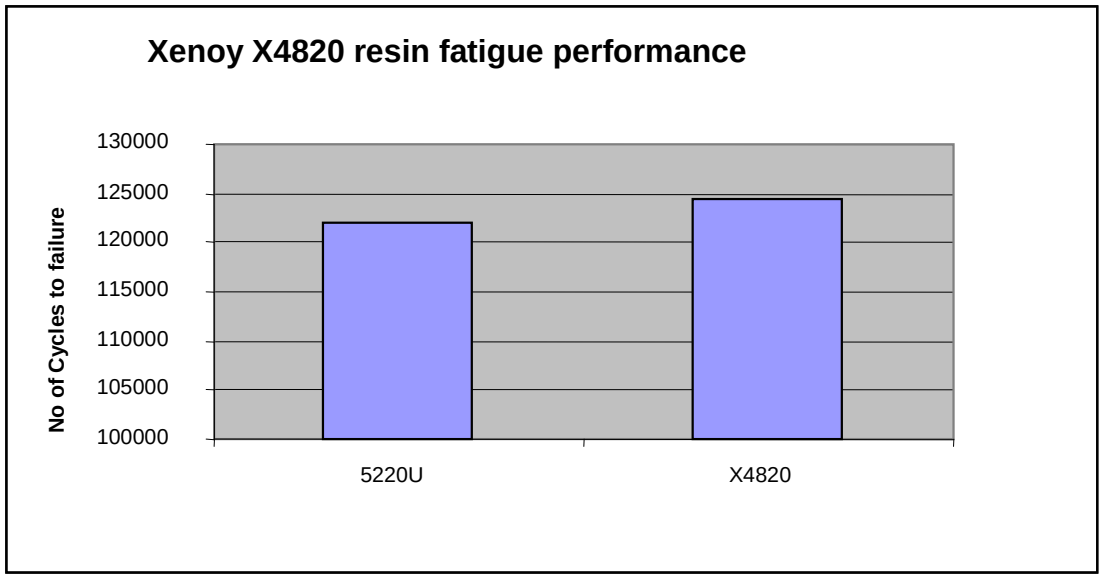
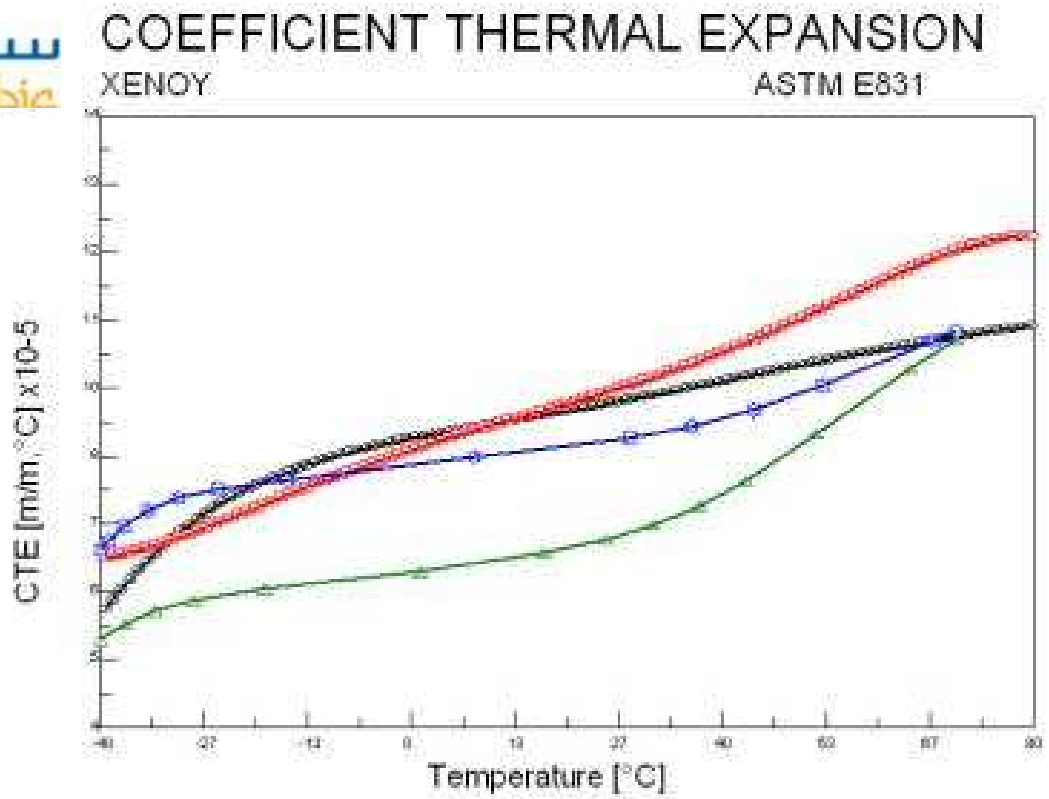
Fatigue properties



Test:	Tensile Fatigue
Frequency	5 Hz
Temp.	23 deg C
Stress	35 MPa

Xenoy X4820 resin : Exhibits excellent fatigue properties similar to unfilled Xenoy resins

CTE Performance



- Xenoy 5220U resin - Flow
- Xenoy 5220U resin - Cross Flow
- Xenoy X4820 resin - Flow
- Xenoy X4820 resin - Cross Flow

Xenoy X4820 resin : Lower CTE in flow direction
Better dimensional stability

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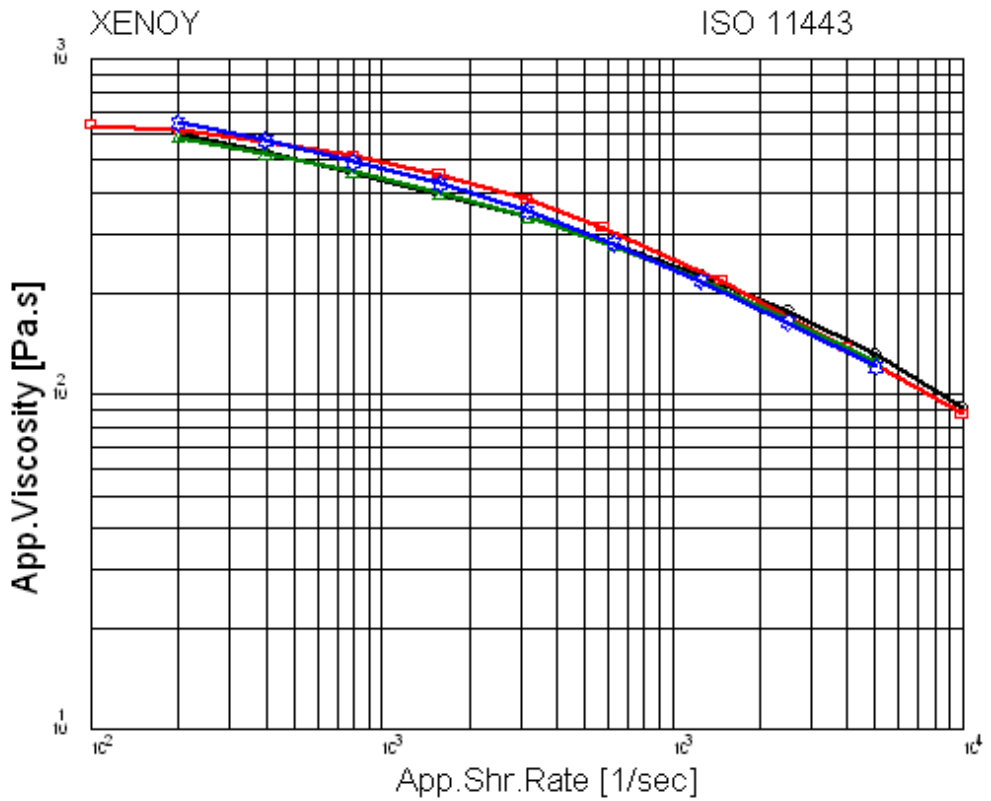
Flow Properties



- Xenoy CL100B resin - 270°C (#)
- Xenoy X4830 resin - 270°C
- Xenoy IQ4840 resin - 265°C
- Xenoy X4820 resin - 265°C

#Has similar performance to Xenoy 5220U resin

Xenoy X4820 resin : Comparable flow performance to unfilled Xenoy resin

High flow Xenoy HMD resins currently in development !!

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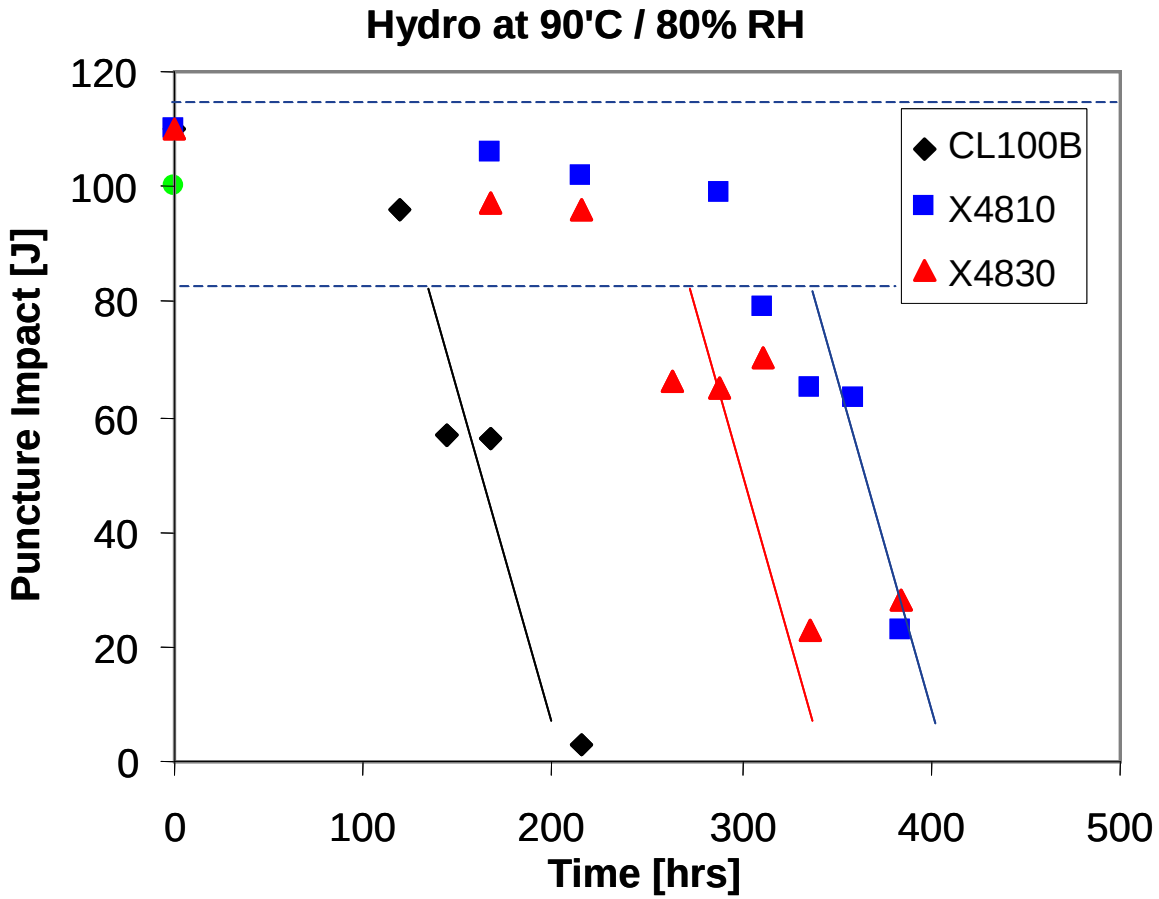
Hydro-Stability



Xenoy* X4820 resin – demonstrates similar hydro stability as Xenoy X4830 resin…~2X better than typical PC/Polyester (unfilled) resin

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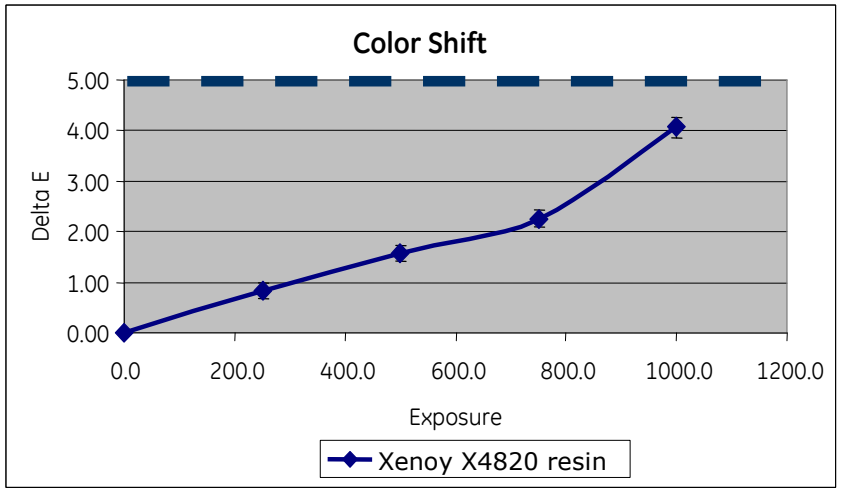
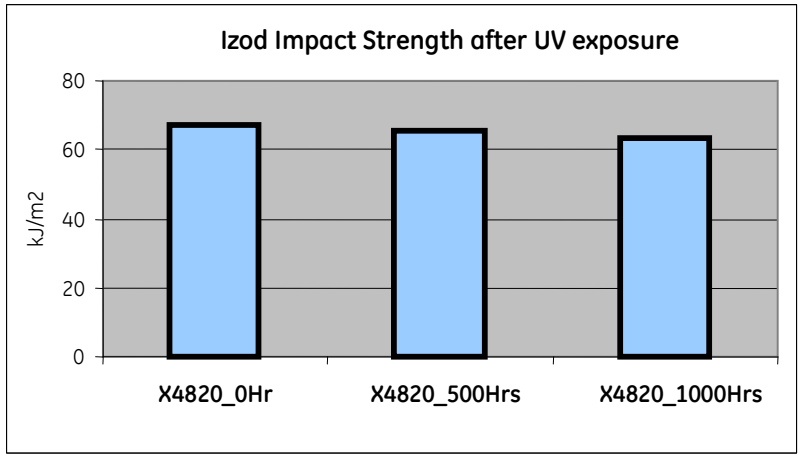
Outdoor weathering





Protocol:ASTM G155
OEM Spec: Delta E < 5 (1000 hr exposure)

Xenoy X4820 resin : Good weatherability, color retention with modulus/ductility balance….

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Aesthetics

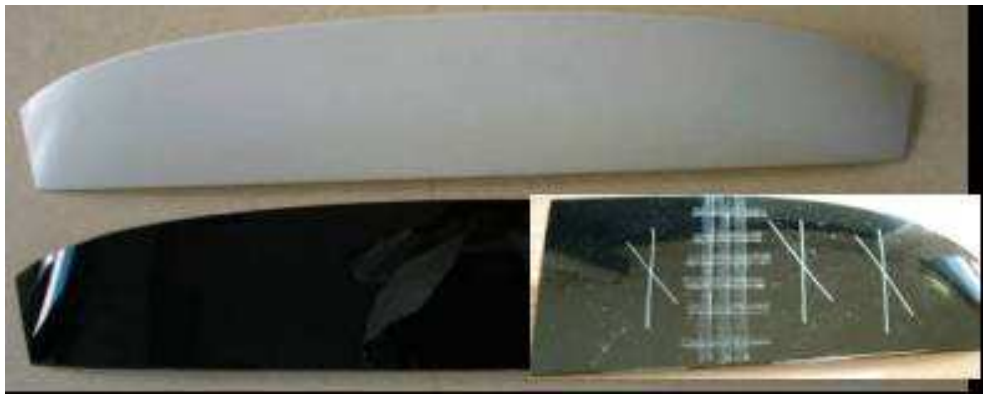
Materials	Paint adhesion by STEAMJET						Crosshatch
	HDW A				HDW B		
	Part 1		Part 2				
	1	2	1	2	Part 1	Part 2	
Xenoy HMD resin	OK	OK	OK	OK	OK	OK	OK
Reference MF Xenoy resin	OK	OK	OK	OK	OK	OK	OK

Paint system details

- Wörwag water based Base coat Black Jack, (10-15 microns) Drying 15' @80 degC
- Wörwag Solvent based Clear coat, (25 – 30 microns) Curing 45' @ 80 –85 degC

	HDW A	HDW B
Pressure (Bar)	65 +/- 1	65 +/- 1
Distance Nozzle Tip / painted surface	10 cm	15 cm
Duration (sec.)	60	60
Temperature (C)	60 +/- 1	60 +/- 1
Nozzle Type	std	"DCX"

HDW B is acc. SMART spec. 96002



Paint Adhesion

(Above testing is done on Xenoy X4870HH resin, Xenoy X4820 resin is expected to perform similar – actual testing required)

Xenoy X4820 resin : Excellent surface finish and paint adhesion (w/o primer) provides superior paint quality

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UL Yellow Card

QMFZ2 Component - Plastics Monday, July 02, 2007 E161759

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GLOBAL GRADES - RESIN 1 PLASTICS AVE PITTSFIELD MA 01201

Material Designation: **X4820 (f2)(1)(5)**

Product Description: Polybutylene Terephthalate/Polycarbonate (PBT/PC), designated "Xenoy" furnished as pellets.

Color	Min. Thick. (mm)	Flame Class	HWI	HAI	RTI Elec	RTI Imp	RTI Str	IEC GWIT	IEC GWFI
YL	1.5	HB	3	0	75	75	75	-	-
	3.0	HB	2	0	75	75	75	-	-

CTI: 2 **IEC CTI** (V): - **HVTR:** 3 **D495:** 6 **IEC Ball Pressure** (°C): -

Dielectric Strength (kV/mm): 27
Volume Resistivity (10^Xohm-cm): 15
Dimensional Stability(%): 0.04
ISO Tensile Strength (MPa): -
ISO Flexural Strength (MPa): -
ISO Heat Deflection (°C): -
ISO Tensile Impact (kJ/m^2): -
ISO Izod Impact (kJ/m^2): -
ISO Charpy Impact (kJ/m^2): -

(1) Americas E121562

(5) Australia E101788

(f2) Subjected to one or more of the following tests: Ultraviolet Light, Water Exposure or Immersion in accordance with UL 746C, where the acceptability for outdoor use is to be determined by UL Inc.

NOTE Material designation may be followed by a color nomenclature consisting of either an alpha/numeric or a numeric/alpha combination.

Report Date: 8/12/1994 Underwriters Laboratories Inc®

UL94 small-scale test data does not pertain to building materials, furnishings and related contents. UL 94 small-scale test data is intended solely for determining the flammability of plastic materials used in components and parts of end-product devices and appliances, where the acceptability of the combination is determined by ULI.

Xenoy X4820 resin : UL 94 HB, UL F2 Rated…CTI = 2

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Regrind Capability….Property retention

Xenoy X4810 resin

Property	condition	standard	unit	Xenoy X4810 resin	25% regrind	50% regrind	100 % regrind
Tensile stress at yield	50 mm/min, RT	ISO 527	MPa	60	100	100	100
Tensile nominal strain at break	50 mm/min, RT	ISO 527	%	110	95	99	99
Flexural modulus	2 mm/min, RT	ISO 178	MPa	2500	96	96	95
Flexural strength	2 mm/min, RT	ISO 178	MPa	87	99	99	99
Multi axial Impact	4.4 m/s, +23° C	ISO 6603-2	J	110	117	117	116
	4.4 m/s, -20° C	ISO 6603-2	J	100	107	104	104
Izod Impact	5.5J, notched, +23° C	ISO 180/1A	kJ/m2	50	99	95	90
	5.5J, notched, +0° C	ISO 180/1A	kJ/m2	20	96	93	92
	5.5J, notched, -20° C	ISO 180/1A	kJ/m2	16	113	109	104
Vicat B120	50N, 120° C/h	ISO 306	° C	131	100	99	99
HDT-A	1.80 MPa, flat	ISO 75	° C	91	99	96	100

Property retention (%)

Mechanical: No significant change

Impact: Multi axial not affected

Heat: No effect up to 100% regrind

Xenoy X4820 resin : Similar regrind performance expected … retain mechanical and impact properties up to 25% regrind, retain heat performance with 100% regrind.

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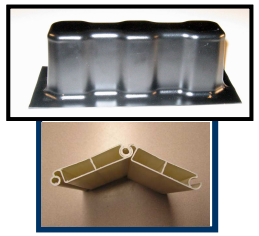
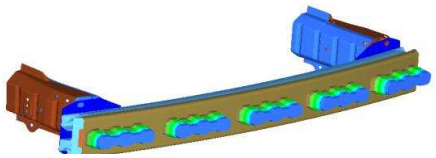
Alternative Processing Techniques

Extrusion/Thermoforming & Profile Extrusion



- Extrusion/T'forming process
- Structural layer for co-extrusion
- High stiffness at lower thickness
- Dent & corrosion resistance…

→ OVAD & Agril. hoods, enclosures
→ Sliding doors (profile extrusion)
→ EAs and other Auto parts



Blow Molding

- Extrusion/Blow molding process
- Excellent melt strength
- Hang time up to 90 sec
- Blow ratio of up to 3:1
- Stiffer part with ductility

→ Rugged packaging
→ Structural shells, enclosures
→ Structural EAs for Auto

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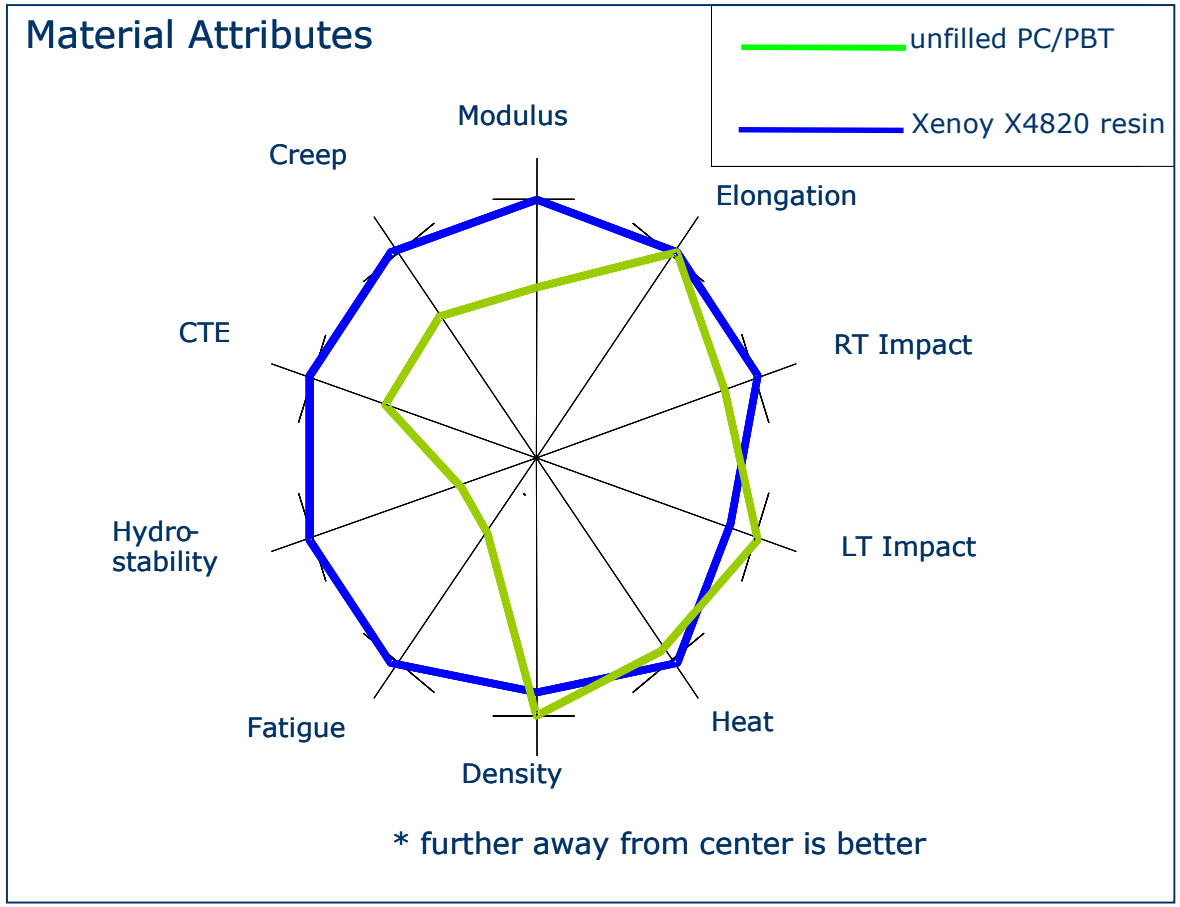
Xenoy X4820 resin : Versatile product for various processing techniques and demanding applications!

Conclusion…



Xenoy X4820 resin : A versatile engineering thermoplastic for demanding applications…

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Portfolio Expansion…FR version of Xenoy X4820 resin

All are tested according to ISO standards		Xenooy X4820 resin lab	Xenoy EXXY0198 resin Lab dev.
INI, 5.5 J (23℃)	kJ/m2	57	45
ductility	%	100	100
PI, 4.4 m/s, (23℃)	J	108	117
ductility	%	100	100
PI, 4.4 m/s, (-20℃)	J	97	94
ductility	%	100	80
TM	MPa	3070	3010
TY	MPa	57	56
EB	%	114	111
Vicat B120	℃	133	141
BPT at 125℃, 3.2 mm	-	Pass	Pass
GWFT, 850 ℃, 3.2 mm	%	Fail	Pass
UL V-rating, 1.5 mm	-	V2	V0
UL V-rating, 0.8 mm	-	V2	V0/V1
CTI, 175V	-	Pass	Pass

FR HMD Xenoy – EXXY0198 resin

- UL 94 V0 @ 1.5mm
- BPT @ 125 Deg C
- UL 94 V0 @ 0.8mm expected

Potential Markets:

- Electronics & Electrical
- Appliances
- Consumer electronics
- Communication & Navigation
- Other

Potential Applications:

- Electrical housing, covers
- Appliance handles, enclosures
- Antenna covers
- Battery packs, housings etc…

Xenoy EXXY0198 resin : Robust FR system with higher mechanical performance

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Case Study – Xenoy X4820 resin

DEWALT "COMPACT" Power tools

DEWALT Power tools

Application Needs:

- High stiffness (Structural thinner housing, rigidity against motor vibration)
- Drop Impact (up to –10°C) (Compact design capable of bearing load)
- Weatherability (Property retention, 1000 Hr UV exposure)
- Color stability and Color consistency
- UL 94-HB, UL F2, CTI >= 2
- Chemical resistance to grease & motor oil

Xenoy X4820 resin : **Ductile & Stiff** alternative to **filled** & **unfilled** thermoplastics for B&C, Consumer, Industrial and other markets

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Case Study – Xenoy X4820 resin

East Hill Instruments
Pressure calibration pump handle (orange)

Application needs:

- High stiffness/rigidity (No buckling)
- Fatigue performance (preventing cracking issue)
- Drop Impact (up to –10 deg C)
- Chemical resistance to grease & motor oil

Xenoy X4820 resin : **Ductile & Stiff** alternative to **filled** & **unfilled** thermoplastics for B&C, Consumer, Industrial and other markets

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Markets & Applications

Tough, durable & versatile ***Xenoy X4820*** resin allows design flexibility, parts consolidation and lasting application performance….. an excellent material candidate for parts **requiring**…

- Higher **stiffness** & **structural** strength --> thinner wall…weight out!
- **Ductility** --> durability for long-term performance
- **Creep** & **fatigue** resistance --> enhanced part performance
- Lower **CTE** --> improved dimensional stability
- Exposure to heat and hydro conditions --> longer product life!
- Aesthetics via custom colors or painting
- **Processing flexibility** (Injection moldable, T'formable & Extrudable)

Potential <u>Markets</u> & <u>Applications</u>:

- **B&C** – Power tool housing & battery packs
- **Defense** – Rugged communication equipments, antenna housing, packaging
- **Industrial** – Farm equipment components profile extrusion, sport accessories
- **Automotive** & **Heavy truck** – Energy absorbers, door handles, fuel tank flaps
- **Portable electronics** – enclosures, frames

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Datasheet

Xenoy X4820 is a high modulus PC/PBT Blend. This resin provides high chemical resistance, excellent impact, very low creep, low CTE, excellent fatigue and dimensional stability.

TYPICAL PROPERTIES [1]	TYPICAL VALUE	UNIT	STANDARD
MECHANICAL			
Tensile Stress, yld, Type I, 2.0 in/min	8200	psi	ASTM D 638
Tensile Stress, brk, Type I, 2.0 in/min	8400	psi	ASTM D 638
Tensile Strain, yld, Type I, 2.0 in/min	4.2	%	ASTM D 638
Tensile Strain, brk, Type I, 2.0 in/min	140	%	ASTM D 638
Tensile Modulus, 2.0 in/min	464000	psi	ASTM D 638
Flexural Stress, yld, 0.05 in/min, 2 in span	13100	psi	ASTM D 790
Flexural Modulus, 0.05 in/min, 2 in span	420000	psi	ASTM D 790
Tensile Stress, yield, 50 mm/min	58	MPa	ISO 527
Tensile Stress, break, 50 mm/min	52	MPa	ISO 527
Tensile Strain, yield, 50 mm/min	4.2	%	ISO 527
Tensile Strain, break, 50 mm/min	100	%	ISO 527
Tensile Modulus, 1 mm/min	3000	MPa	ISO 527
Flexural Stress, yield, 2 mm/min	87	MPa	ISO 178
Flexural Modulus, 2 mm/min	2850	MPa	ISO 178
IMPACT			
Izod Impact, notched, 73°F	13.1	ft-lb/in	ASTM D 256
Izod Impact, notched, -22°F	2.8	ft-lb/in	ASTM D 256
Instrumented Impact Total Energy, 73°F	531	in-lb	ASTM D 3763
Izod Impact, notched 80*10*4 +23°C	55	kJ/m²	ISO 180/1A
Izod Impact, notched 80*10*4 -30°C	15	kJ/m²	ISO 180/1A
Charpy 23°C, V-notch Edgew 80*10*4 sp=62mm	60	kJ/m²	ISO 179/1eA
THERMAL			
Vicat Softening Temp, Rate B/50	266	°F	ASTM D 1525
HDT, 264 psi, 0.125", unannealed	208	°F	ASTM D 648
HDT, 264 psi, 0.125", unannealed	208	°F	ASTM D 648
CTE, flow, -40°F to 100°F	4.16E-05	1/°F	ASTM E 831
CTE, xflow, -40°F to 100°F	6.11E-05	1/°F	ASTM E 831
CTE, -40°C to 40°C, flow	7.5E-05	1/°C	ISO 11359-2
CTE, -40°C to 40°C, xflow	1.1E-04	1/°C	ISO 11359-2
Vicat Softening Temp, Rate B/50	132	°C	ISO 306
Vicat Softening Temp, Rate B/120	134	°C	ISO 306
HDT/Af, 1.8 MPa Flatw 80*10*4 sp=64mm	94	°C	ISO 75/Af
PHYSICAL			
Specific Gravity	1.25	-	ASTM D 792
Mold Shrinkage, flow, 0.125"	0.95 - 1.1	%	GE Method
Melt Flow Rate, 250°C/5.0 kgf	10	g/10 min	ASTM D 1238
Density	0.04	lb/in³	ISO 1183
Water Absorption, equilibrium, 73°F	0.42	%	ISO 62
Moisture Absorption (23°C / 50% RH)	0.14	%	ISO 62
Melt Volume Rate, MVR at 265°C/5.0 kg	12	cm³/10 min	ISO 1133

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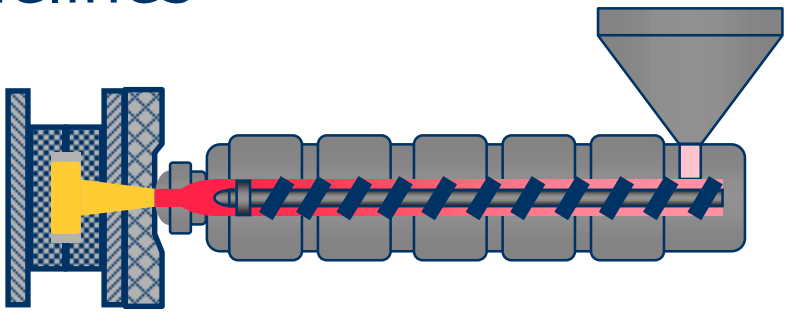
Processing Guidelines



Parameter	Value	Unit
Drying Temperature	90 - 110	°C
Drying Time	2 - 4	hrs
Maximum Moisture Content	0.02	%
Melt Temperature	255 - 270	°C
Nozzle Temperature	250 - 265	°C
Front Temperature	250 - 270	°C
Middle Temperature	240 - 265	°C
Rear Temperature	230 - 250	°C
Hopper Temperature	40 - 60	°C
Mold Temperature	60 - 80	°C

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Xenoy X4820 resin : Can be used in existing unfilled Xenoy tools

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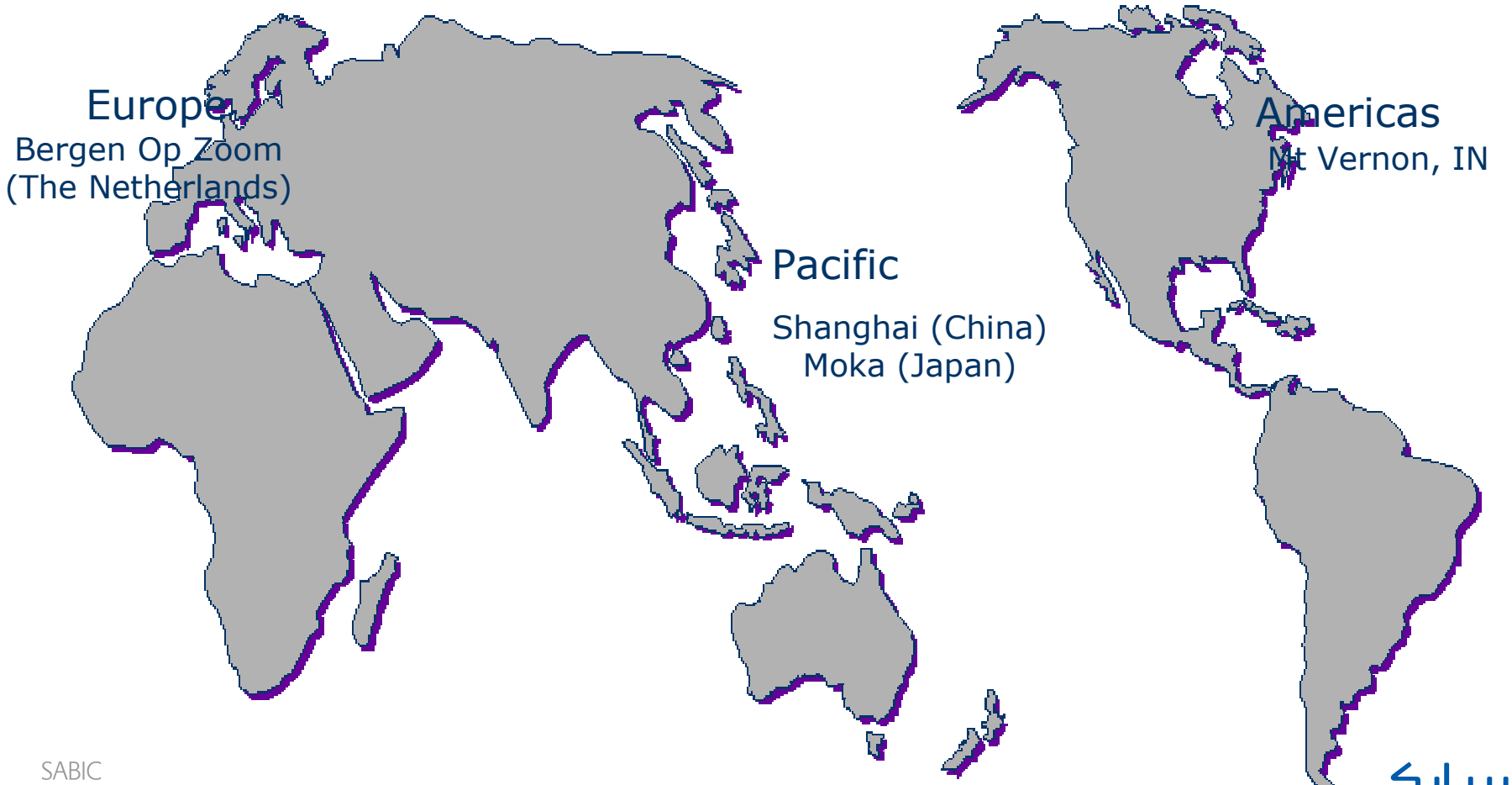
Global Production Sites

Global Production capabilities & Potential translation sites



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Thanks for Attending!

- You May Continue to Ask Questions to Our Product Experts
- We have recorded today's event but will not post the recording until Webex' recording playback is fixed. In the meantime you will receive a link to the pdf version of the presentation.

They Can Assist You in Getting What You Need, Including a Field Representative to Contact You About Your Application

Xenoy X4820 resin：Nano technology based PC/PBT blend with unique balance of properties

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