EASTMAN

Eastman **Tritan™ MXF** copolyesters

*Matching the **housing** and **hardware** needs of medical electronic devices*

Eastman **TRITAN™**
copolyester

Preventing medical device failures starts with the right materials.

The healthcare industry is experiencing a growing number of premature housing failures that can't be accounted for by a traumatic bump or accidental drop. Many healthcare leaders are discovering that the disinfectants used to prevent healthcare-associated infections (HAIs) are causing housings and hardware to crack, break, warp, or become discolored or sticky.

Designers and engineers need housing and hardware materials that provide greater reliability and cleanability for their latest electronic devices. The Eastman MXF portfolio of medical polymers provides many options.

> "Making the equipment properly so that it can be disinfected and, therefore, be safer for patients… any company that chooses to go down that path is a good partner for hospitals."
>
> ALAN LEVINE
>
> EXECUTIVE CHAIR, PRESIDENT & CEO | BALLAD HEALTH

One portfolio of products for many needs

The history of the Eastman MXF portfolio is built on responding to customer needs. What started with Eastman Tritan™ MXF121 copolyester has evolved to include products that meet special needs for greater toughness, easier mold release, and different viscosities to meet the high-flow requirements of filling complex molds.

The MXF portfolio builds on the advantages of Tritan

- Measurable and outstanding disinfectant resistance
- Higher flow options to fill complex or existing tooling
- Higher impact strength options for added durability
- Fully compounded, stable colors
- Similar shrinkage to PC/ABS—potential to use existing tools
- UL 94 V-2 flame-retardant rating

You can compare the mechanical properties and chemical resistance of individual Eastman MXF portfolio products and competitive materials on the following pages.

Match the physical properties and manufacturability you need.

Different designs require different material strengths—and all require manufacturability to profitably bring them to market.

Table 1 lets you compare key physical properties of polymers in the Eastman MXF portfolio along with polycarbonate and polycarbonate blends.

Table 1. Eastman MXF portfolio physical properties

Properties[a]	Test method (ASTM)	Eastman Tritan™ MX731 copolyester	Eastman Tritan™ MXF121 copolyester	Eastman MXF221 copolyester	Eastman Tritan™ MXF321 copolyester	Eastman Tritan™ MXF321HF copolyester	Eastman Tritan™ MXF421 copolyester	Eastman Tritan™ MXF421HF copolyester	PC (high flow)	PC/ABS blends	PC/polyester blends	PC/PBT
General properties												
Specific gravity	D792	1.18	1.19	1.19	1.2	1.2	1.21	1.21	1.19–1.21	1.14–1.19	1.20–1.21	1.3
Mold shrinkage, mm/mm	D955	0.005–0.007	0.003–0.006	0.003–0.006	0.003–0.006	0.003–0.006	0.003–0.006	0.003–0.006	0.005–0.008	0.004–0.007[c]	0.006	0.012–0.014
Potential transparency	D1003	YES	NO	YES	YES[b]	YES[b]	YES[b]	YES[b]	YES	NO	NO	NO
Mechanical properties												
Tensile stress at yield, MPa	D638	44	43	47	49	49	47	46	62	54–63	59	48
Tensile stress at break, MPa	D638	49	47	50	48	50	51	51	55–65	49–50	58–60	40
Elongation at yield, %	D638	7	6	5	5	5	6	5	6–7	4–5	6–8	6
Elongation at break, %	D638	>100	>100	>100	>100	>100	>100	>100	90	40–80	150	>50
Tensile modulus, MPa	D638	1580	1600	1670	1850	1850	1710	1700	2270	2300–3000	1700	1960
Flexural modulus, MPa	D790	1580	1750	1850	1890	1900	1740	1800	2240–2340	2620–2650	2500	1990
Izod impact strength (notched) @ 23°C (73°F), J/m	D256	860	150–200	1080	1100	1030	1000	900	640–800	530–550	1000–1290	670
Thermal properties—heat deflection temperature												
@ 0.455 MPa (66 psi), °C	D648	94	94	90	76	76	94	92	137	98–126	126–127	126
@ 1.82 MPa (264 psi), °C	D648	81	83	76	66	66	81	81	126–132	83–107	106–107	85
Flammability												
1.5-mm thickness	UL 94	HB	V-2	V-2	V-2	V-2	V-2	V-2	HB–V-0	V-0	V-2–V-0	V-0
3.0-mm thickness	UL 94	HB	V-2	V-2	V-2	V-2	V-2	V-2	HB–V-0	V-0	V-2–V-0	5VA @ 2.49 mm
Regulatory compliance												
REACH	Regulation (EC) No. 1907/2006	Complies	Complies	Complies (limited volume)	Complies	Complies	Complies	Complies	Complies	Complies	Complies	Complies
Biocompatibility	ISO 10993-5,-10	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

[a]*All properties dependent on color and other additive requirements* [b]*Processing and product testing for transparency in progress* [c]*Various methods, including ISO 2577, ASTM D955, etc.*

> "The Eastman polymers satisfied not only the chemical resistance but all other durability and functionality we needed."
>
> RICH CIPOLLI
>
> VICE PRESIDENT OF PRODUCT DEVELOPMENT | MINDRAY NORTH AMERICA

Materials in the Eastman MXF portfolio enable ease of processing, including part filling. Lower ejection force indicates easier demolding.

Table 2. Eastman MXF portfolio ejection force and viscosity

Material	DEMOLDING Part ejection force* (lbf)	MOLD FILLING Viscosity (1200 s-1 @ 280° C; Pa•s)	MELT-FLOW RATE 9 g/10 min @ 260°C, 2.16 kg load
Eastman MXF221	963	170	8–11
Tritan MXF121	475	276	7–9
Tritan MXF321	359	256	9–13
Tritan MXF321HF	380	163	13–17
Tritan MXF421	506	304	6–10
Tritan MXF421HF	514	220	12–16
PC/ABS 1	502	100	21
PC/ABS 2	578	200[a]	17[b]
PC/PBT 1	—	175	8[c]

**Data is generated based on internal zero-draft cup mold study; more details available on request*
[a]Data reported at 1000 s^{-1} @ 260°C
[b]Data reported at 260°C, 5 kg load
[c]Data reported at 260°C, 5 kg load

Eastman helps you select polymers for chemical resistance, manufacturability, and reliability.

Eastman has the polymer expertise you need to design housings and hardware that are easy to clean and can retain their impact strength and good looks after disinfection.

Table 3. Eastman MXF portfolio chemical resistance data based on Eastman's 4-step test[a]

Material	Control (joules)	Virex® TB (ether, benzyl quat)	Super Sani-Cloth® (IPA quat)	Clorox® Bleach (hypochlorite)	IPA
		Retention of impact energy to break (%)			
Tritan MXF121	4.8	90 ± 1	87 ± 2	91 ± 2	82 ± 1
Eastman MXF221	5.2	94 ± 2	83 ± 1	95 ± 3	85 ± 3
Tritan MXF321	4.8	96 ± 3	87 ± 4	97 ± 4	80 ± 10[b]
Tritan MXF321HF	4.8	93 ± 1	81 ± 3	90 ± 20	84 ± 5[b]
Tritan MXF421	4.1	98 ± 4	95 ± 4	97 ± 3	93 ± 1[b]
Tritan MXF421HF	4.3	85 ± 23	83 ± 20	97 ± 4	80 ± 10[b]
PC/PBT 1	5.3	8 ± 3	91 ± 8	95 ± 5	30 ± 3
PC/polyester 1	5.5	6 ± 1	75 ± 28	94 ± 3	47 ± 10
PC/polyester 2	5.8	11 ± 2	26 ± 1	65 ± 51	23 ± 3
PC/ABS 1	6.8	15 ± 1	16 ± 1	92 ± 1	16 ± 1
PC/ABS 2	6.6	Break on jig	42 ± 37	100 ± 1	15 ± 1

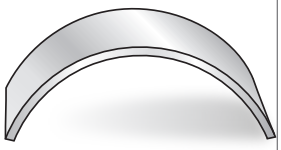
Excellent (≥80%)
Good (≥60%)
Poor (<60%)

[a]*Four-step test video available on request; based on 1.5% strain, 24-hour exposure at room temperature followed by reverse side impact test.*
[b]*70% IPA was evaluated.*

Test housing material performance using this simple 4-step test.

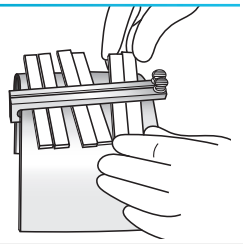
1. Select the appropriate jig.

Choose the strain level that most appropriately reflects environmental stress cracking.



2. Load flex bars onto jig.

Remember to load some control samples that will not be exposed to chemicals.



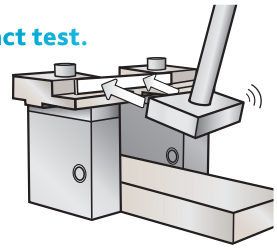
3. Apply chemicals to the flex bars using presoaked pieces of cotton.

Chemicals such as commonly used hospital disinfectants, lipids, drugs, or drug carrier solvents can be used. Enclose the entire sample jig in a plastic bag to prevent evaporation and leave at room temperature for 24 hours.

4. Perform reverse side impact test.

This is the differentiating step.

Unload the samples, and run a reverse side impact test on the exposed and control samples.



NOTE: Part and tool design and processing can affect compatibility with disinfectants; therefore, all parts and assemblies should be tested in their final form.

More than polymers—partners in product design and development

Designing housings for medical electronic devices with greater cleanability and lower cost of ownership takes a team effort. Beyond the inherent properties of our disinfectant-ready polymers, Eastman can add value throughout product design and commercialization.

- Eastman starts with a technical review of your product requirements, part design, and tooling with special attention to the most efficient design elements for copolyesters, such as gate design, venting, and cooling.
- We offer new options that address design constraints with existing tooling—options that facilitate easier filling and part ejection.
- We can match your brand colors in fully compounded formulations.
- Eastman can provide simple testing that allows designers to quickly screen polymers for cleanability, disinfectant resistance, and durability.

The switch to Eastman Tritan™ MXF copolyesters **can save you money:**

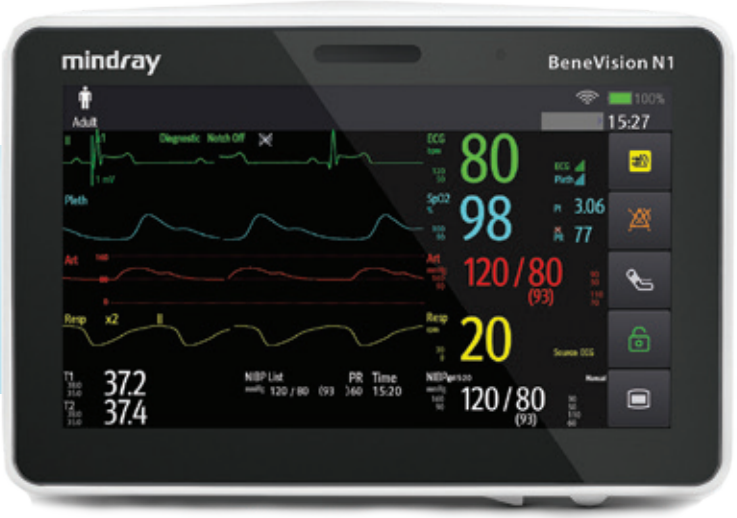
- Reduce repairs, returns, and warranty claims from breakage while boosting durability.
- No new tooling required—switch from PC/ABS with minor mold modifications.
- Low scrap rate—avoid warpage and assembly problems associated with PC/PBT polymers by switching to Tritan MXF.
- One polymer for most needs—using only Tritan MXF in an assembly will save money by avoiding problems caused by the use of multiple polymers, including discoloration and durability problems that stem from lack of chemical resistance.

Grow and protect market share with Eastman Tritan™ MXF copolyesters

Device manufacturers are finding that by switching to Tritan MXF they can extend warranties. A longer warranty translates into real value for healthcare, signaling the need for fewer repairs and a longer device life.

Healthcare must focus on reduction of infections, and cleanability is key to allowing the use of most effective disinfectants and protocols. With Tritan MXF, manufacturers can market devices with an exhaustive list of approved cleaners **and** the science behind why their devices are made to last. A list of disinfectants that have been tested with Tritan MXF polymers and shown favorable results is included on the following page.

Mindray extended their warranty from one to five years on all patient monitors in North America, confident that the switch to Tritan MXF polymers for the housings ensures their durability and longer life.



> "Some manufacturers are getting it, and they're actively testing their products with various cleaning products."
>
> RICHARD FECHTER
>
> BIOMEDICAL ENGINEER | USCF MEDICAL CENTER

Based on Eastman's internal testing, the following disinfectants have shown good results with Tritan MXF polymers.

OEMs may wish to include a list of compatible disinfectants in instructions for use or a cleaning brochure following their own independent testing on fully assembled devices. Other sanitizing agents may be compatible, so Eastman continuously conducts testing with new disinfectants. Contact your Eastman representative to initiate testing with any disinfectants you would like to see added to this list.

Disinfectants

- Hydrogen peroxide
- Isopropyl alcohol
- Clorox® Bleach (hypochlorite)
- 3M Neutral Quat (quat)
- Cidex® (aldehyde)
- Wonder Woman wipe (IPA)
- Virex® TB (ether, benzyl quat)
- CaviCide™ (IPA, ether)
- Envirocide™ (IPA, ether)
- Wex-Cide Ready to Use (RTU) (phenylphenol)
- GS HD Disinfectant 256 (quat)
- Bleach (germicidal hypochlorite)
- Quat alcohol cleaner (quat, IPA)
- D Towel lotion (hypochlorite)
- H_2O_2 cleaner disinfectant (H_2O_2)
- Sani-Cloth® AF3 (benzyl quat, DPG ether)
- Sani-Cloth® HB (benzyl quat)
- Super Sani-Cloth® (IPA quat)
- Sani-Cloth® Plus (IPA benzyl quat)
- Sani-Cloth® Bleach (hypochlorite)
- Sani-Cloth® Prime (quat, alcohol)
- Oxivir® TB wipes (H_2O_2 cleaner)
- Clinell Universal Wipes (quat)
- Accel® TB Wipes (H_2O_2)
- Accel® TB RTU (H_2O_2)
- 8.5% bleach solution (hypochlorite)
- OxyCide™ 230 (H_2O_2, peracetic acid)
- Virex® II 256 (benzyl quat)
- Virox® AHP 5 RTU (H_2O_2)
- Aniospray 29 (quat, ethanol)
- ASP Enzol® (enzyme)
- Cidex® OPA (phthalaldehyde)

Stay in contact with your Eastman representative to be the first to know about new polymers in our expanding MXF portfolio.

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The results of **insight**™

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