EASTMAN

Technical guidance for injection-molded eyewear frames made with Eastman Tritan™ Renew copolyester

Tritan Renew VX301-50 and VX351HF-50

Introduction

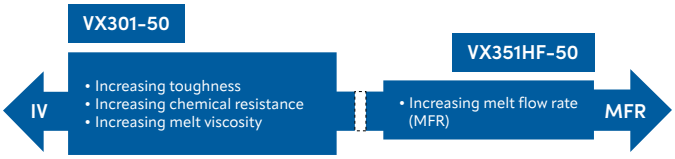
Sustainability has increasingly become a need in the eyewear industry. To help achieve their sustainability goals, brands and manufacturers can opt for Eastman Tritan™ Renew copolyester VX301-50 and VX351HF-50, which includes 50% certified recycled content derived from advanced molecular recycling technology. Unlike mechanical recycling, molecular recycling breaks down plastic waste into its fundamental building blocks to be reused in the manufacturing process. With molecular recycling, Tritan Renew maintains identical processing conditions, mold design, design options and secondary operations of legacy Tritan, ensuring a hassle-free switch for greater sustainability.

Scope:

Tritan Renew can be used for injection-molded eyewear frames, including sunglasses and reading glasses.

1. Material

Tritan Renew VX301-50 offers excellent chemical resistance and toughness and is ideal for sunglass and reader frames with a thickness greater than 2.0 mm.



Trade-offs in chemical resistance, impact and flow

Tritan Renew VX351HF-50 offers excellent flowability and low internal stress and is ideal for frame designs requiring high flow.

	Tritan VX301-50		Tritan VX351HF-50	
	MFR (g/10 min)		MFR (g/10 min)	
Temperature (°C)	1.25 kg	2.16 kg	1.25 kg	2.16 kg
260	3.5	6.0	8.3	13.6
280	6.5	12.9	19.3	29.5

Most plastics used in injection-molded frames, including polycarbonate (PC) and transparent polyamide (tPA), may be replaced with Tritan Renew.

If you have any special requirements for your material selection, contact your Eastman engineering expert to discuss possible solutions.

2. Eyewear injection process introduction

Tritan Renew VX301-50 offers excellent chemical resistance and toughness and is ideal for sunglass and reader frames with a thickness greater than 2.0 mm.

1. Shot size vs. barrel capacity

To avoid undesirable molding issues, it is recommended to use an injection machine with a shot size of 30%–70% of barrel capacity. Polymer in the barrel can be degraded easily if small parts are molded on a machine with a large barrel capacity.

2. Melt residence time

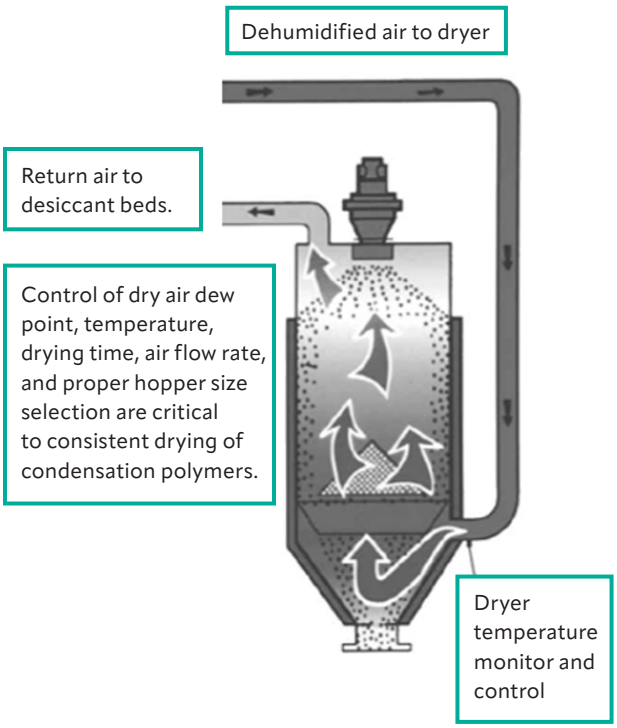
Maximum residence time is halved with T 10 degree higher or doubled with T 10 degree lower (example: T_R < 5 min @ 280°C, T_R < 10 min @ 270°C). The time in a hot runner should also be included in the residence time. The calculation of residence time in barrel is: T_R (minutes) = (injection stroke / (injection start – cushion) x (cycle time/60) x 2

3. Screw

We recommend a screw compression ratio of 2.8~3.2:1 and length-to-diameter ratio of 18~22:1.

4. Dryer

We recommend using a desiccant dryer that can provide a hermetic vacuum hose connection between the dryer and injection machine feeding port. The dew point of dryer should be less than -30°C.



For orders with small quantities or needs to change color frequently, a small hopper dryer (< 10 kg pellets) with a heating function and good sealing is preferred for heat preservation after the pellets are dried in the desiccant dryer and blended with colorants.

Drying conditions for Tritan Renew	
Drying temp.	88°C
Drying time	4-6 hours
Dryer dew point	< -30°C

Pellet moisture content below 0.03% (300 ppm) or 0.015% (150 ppm) is required.

5. Mold temperature

The mold temperature could be adjusted between 38°C-66°C. For eyewear frames, it is acceptable to lower the mold temperature to reduce injection cycle time. Some frame designs can benefit from water chillers, which can lower the mold's temperature more quickly.

6. Moisture inspection

The goal of drying is to reduce the polymer's moisture content to 0.03% or lower as measured by Karl Fischer titration or by calibrated weight-loss methods.

7. Barrel purging

It is recommended to purge the barrel with Tritan or Tritan Renew resin. PC can also be used as a purging agent prior to Tritan Renew processing. However, take note of possible BPA contamination when purging with PC. PE, PP, PS and PMMA should be avoided because they can mix with Tritan and result in extended time for purging.

Purging approximately five shots is recommended after any interruption or disturbance more than five minutes.

8. Melt temperature measurement

Set the barrel temperature to 260°C–~280°C. Measure the actual melt temperature by air shots (with proper back pressure setting) to ensure the actual melt temperature to be in the range of 260°C—~280°C.

Calculate residence time and adjust temperature settings accordingly to avoid material degradation.

9. IV retention

Molecular weight (IV) affects many polymer properties, i.e., tensile properties, impact properties, creep and chemical resistance. Properly processed Tritan will show minimal IV loss.

Eastman can support customers in IV loss analysis.

Typical processing conditions for Tritan Renew

General guidelines	= Initial IV - final IV	VX301-50	VX351HF-50
Nominal pellet IV*	0.00	Typically 0.72	Typically 0.63
Proper processing	< 0.05	> 0.67	> 0.58
Poor drying/processing	0.05–0.08	0.64–0.67	0.55–0.58
Unacceptable	> 0.08	< 0.64	< 0.55

*The range of nominal pellet IV's for Tritan™ materials is detailed in the material sales specifications.

10. Shut-down procedure

In general, material feed can be stopped and injection molding can continue until the screw and barrel are empty. When switching to another material, purge with a material of interest or a commercial purge compound and run the screw empty, followed by powering down the equipment.

When stopping production with Tritan Renew for some time (provided that production will resume with Tritan Renew):

- Run the barrel empty.
- Move the screw forward.
- Shut down the barrel heater.
- Reset the barrel temperature to nominal.
- Purge with dried Tritan Renew or Tritan resin until clean material exits from the nozzle.

To avoid chemical or aesthetic contamination, do not use other polymers.

When purging Tritan Renew in preparation for production with other polymers:

- Run the barrel empty.
- Purge the machine with an appropriate purge compound using ~ 260°C barrel-setting temperature.
- Move the screw forward.
- Change to the targeted polymer.
- Purge as usual using the new polymer temperature settings (low range).
- Run production.

3. Design suggestions

Tritan Renew can be used to mold full-rim and semi-rimless frames. From a rheological standpoint, it can fill well in a mold cut for (PC).

Cooling system improvements/optimization can reduce the cycle time of the molding process.

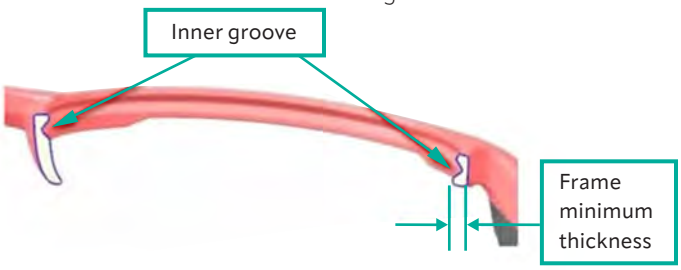
A proper gate size can dramatically improve the moldability of a design. Excessive filling pressure will be experienced with a very thin gate and result in:

- Large shrink marks at pile head
- A small gate, making the molten polymer freeze rapidly, leading to improper cavity fill
- High shear stress at gate location, leading to fracture failures in post-injection manufacturing processes

3.1 Full-rim designs

Aside from aesthetics, a rim's function is to keep the lens in the proper location. The inner groove is a very important design element for the rim (as shown on page 5). Typically, the depth of the groove is 0.50 mm—0.75 mm.

The groove design of the rim directly mates to the edge groove of the lens. Additionally, the moveable inserts in the mold should account for the same groove dimensions.



Recommended minimum frame thickness should be greater than 2.0 mm. Ensuring that the frame thickness is larger than 2.0 mm will provide enough strength to allow the entire frame to be produced with Tritan Renew. Designs with gradual transitions in thickness will minimize the opportunity for cracking and/or breaks.

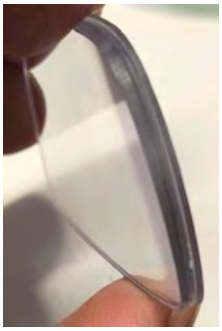
For applications requiring a frame thickness smaller than 2.0 mm, contact an Eastman engineering expert for material and/or design recommendations.

3.2 Semi-rimless designs

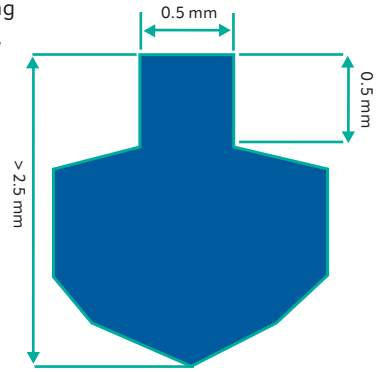
It is recommended that semi-rimless frames made with Tritan Renew have an overall thickness greater than 2.5 mm. This is to ensure that the frame has sufficient dimensional stability and will not deform.

Semi-rimless frames use a thin retaining thread/wire to secure the lens to the rim. Therefore, the lens cutting differs from full-rim designs in that grooves must be cut into the edges of the lens.

For applications where there is no inner groove in the frame, a rib must be designed on the rim, with a smaller gate implemented at the nose bridge location.



Lens cutting (W0.6 mm, D0.5 mm)



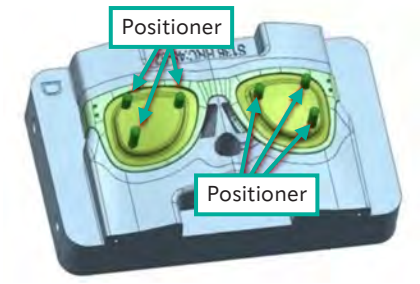
Cross-section of semi-rimless design

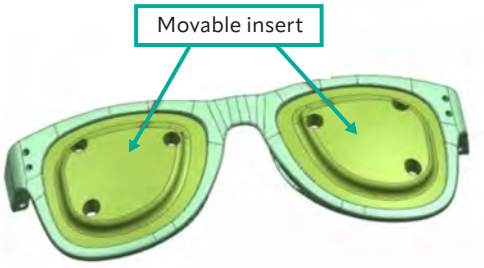
The section of rims

It is recommended to add a radius at sharp edges to reduce stress concentration and improve toughness. This can help reduce the risk of breakages during testing.

3.3 Mold design

Mold designs for Tritan and Tritan Renew eyeglass frames are similar to molds for PC and tPA materials. Often, moveable inserts are used for low-volume eyeglass manufacturing. As shown in the following, movable inserts can be used to add versatility in the size/shape of the rim and lens grooves, while reducing cost, vs. standard molds.

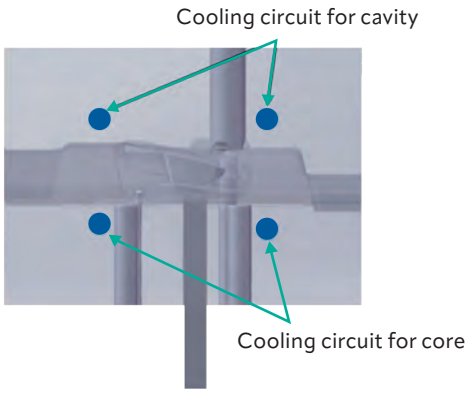


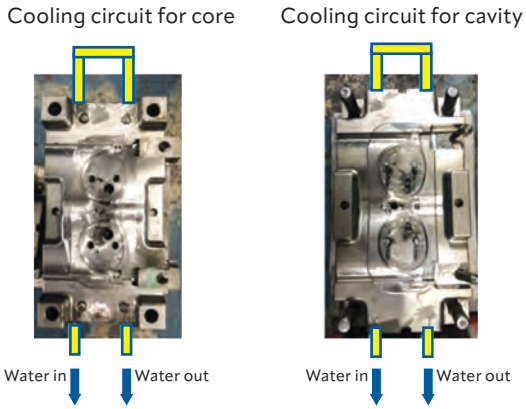


3.3.1 Cooling system

A proper cooling system design can reduce injection-molding cycle time and result in higher-quality products. The cooling inlet and outlet of the separate cooling circuit should be independently connected to a water chiller. The following images shows the recommended cooling design for eyewear frames.

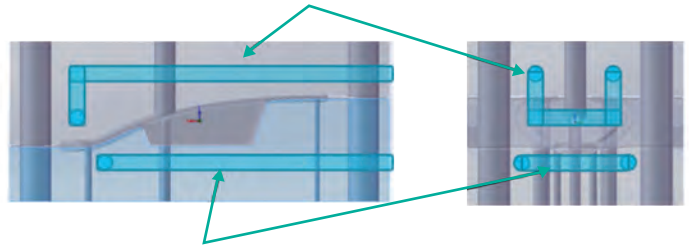
Rim cooling design





Temple cooling design

Direct cooling channels in the cavity block of the temple mold.



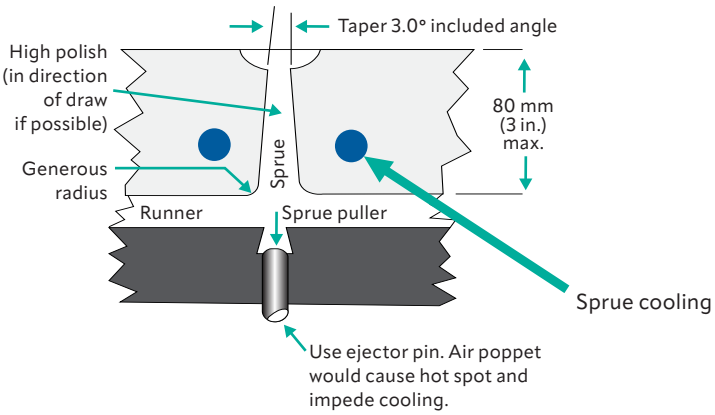
Cooling channels in core block of leg mold

3.3.2 Runner and gate design

Sprue design

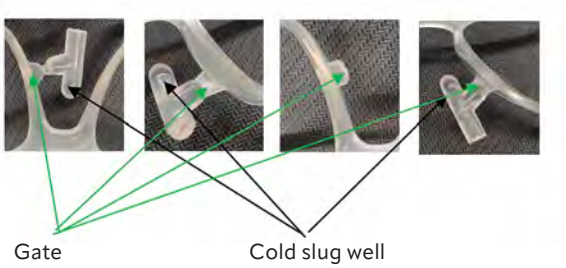
- A maximum sprue length of 80 mm with draft angle of 3.0°—5.0° is suggested. To aid in ejection, polish the sprue in the draw direction. Put a generous radius or supporting ribs at the junction of the sprue and runner system to avoid breakage during ejection.
- Set separated cooling circuits to cool the root of the sprue if possible. An efficient cooling on this area can provide cycle time advantages by reducing the cooling time.
- Place an ejector pin under the sprue puller rather than under an air poppet valve. An air poppet will cause a hot spot and impede cooling.

Sprue design



3.3.3 Runner and gate type

- Pictured are four types of edge gates that have been successful for Tritan Renew rims and temples.
- Gate design and/or sizes can be trialed for a robust rim and frame.



- The cold slug well is a good design aspect at the end of the runner.
- Gate thickness > 1.5 mm and width > 5.0 mm is recommended.
- When the gate is removed, it is recommended to leave behind a 3–mm to 5-mm remnant on the rim to reduce the risk of notching at that location. A notch can cause cracks.

3.3.4 Gate location

For most frame designs, the recommended gate location is near the nose-pad area. This gate location also results in a preferred location for weld lines and overall strength of the rims.

It is not recommended to position the gate near the transition area of a nose pad on thinner rim designs. This may cause crack propagation from the gate when the rims are squeezed.

Temples

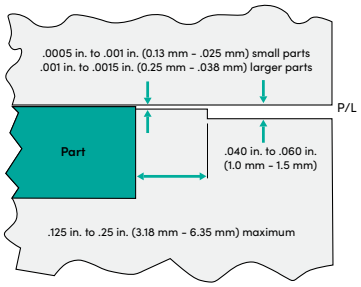
- It is recommended to place the gate position on the hinge side. A mirrored temple cavity layout offers a balanced melt flow.
- A gate thickness of > 1.5 mm and width > 5.0 mm is suggested.
- When the gate is removed from the temple, it is recommended to leave a 3-mm to 5-mm remnant on the temple to reduce the risk of notching at that location.

3.2.3 Mold venting

Venting

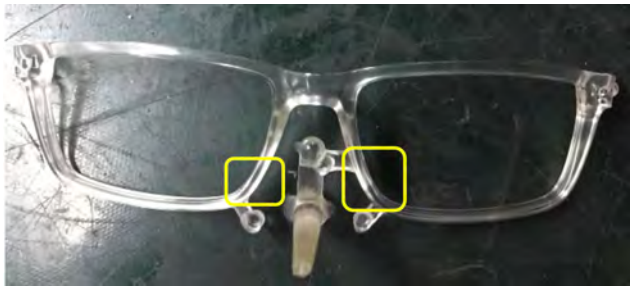
- Air displaced during filling process must be vented.
- Poor venting can result in:
  - Incomplete fill (short shot)
  - Burn marks (heat of compression)
- Suggested vent depths typically recommended are 0.0005 in. to 0.0015 in.
  - Vent depths can be affected by:
    - Size of part
    - Location in the cavity
    - Part fill pressure requirements
    - Viscosity of resin

Venting design



3.2.4 Knit lines and weld lines

- Knit lines occur when two flow fronts come together but do not completely merge/weld. This results in a low-pressure area in the cavity and a weak point in the final frame.
- Knit-line interfaces can be improved to minimize cosmetic defects and/or weak spots.
- Cold slugs and/or wells (shown in the following photo) can be used to improve knit-line interfaces; however, this is generally not included in original designs and is used only when necessary.



4. Secondary operations

The following table summarizes secondary operations with which Tritan Renew is compatible.

Frame type	Sun	Reader
Surface treatment		
Gate removal	✓	✓
Polishing	✓	✓
Ultrasonic cleaning	✓	✓
Hinge type		
Metal	✓	✓
Snap	✓	✓
Painting	✓	✓
Printing		
Rubber/stamp	✓	✓
Water transfer	✓	✓
Heat transfer	✓	✓
Silk screen	✓	✓
Paper wrap	x	x
Wire core	x	x
Overmolding	✓	✓

Eastman does not recommend Tritan Renew for paper-wrap printing techniques as this method requires higher processing temperatures than can be supported by Tritan Renew's HDT. Instead, water-transfer printing techniques are recommended.

Additionally, Tritan Renew is not recommended for use in wire-core or pin-insertion applications commonly found in temple portions of the frame. Eastman recommends Tenite™ cellulosics as suitable materials for these applications.

Precautions for Tritan Renew

As the HDT of Tritan Renew (85°C @ 1.80 MPa) is lower than that of PC (125°C @ 1.80 MPa), there are some precautions that should be taken into consideration:

- Processing temperatures
- Contact time
- Clamping force

Ultrasonic cleaning:

- Preferred drying temperature is below 65°C.

Painting:

- As the drying process for painting could last for many hours, the preferred drying temperature for Tritan Renew is below 65°C to avoid frame deformation.
- When securing articles to any type of fixture, lower clamp force is preferred to maintain dimensional stability of the product.
- Please ensure ample drying time between each layer of painting — preferred drying temperature is lower than 65°C.

The following table shows qualified TPU/TPE list for Tritan Renew over-molding applications.

Grade	Vendor	Hardness	Remark
IT85AU	Covestro	89A	TPU; UV stabilizer
ITB85AU-(TPS)	Covestro	87A	TPU; UV resistance
IT75AU (preferred)	Covestro	78A	TPU; UV resistance
Texin 285	Covestro	85A	FDA; all TPU of FDA in Covestro do not contain UV stabilizer
UE85Au	Covestro	89A	TPU; UV stabilizer
H85P4394	Huntsman	85A/36D	FCM (FDA)
LPR7725	COIM	80A	FDA; 45RMB/kg (MOQ1mt)
LPR8025	BASF	84A	Ester-based TPU; 45RMB/kg (MOQ1mt)
1185A10	BASF	85A	
1170A10	BASF	70A	
C85A10	BASF	85A	
785A10 HPM	BASF	85A	

Packaging:

- It is recommended to pack individual Tritan Renew frames separately to avoid deformation caused by the pressure of neighboring frames.

Eastman technical contacts

For AP and the U.S.

Rock Jiang/ 姜洪镭
Ophthalmic Technical Service, specialty plastics
Email: honglei.jiang@eastman.com
Office: (86)21-61208747
MP: (86)13651671513
Building 3, Yaxin Science & Technology Park, Lane
399 Shengxia Road, Pudong New District, SH, China

Vincent Liu/*刘斌*
Senior technical service representative
Email: vincent.liu@eastman.com
Tel: (86)20-3868 2188 Fax: (86)20-3868 2351
Mobile: (86)139-2608-0387
Room 703, Taikoo Hui Tower 1, 385 Tian He Road,
Tian He District, Guanghou, China

For EU

Gianandrea Teruzzi
Senior Application Development and Technical Service
Representative, specialty plastics
Email: g.teruzzi@eastman.com
Mobile: +39 338 4520780
Eastman Italia S.r.l. Sede Legale presso Studio Tributario
Societario Via Matteo Bandello, 5 - 20123 Milano - Italy

EASTMAN

Eastman Corporate Headquarters
P.O. Box 431
Kingsport, TN 37662-5280 U.S.A.

U.S.A. and Canada, 800-EASTMAN (800-327-8626)
Other locations, +(1) 423-229-2000

eastman.com/locations

SP-EYE-15218 7/23