

Triple-threat lens
Winning
combination
positions
material as a
market leader

Lens material is a triple jump in technology

By Edward C. August, ABOM, NCLE, MBA
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For strength, light weight, and visual clarity, many eye-care professionals are turning to Trivex, a completely new category of lens material.

Made by Pittsburgh-based PPG Industries Inc., the lens material has a chemistry that enables it to deliver three key qualities in a single lens. This triple jump in technology is not only an advancement over CR-39 material but also a major competitor for polycarbonate, making it an excellent choice for all eyewear, particularly for rimless, three-piece mountings.

Because the lens material delivers its unique trifecta of superior optics and impact resistance in an ultra-lightweight lens, eye-care professionals and their customers no longer need to sacrifice one lens attribute for another. That makes the lens material well suited for children, sports activities, and overall lens performance.

Character traits

Originally developed as visual armor for the military, the lens material monomer is sold to lens manufacturers for copolymerization and casting for lens production. Its inherent chemical properties allow lenses made from Trivex material to be virtually stress-free.

Although the lens material is a thermosetting plastic (thermoset), it also has thermoplastic characteristics. In thermoplastics, the molecular chains are independent of each other and can flow freely so the material can be re-formed. But in thermoset materials, cross-links are created during polymerization,

resulting in a complex, interconnected, and permanent network. Thermosets cannot be melted and reshaped.

PPG has developed the ability to control the amount of cross-linking in the manufacture of the lens material, which allows it to be the first optical material to combine the best of both structures.

Visual clarity, excellent optics

The lens material has an index of refraction at 1.53 and its specific gravity is 1.1, making it the lightest of any prescription lens material available today. There is also 100% UV protection from 315 nm to 394 nm. Because its tensile strength makes it resistant to cracking around the drill holes, lenses made with Trivex material are ideal for drill mountings. An Abbe value of between 43 and 45 makes the lens material optically superior. Polycarbonate has an Abbe value of 29.

Named after optical pioneer Dr. Ernst Karl Abbe, Abbe value is a numerical value indicating the amount of chromatic aberration that occurs when light is bent through the lens. The higher the Abbe value, the lower the amount of chromatic aberration. According to one German study, patients are more likely to perceive color blur in Abbe values less than 40.

Making an impact

Trivex material qualifies for the new high impact requirement created under the American National Standards Institute (ANSI) standard number Z 87.1-2003. Under ANSI Z 87.1-2003, two new impact resistance classifications were established: basic impact and high impact.

Not only does the lens material meet ANSI guidelines, it also complies with the 1972 FDA "drop-ball test" law. That standard defined spectacle lens impact strength as sustaining the force of a 5/8-in. steel ball weighing 0.56 oz. dropped from 50 ft. without breaking or splintering. All lenses must meet this standard. That being said, true strength is measured in foot-pounds (ft-lb.) and high mass tests.

In general, impact-resistant glass does not even take 0.1 ft-lb. CR-39 monomer takes 0.3 ft-lb. Polycarbonate and lenses made



Strength, light weight, and visual clarity make Trivex lens material (PPG Optical Materials) an excellent choice for all eyewear, particularly for rimless, three-piece mountings. (Images courtesy of PPG Optical Materials)

from Trivex are comparable at about 16 ft-lb., depending on the lens design.

As a result, lenses made from the material or polycarbonate should be recommended to children under 18, monocular individuals, and sports activity enthusiasts, as well as those in many occupations and industrial settings where eyes safety is a concern. Be aware that subsequent processing and coating may reduce impact resistance. Check with your supplier for certification.

Tensile strength

In addition to impact strength, tensile strength is crucial in all metal frames and rimless mountings. Tensile strength is the maximum force of tension to which a lens material can respond without breaking. Lenses made from Trivex do very well and outperform most materials, including polycarbonate and CR-39 monomer.

The tensile strength of materials leads to many additional concerns about drill holes in relation to different materials and lens defects. Polycarbonate has been known for both star-like micro-cracks due to screw tension, and hole elongations caused by constant rubbing of the screw.

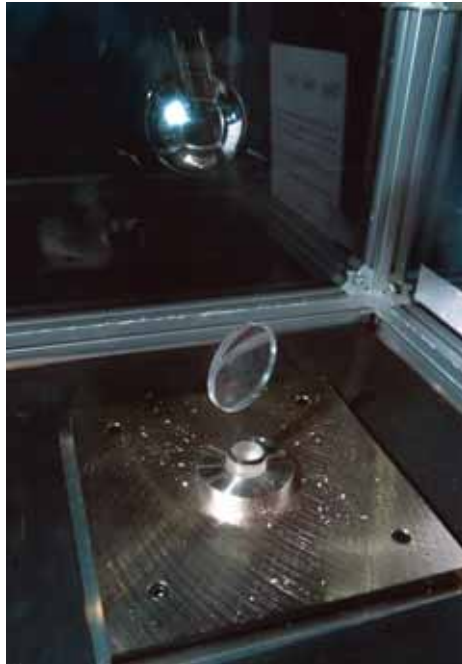
Though future testing will be able to quantify these values for all lens materials, 1.67, 1.70, and lenses made from Trivex material do not seem to give the same issues with rimless mountings.

Ultra lightweight

Many factors control the overall thickness and weight of a lens. Refractive index of a material, density of a material, center thickness of a lens, aspheric curves, and decentration and minimum effective diameter are all factors that play a part in lens material selection.

Light weight is also a function of overall lens design, including the index of refraction, lens curves, aspheric curves, and center thickness. The index refraction calculation for the lens material is 1.53. In both aspheric lens design and mid-index lens, which can be surfaced to 1 mm in the center, Trivex material compares with all lens materials in -6 to +4-D ranges, when center thickness is the major issue.

Here's a guide to recommended mini-



Trivex lens material has been proven to meet ANSI and FDA standards for impact resistance.

imum grinding center thickness of various lens materials:

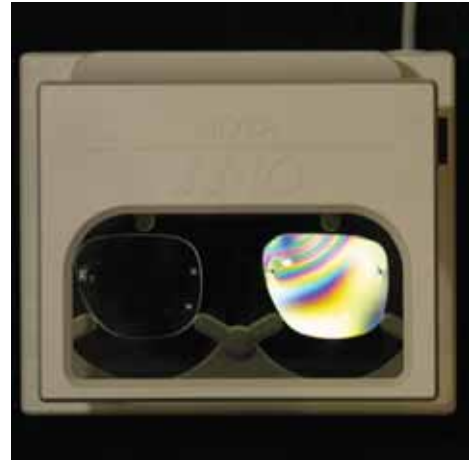
■ Trivex	1.0 mm
■ CR-39	1.8 mm
■ Polycarbonate	1.0 mm
■ Mid-index	1.5 mm
■ High index	1.5 mm

Specific gravity

Specific gravity is a measure of physical density or weight of a material. It is expressed in grams per cubic centimeter. The lower the specific gravity of a material, the lighter the weight of the resulting lens. At 1.11 g/cm³, the material has the lowest specific gravity of all prescription lens materials.

Currently, Trivex material is available in many lens designs, including single vision, progressive addition lenses, multifocals, and aspherics. In addition, lenses made from Trivex are now available in Transition lenses by several different manufactures.

Lenses made from the material come with a durable, front-side hard coat, and are more scratch resistant than many plastic lens materials. However, for maximum scratch resistance, a backside coating may be applied. Anti-reflective (AR) coatings



Viewed through a strain scope, the Trivex lens (left) appears clear while the polycarbonate lens displays colored striations that indicate stress.

work well on lenses made from the material. The molecular structure of the material also gives a jewel-like appearance to edges that are rolled and polished.

Prescription analysis is a crucial methodology for presenting premium products for optimum vision. Eye-care professionals can recommend lenses made with the material to all patients and discuss the different material options. AR coating in a rimless frame would be an optimum solution for most patients.

Although the material is formulated for processing with standard tooling and machinery, each manufacturer's equipment responds differently. PPG has created an instructional CD-ROM that provides video demonstration and information on techniques for edging lenses made with Trivex material for optimal results with most widely used edgers.OT

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