The Technical Features of Trivex™ Lens Material

The technical features of *Trivex* optical lens material provide superior benefits to your patients. Once you understand them, you will appreciate why lenses made from *Trivex* material represent the best choice for nearly every one of your customers.

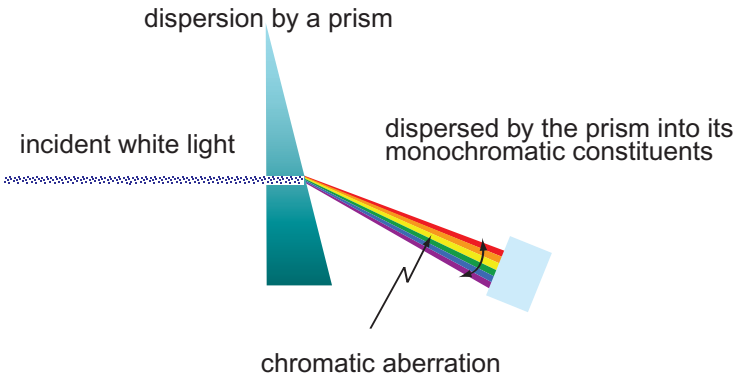
Trivex material is a urethane-based pre-polymer. In 2001, PPG developed and refined it for use as an ophthalmic lens material. Lenses made from *Trivex* material are cast in molds using a special machine and thermally cured. The tri- performance properties of the material provide for crisp and clear, strong and safe, light and thin lenses when compared to other materials currently available. *Trivex* material's unique properties make it an ideal lens material for nearly every eyeglass wearer. Here is a review of the technical features of *Trivex* material as measured under recognized industry standards for optical materials.

Trivex Lens Material Technical Properties

Optical Tests	Method	Values
Abbe (d-line)	ASTM D542	43 - 45
% Transmittance	ASTM D1003	89.19 - 91.54
Impact	ANSI Z87.1	Passes high velocity impact test
Impact	FDA drop ball	Pass
UV cut-off	Detemined using a Cary 4000 UV-Vis spectrophotometer	394 nm
UV protection	Detemined using a Cary 4000 UV-Vis spectrophotometer	Blocks 100% of UVA and UVB
Chemical Resistance	ISO 175	Pass
Density (g/cm3) @ 25°C	ASTM D792	1.105 - 1.11
Refractive Index (d-line) @ 20°C	ASTM D542	1.528 - 1.533
Refractive Index (e-line) @ 20°C	ASTM D542	1.530 - 1.536

THE CRISP AND CLEAR FEATURE

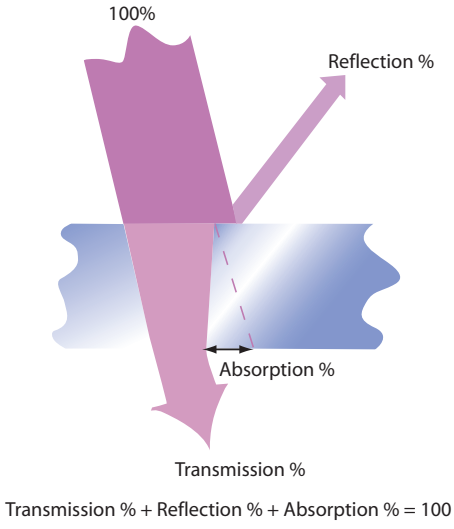
Abbe Value



Abbe value is a measure of the dispersion of light through a lens into its color elements. This dispersion is known as the chromatic aberration. Wearers of lenses with a higher level of chromatic aberration can suffer from a distortion of images viewed through the lenses. The higher the Abbe value assigned to a lens material, the lower the chromatic effect and the lower the possibility of visual distortion.

Lenses made from *Trivex* material have an Abbe value ranging from 43 to 45. Compared to polycarbonate with an Abbe value of 30 and high index materials with Abbe values of 32 to 34, the high Abbe values of *Trivex* material mean that color aberration is virtually undetectable by patients who wear lenses made from *Trivex* material, even with higher powered lens prescriptions.

Percent Transmittance



Transmission % + Reflection % + Absorption % = 100

As light travels through a lens, a certain percentage of that light is lost through absorption and reflection at each air-to-surface interface. The amount of original light available to the eyeglass wearer by the time it exits the lens will vary depending on the quality of the lens material and type and amount of anti-reflection coatings applied to the lens surface. This is an important factor that directly affects the actual brightness of an observed image. The term used to describe this percentage of light that is not lost is transmittance, and for most quality optical lenses this figure will usually be above 90 percent. *Trivex* lens material has one of the highest transmission levels of all commonly utilized lens materials at 91.4%. This means that patients will enjoy sharp, clear and crisp vision through lenses made from *Trivex* material.

THE STRONG AND SAFE FEATURE

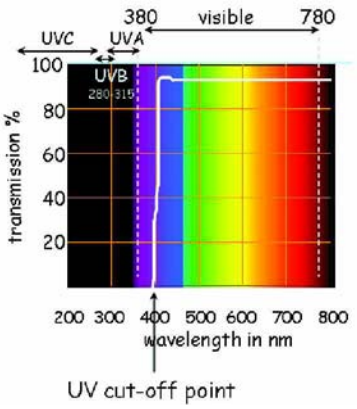
Impact Resistance

Lenses made from *Trivex* material are tough enough to pass the most rigorous optical industry standard for eyewear: the ANSI Z87.1 High Velocity Impact Test[1]. This is the test required for safety lenses that have center thicknesses as thin as 2.0mm. In this test, the lens is mounted in a holder and is able to withstand an impact from a ¼-inch steel pellet traveling at a velocity of 150 ft/sec.

In 1972 when the majority of spectacle lenses were made from glass, the US Food and Drug Administration (FDA) required that "all lenses must be impact resistant". Their regulation requires that all lenses must be capable of withstanding the impact of a 5/8 inch steel ball dropped from the height of 50 inches onto the horizontal upper surface of the lens. Lenses made from *Trivex* material can not only pass the FDA impact resistance test at the usual 2.0mm center thickness, they can pass it at a 1.0 mm center thickness and are even stronger than the FDA requirement.

Ultra-Violet Absorption

Ultra-violet (UV) radiation can have damaging short-term and long-term effects on essential parts of the eye. The wavelengths that pose these problems fall below the visible spectrum starting at 400 nanometers (nm). *Trivex* lens material filters out the harmful UV-A and UV-B wavelengths naturally thereby providing 100% UV blockage up to 394nm. This means that it is not necessary to dye lenses made from *Trivex* material to obtain this level of UV protection – the lenses inherently absorb harmful UV wavelengths.

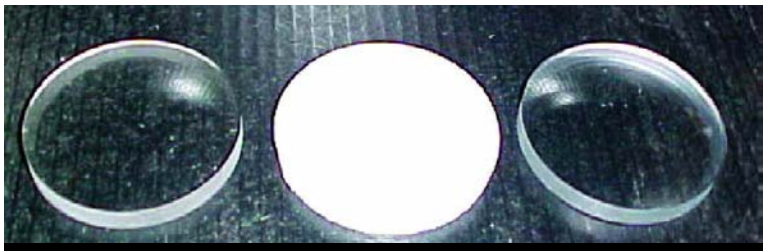


Chemically Resistant

Lenses made from *Trivex*, polycarbonate and CR-39™ materials were tested according the ISO 175[2] test method for chemical resistance. Each lens was immersed in separate containers of various chemicals commonly used in lens laboratories such as acetone (featured in this section) for 10 days. The test measures the changes in weight and diameter of the lenses after soaking as well as allows for a visual inspection for changes in clarity. The lenses made

1 American National Standards Institute, Occupational and Educational Personal Eye and Face Protection Devices, 2003

2 International Standard BS EN ISO 175:2001 BS 2782-8:Method 830A: 1999, Plastics – Methods of test for the determination of the effects of immersion in liquids chemicals



Lenses immersed in acetone for 10 days (PPG in-house test followed ISO 175.)

from *Trivex* and *CR-39* materials did not register any change in weight, diameter or clarity. The polycarbonate lenses turned solid white after being soaked in acetone as shown in the photograph.

Results from tests performed at COLTS Laboratory in the U.S. (an independent laboratory) reveal that lenses made from *Trivex* material are also resistant to household chemicals such as bleach, salt water, *WINDEX*, sun tan lotion, and nail polish remover.

THE LIGHT AND THIN FEATURE

Specific Gravity

Specific Gravity is a way in which weight of a lens material is specified. The lower the value, the less dense (and subsequently, lighter) the material is. The specific gravity of *Trivex* material is 1.11. This value makes it the lightest of all commonly utilized ophthalmic lens materials currently available. Compared to the density of *CR-39* monomer (1.32), *Trivex* material is 16% lighter; compared to polycarbonate, it is 8% lighter, and nearly 25% lighter than ultra high index (1.66 and 1.74) materials. When aspheric curvatures are used on lenses, even more thickness and weight reduction can be achieved.

Refractive Index

Trivex lens material has a 1.53 index of refraction. This mid-index value enables lenses made from *Trivex* material to be thinner, lighter and more comfortable. For example, when compared to lenses made with *CR-39* monomer (with an index of 1.50) of the same power and diameter, lenses made from *Trivex* material are up to 50% thinner and 50% lighter resulting in improved comfort for the wearer. Due to the strength of the *Trivex* material, it can also be surfaced to a 1.0mm thickness thereby reducing the weight and thinness of the lenses even further.

For more details on test results, please visit ***www.ppgtrivex.com***.