The exceptional performance of HOYA Phoenix® lenses

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Introduction and overview of testing

HOYA Vision Care and PPG have enjoyed a long-standing collaboration spanning 25 years. Our shared goal is to make a best-in-class optical material available to as many patients as possible. PPG Trivex® lens material was designed to deliver impact resistance, light weight and maximum clarity. PPG TRIVEX® lens material is specifically formulated and manufactured with enhanced scratch resistance for HOYA to bring you HOYA Phoenix® lenses.

The purpose of this report is to share with you the results of the latest rigorous testing PPG and HOYA conducted from April to June of 2025. These test results will leave you confident in your recommendation of HOYA Phoenix® lenses to your patients.

PPG Trivex® lens material was designed to deliver impact resistance, light weight and maximum clarity.

Testing Conducted

- **Impact strength**
- **Birefringence**
- **Optical clarity (Abbe value)**
- **Density**
- **Chemical resistance**
- **Refractive index**

This white paper focuses on the scientific test methodologies, clinical relevance, and patient benefits of HOYA Phoenix® lenses made with PPG Trivex® lens material, providing practitioners with an evidence-based framework to elevate lens recommendations and optimize patient outcomes.

Why lens materials matter

Patient expectations for vision clarity, comfort, safety, and durability continue to rise, and selecting the right lens material has become more important than ever. The default lens material in the US market is polycarbonate. Polycarbonate lenses are known for being impact resistant, thinner, lighter, and more durable than standard plastic lenses, such as PPG CR-39® lenses. Before the introduction of polycarbonate, CR-39 lenses were the favorite because they were thinner, lighter, and more durable than glass.

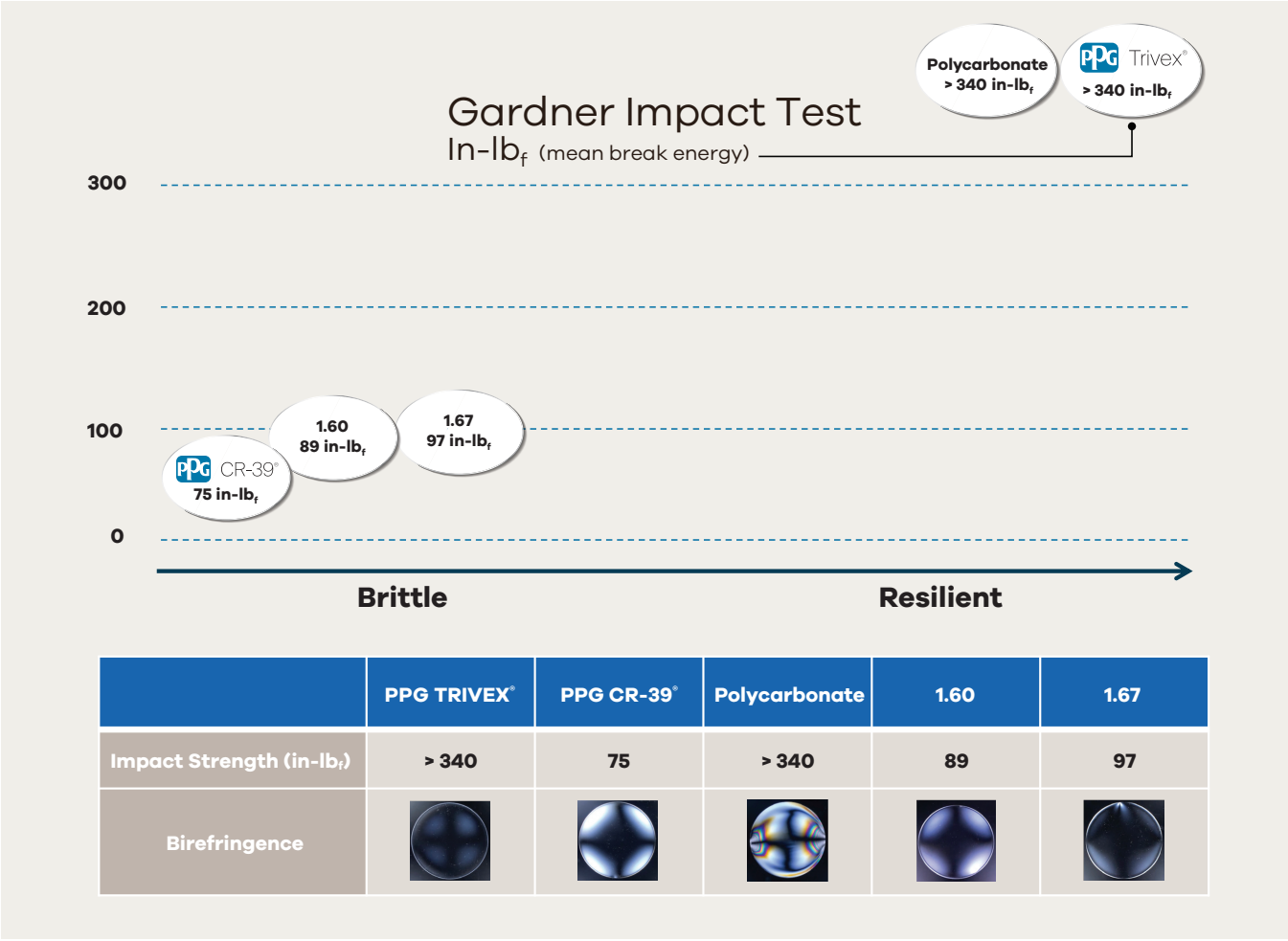
As improvements in materials evolve, our prescribing habits need to as well.

Durability and impact resistance

Ocular trauma can result in irreversible vision loss. Globally, an estimated 55 million people experience ocular trauma each year, leading to 1.6 million cases of blindness and 2.3 million cases of low vision annually.[1] For populations like children, sports enthusiasts, and industrial workers, reliable impact resistance is key.[2] Both polycarbonate and PPG Trivex® lens material are classified as high-impact materials by ANSI Z87.1 and FDA standards. Testing has proven their real-world performance is significantly different.

The Gardner Impact Test **(Figure 1)** involves a vertical free-falling weight impacting the lens mounted horizontally. The pendulum delivers a precisely measured energy strike to simulate blunt force trauma. The test escalates in measured increments until lens failure occurs (cracking, chipping, or shattering). Although both HOYA Phoenix® lenses and polycarbonate lenses were able to withstand a force as high as 340 in-lbf, the polycarbonate lenses received irreversible “dimpling” damage.[3] Polycarbonate often exhibits surface micro-dimpling, micro-fractures, and localized stress concentrations post-impact. **(Figure 2)** The HOYA Phoenix® lenses did not exhibit the dimpling that was observed in the polycarbonate lens because of the PPG Trivex® lens material, though the HOYA Phoenix® lenses did show minor surface blemishes.

In the real-world where impacts occur (e.g. sports or occupational hazards), HOYA Phoenix® lenses made with PPG Trivex® lens material maintain protective and optical performance longer than polycarbonate, reducing replacement needs.[3]



	PPG TRIVEX®	PPG CR-39®	Polycarbonate	1.60	1.67
Impact Strength (in-lbf)	> 340	75	> 340	89	97
Birefringence					

Figure 1. Gardner Impact Test

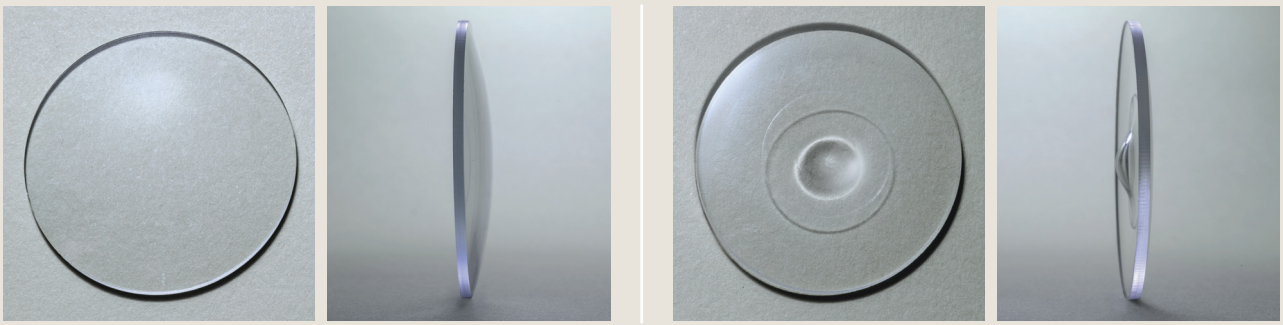


Figure 2. Dimpling of lens

Lightweight comfort

According to The Vision Council, light and thin are important attributes across multiple demographics.[5] This preference highlights the importance of comfort—particularly for patients who experience issues such as frames slipping down their nose, nose pads leaving pressure marks, and constant readjusting. These discomforts are often directly linked to lens weight, especially for larger frames or higher prescriptions. Lightweight lenses offer a great solution to the patient's primary concern, enhancing overall wearability and satisfaction.

To measure the weight of a lens we look at the density of the material **(Figure 3)**. This is measured by calculating the specific gravity, which tells you how heavy an object is compared to water. Specific gravity is calculated by taking the weight of a material and dividing it by the weight of an equal amount of water. Therefore, water has a specific gravity of 1.0. If a material's specific gravity is higher than 1.0, it's heavier, or denser, than water; if it's lower than 1.0, it's lighter, or less dense. In optics, we use specific gravity to help understand how heavy a lens will feel, a lower specific gravity means a lighter lens, which can be more comfortable for patients.

HOYA Phoenix® lenses have an exceptionally low specific gravity because of the PPG Trivex® lens material, which is one of the lightest lens materials on the market.[3] There are other variables that will affect weight, including lens thickness and shape, which is caused by a variety of factors, primarily due to the index of refraction. While lens weight is also influenced by factors such as thickness and shape—both of which are largely determined by the lens's index of refraction—PPG Trivex® lens material offers a distinct advantage in minimizing overall weight without compromising optical performance.

The index of refraction tells you how much a material slows down the speed of light and is calculated by dividing the speed of light in a vacuum by the speed of light in the material. If a material has an index higher than 1.0, it means light refracts, or bends, when it moves through it and therefore moves more slowly. For example, a lens material with an index of 1.60 slows light down more than a lens with an index of 1.50. In optics, a higher index allows lenses to be thinner while still correcting vision, because the material bends light more efficiently.

When looking at an average prescription range of +2.00 to -2.00, HOYA Phoenix® lenses made with PPG Trivex® lens material perform as the lightest lens option.[3] This was determined by accommodating for the same center thickness, or edge thickness; then calculating the weight of each lens, leaving the only variables as the material and index of refraction **(Figure 4)**.

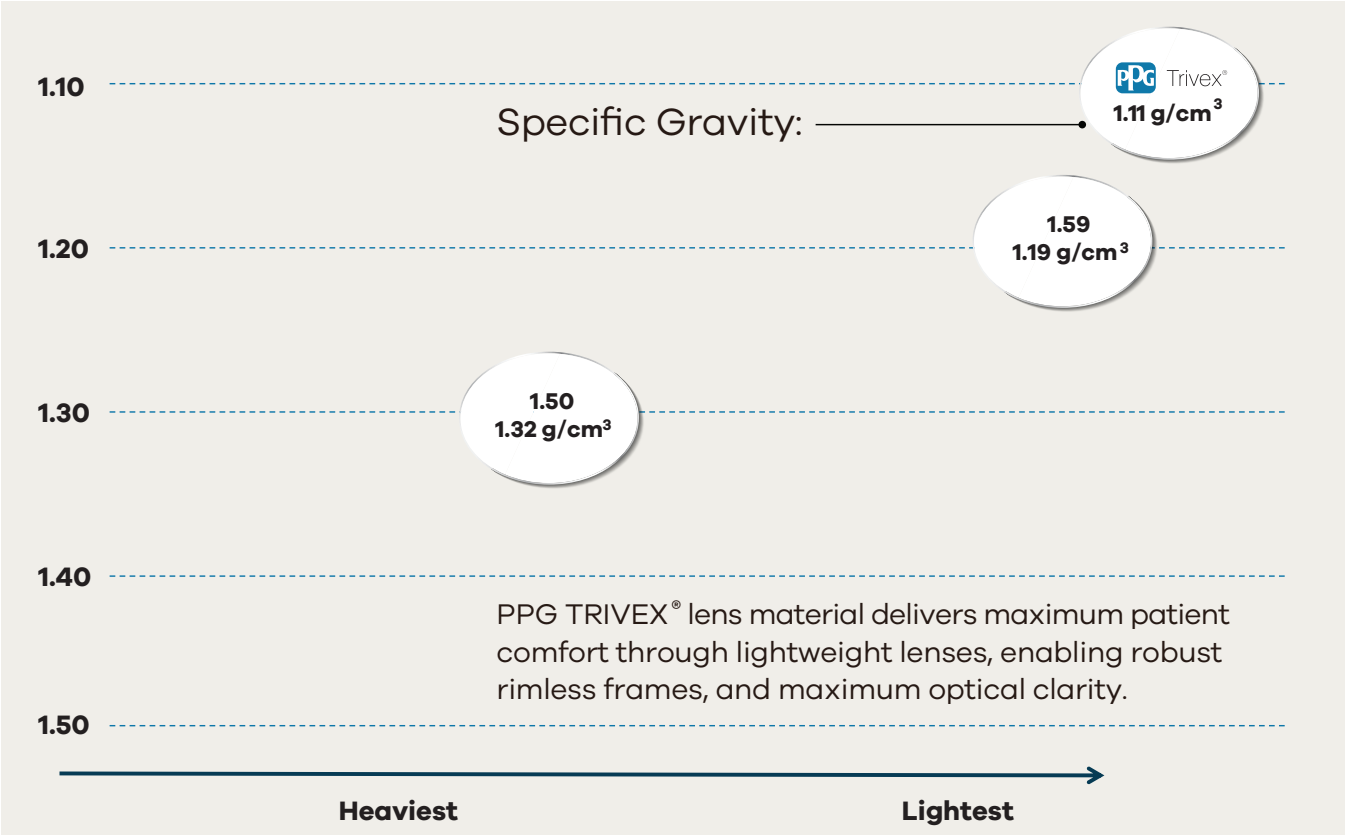


Figure 3. Specific Gravity Test

Index	Power	Diameter	CT	ET	Sg. (g/cm³)	Simulation Weight (g)
1.50	S -2.00	65	**1.40**	3.53	1.32	**11.03**
1.53	S -2.00	65	**1.40**	3.38	1.11	**9.01**
1.59	S -2.00	65	**1.40**	3.43	1.19	**9.33**
1.50	0.00	65	**2.00**	2.1	1.32	**9.1**
1.53	0.00	65	**2.00**	2.2	1.11	**7.8**
1.59	0.00	65	**2.00**	2.3	1.19	**8.7**
1.50	S +2.00	65	3.09	**1.00**	1.32	**9.02**
1.53	S +2.00	65	2.96	**1.00**	1.11	**7.37**
1.59	S +2.00	65	2.76	**1.00**	1.19	**7.50**

Figure 4. Simulation Weight

Optical Clarity: Chromatic Aberration, Abbe Value, and Birefringence

Chromatic aberration happens when different colors of light bend differently as they pass through a lens, which can cause color fringes or blurriness, especially around the edges.

The Abbe value tells us how much this happens. It compares how much the lens bends yellow light compared to how much it bends blue and red light. The more the blue and red light spread apart, the lower the Abbe value, meaning more chromatic aberration. A higher Abbe value means less spreading, so better clarity with less color fringing.

Patients wearing low Abbe materials often report symptoms like "rainbow halos," peripheral blur, eye fatigue, and headaches, all of which are symptoms easily misattributed to prescription inaccuracies.

PPG Trivex® lens material has the third highest Abbe value of all lens materials, **(Figure 5)** only second to glass and PPG CR-39®[3] lens material. Although glass and PPG CR-39® material may have a higher Abbe value, neither is shatter-resistant or lighter than HOYA Phoenix® lenses made with PPG Trivex® lens material.

What is "Poly-intolerance"?

For some patients, switching from a non-poly material or having an astigmatism power with a change, will create visual problems. In the case of switching materials from PPG Trivex® lens material or any other material to polycarbonate the Abbe value clarity will be reduced.

Patients with high amounts of astigmatism experience more peripheral aberrations that overwhelm the visual system's ability to adapt. Often this can be solved by switching from polycarbonate lenses to HOYA Phoenix® lenses.

Birefringence refers to the distortion of light as it passes through differently oriented stress zones in a material. Polycarbonate's injection molding process induces a significant amount of internal stress, producing visible birefringent patterns, which can be observed using polarized light. These stress zones degrade image quality, especially noticeable under certain lighting conditions or for patients with higher prescriptions **(Figure 6)**.

PPG Trivex® lens material's cast-molding process produces virtually stress-free HOYA Phoenix® lenses, nearly eliminating birefringence and delivering uniform optical performance across the lens surface. Patients preferring large fields of vision benefit significantly from HOYA Phoenix® lenses' superior clarity, reducing subjective complaints that often lead to costly remakes.

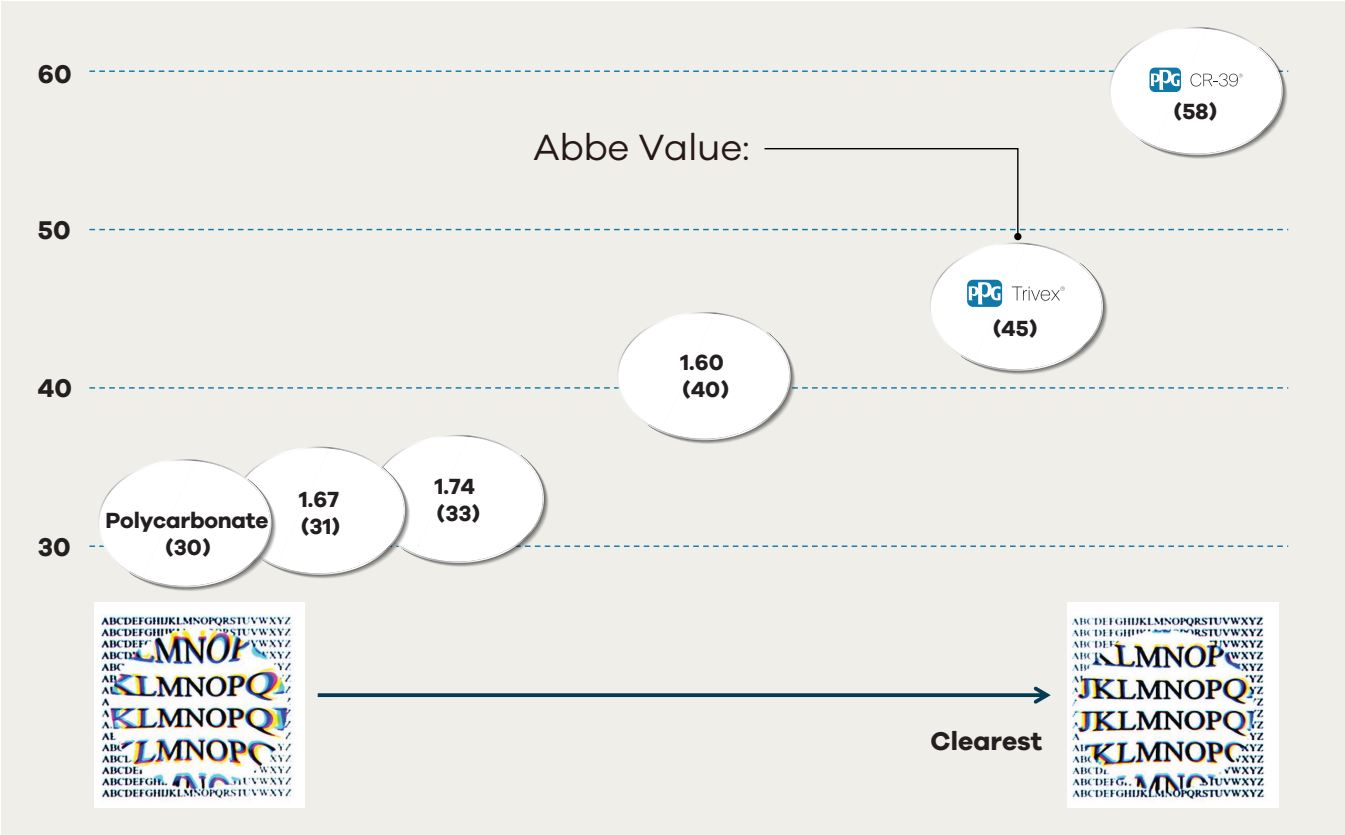


Figure 5. Abbe Value Test

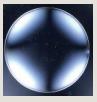
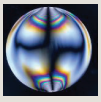
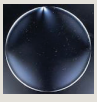
	PPG TRIVEX®	PPG CR-39®	Polycarbonate	1.60	1.67
Impact Strength (in-lb$_f$)	> 340	75	> 340	89	97
Birefringence					
Optical Clarity (Abbe)	45	58	30	40	31

Figure 6. Birefringence comparison of popular lens materials under polarized light. Polycarbonate lenses exhibit visible stress patterns, while the PPG Trivex® lens shows minimal to no birefringence.
(Source: PPG internal photographs, Abbe values based on PPG internal testing).

Chemical resistance

The ISO 175 standard evaluates material resistance to chemical agents. For this testing, lenses were submerged in various chemicals commonly used in laboratories, such as acetone, for 10 days, creating a severe simulation reflecting extreme lab processing scenarios **(Figure 7)**.

After exposure, PPG Trivex® and PPG CR-39® lens materials showed no noticeable changes in weight, diameter, or optical properties. In contrast, polycarbonate lenses exhibited significant whitening, surface damage, and visible optical haze, indicating the material has begun deteriorating.

Repeated exposure to lab solvents like acetone, alcohol, and cleaners or improper patient care, like harsh cleaning wipes or liquids, compromises polycarbonate's surface structure, accelerating fogging and degrading optical quality over time.

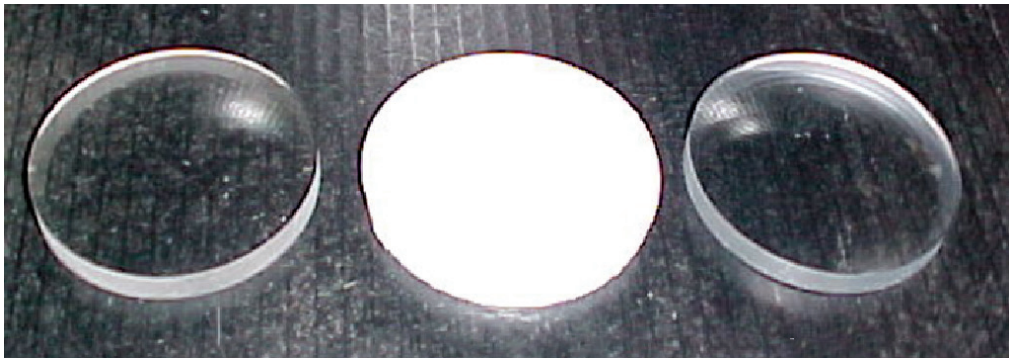


Figure 7. Lenses immersed in acetone for ten days, following ISO 175 testing protocol. Shown left to right: PPG TRIVEX®, polycarbonate, and PPG CR-39® lens materials. (Source: PPG in-house testing).

Conclusion

As lens technologies continue to evolve, patients continue to prioritize visual clarity, comfort, safety, and longevity. While polycarbonate remains the most popular lens material in the U.S.[4], widely due to traditional habits, clinical evidence strongly supports PPG Trivex® lens material as the superior modern lens material. HOYA Phoenix® lenses made with PPG Trivex® lens material offer an unmatched combination of impact protection[2] and optical quality, are the lightest high-impact lenses available for all-day comfort, deliver outstanding clarity free from chromatic aberration and birefringence, and provide exceptional chemical resistance for longer-lasting performance.

For practitioners seeking to differentiate their practice, maximize patient satisfaction, and minimize costly remakes, HOYA Phoenix® lenses made with PPG Trivex® lens material represents the gold standard material of the next generation.

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