Are Polycarbonate Spectacle Lenses Really Safer?

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Accidents resulting in eye injuries can happen to anyone. A Baltimore Eye survey revealed that, approximately 20% of men and 10 % of women older than 40 years have experienced an eye injury at least once.(4) According to the University of Michigan (U of M) Kellogg Eye Center, over half (55%) of the victims of eye injuries are under 25. Many of these injuries, over 100,000 annually, occur during sports or recreational activities. Most important of all, 90% of all injuries could have been prevented.(12) Our question here is, will any form of spectacle lens or eye shield prevent these eye injuries, or is polycarbonate lens material the only safe form of eye protection for prevention of eye injury. At present, four materials are commonly used in eyeglass lenses: glass, CR-39 plastic, high index plastic, and polycarbonate plastic. Evidence has shown that the polycarbonate material, also known by the trade name Lexan, is the most impact resistant material when tested against other spectacle lens materials in the drop ball test.

With this invention of super plastic, there is still evidence that existing eyewear failed to prevent a substantial number of eye injuries. A 1980 report by the US Department of Labor revealed that approximately 40% of 1052 workers who sustained on-the-job eye injuries in 1979 were wearing some form of eye protection at the time of injury. Other data shows, at the time of eye injury, approximately 22% of injured workers wore safety spectacles that were not adequate for the hazard level. Of 635 work-related penetrating eye injuries reported to the National Eye Trauma System (NETS) registry between 1985 and 1991, 20 patients were wearing dress lenses and 35 were wearing industrial safety glasses at the time of injury. Causes of eyewear failure included shattered lenses, broken frames, and objects passing behind or beside the eyewear.(1)

In the early 1980s polycarbonate lenses were entering the spectacle lens marketplace. While the industry had just made the transition from glass to CR-39 polycarbonate was in the forerunning. During the early years of polycarbonate, the number of labs actively processing this material never topped 5%.(9) Polycarbonates slow growth resulted from the fact that many labs that did not fabricate the material discouraged its sale. A shift began when new lab equipment began processing and selling polycarbonate. Gradually in the late 80s, the industry grew interested in lighter and thinner lenses. As this happened the professions discovered that polycarbonate was the lightest and often the thinnest lens available. This marked the start of steadily increasing sales of polycarbonate. By 1991, polycarbonate had grown to 6% of the total market.

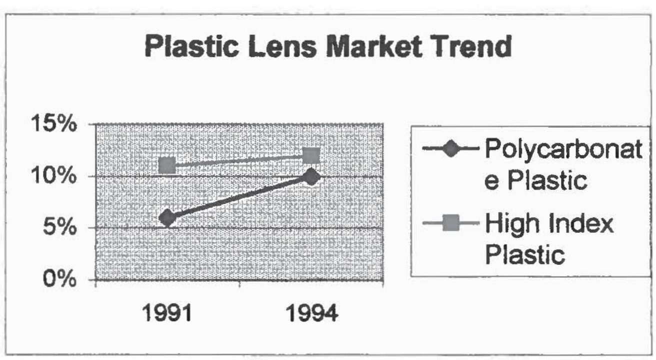

Figure 1: Increase sales trend for polycarbonate compared to high-index plastic lenses in the ophthalmic market.

That same year, all other high index materials were 11% of the market. Three years later (1994), polycarbonate had jumped to 10% of the overall market. All other high index material combined, increased only slightly to 12% (Figure 1)(9).

These dramatic figures illustrate how polycarbonate, the once the second runner of alternative lens materials, developed into the fastest growing segment of the lens market.

Impact resistance standards for dress ophthalmic lenses, established by the American National Standards Institute's (ANSI) Z 80.1 committee. These standards have been incorporated into federal law and are regulated by the US Food and Drug Administration (FDA). Effective in 1972and revised in 1989, the

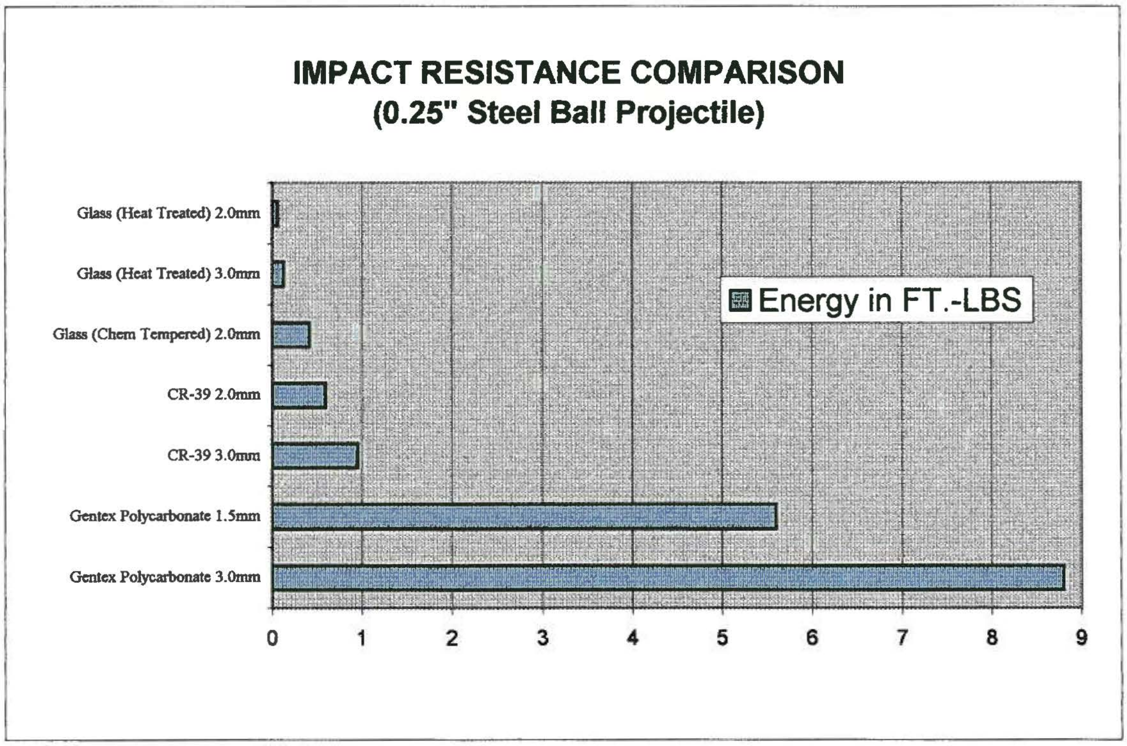

Figure 2: "The impact levels above for Gentex Polycarbonate lenses are the result of tests performed by Gentex Optics Inc., solely for its own internal quality control. They should not be interrupted as meaning that Gentex Optics Inc. warrants its lenses for such impact levels." CR-39 is a registered trademark of PPG Industries.

FDA made it illegal for ophthalmic practitioners to prescribe dress safety lenses that are not impact resistant.(13) The referee test is the dress safety drop ball test. The lens must be able to withstand the impact of a 5/8 inch steel ball weighing approximately 0.56 oz dropped 50 inches onto the front surface of the lens (or an equivalent impact).(8) Figure 2 above shows the impact resistance of Glass, CR-39, and Polycarbonate plastic lenses tested against a 0.25 " steel ball. Polycarbonate exceeded other materials in the energy required to break the lens. When decreasing the center thickness of the polycarbonate lens form 3.0mm to 2.0mm, it took 3.3 ft-lbs less energy to fracture the lens. The same was true for Glass and CR-39 materials. When decreasing the center thickness of the lens, less energy was required to break the lens.(13)

In a study evaluating the national standards for shatter resistance, the relative strength and shatter resistance of spectacle lenses currently used in sunglasses, dress, sports, and industrial eyewear were evaluated. Four lenses that met the US standards for industrial spectacle lenses (ANSI Z87.1-1989 and 7 lenses that met the standards for dress (ANSI Z80.1). The industrial lenses used had a minimum thickness of 3mm and were made from polycarbonate plastic, allyl resin plastic, heat-tempered glass, and chemically tempered glass. The dress lenses used were made of the same materials with the addition of Plastic, allyl resin plastic, heat-tempered glass, and chemically tempered glass. The dress lenses used were made of the same materials with the addition of high-index plastic and had center thickness ranging from 1mm to 2.2mm. All lenses tested were –3.00 diopter, edged 55mm round affixed with plastic clips onto a 6.4-mm (0.25-in) steel plate. The holder was mounted on a spring-hinged plate and allowed to pivot on the hinges when impacted. Lenses were impacted with objects ranging from small, hard, and fast moving (air gun pellet, golf ball) to larger soft (tennis ball), intermediate hardness (lacrosse ball), and hard (baseball) test objects. Based on 348 lens impacts, dress and industrial lenses made from glass, allyl resin plastic, and high-index plastic shattered at impact energies less than those expected to be encountered from the test objects during their routine use. Polycarbonate plastic lenses demonstrated resistance to impact potential expected during routine use.(15)

Data from the US Eye Injury Registry (USEIRS) shows that existing spectacle standards offer some eye protection. Of the 8200 eye injuries recorded in the USEIRS database, eyewear was not worn at the time of injury in 82%, dress glasses were worn in 3%, safety glasses were worn in 2% of the time of injury, and eyewear status was unknown in 13%.(11) Vinger concluded, that the widespread use of more impact resistant lenses in eyewear would be beneficial in reducing injuries.(15) USEIRS data show 246 serious eye injuries among people who were wearing dress glasses and 164 serious eye injuries in wearers of safety glasses.(11) The US Consumer Product Safety Commission estimates that 2417 eye injuries were related to eye protection devices and 2651 eye injuries were related to eyeglasses in 1995.(5) From information provided by NETS, a consortium of approximately 50 regional eye trauma centers, a search of the registry from June 29, 1988 to September 7, 1993 found 3659 instances of traumatic rupture of the eye. Only 61 (1.7%) involved rupture by shattered spectacle lenses.(15) No data are available as to the lens material that shattered.

Glass, CR-39, Polycarbonate, and High Index Plastic lens sales were evaluated for June 1997 to December 1997 and January 1999 to December

1999 at Ferris State University Michigan College of Optometry optical dispensary. Sales trends showed the only increase in sales for the 3-year period was for polycarbonate lenses with a 10% bump in sales. Sales for Glass lenses dropped slightly by 1.2% and CR-39 dropped by 9%. Sales trends for High Index remained about the same (see Figure 3).

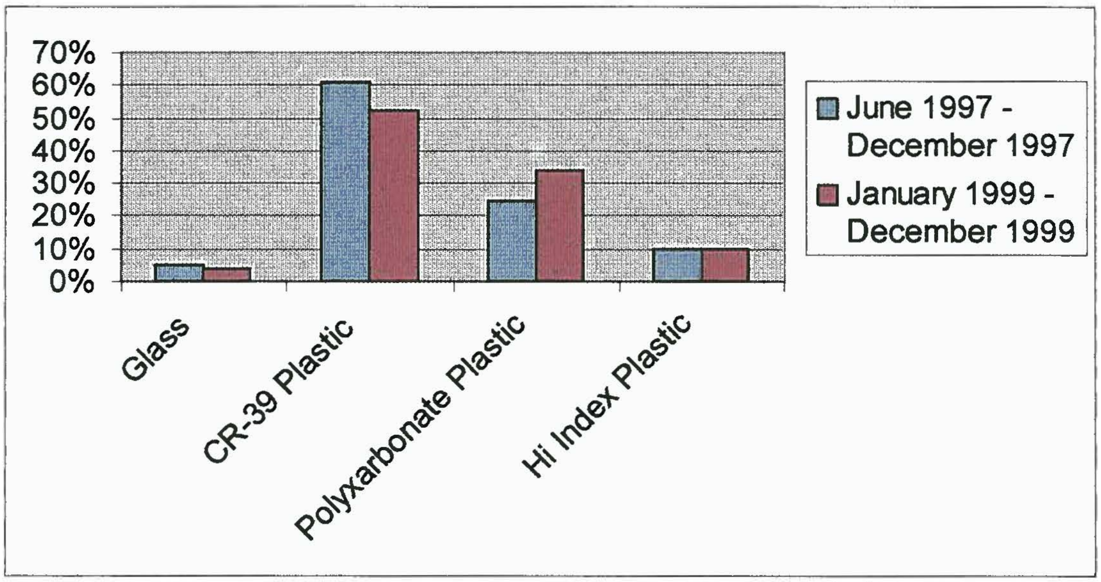

Figure 3: Lens Sales for Glass, CR-37, Polycarbonate, and Hi Index Plastic.
Provided by Ferris State University Michigan College of Optometry Optical Dispensary.

Statistical information provided by the Michigan College of Optometry for the number of eye injuries, over a three-year period, for superficial, corneal, and eyelid foreign body removals showed only a 1% decrease in incidence of reported injuries from 1997 to 1999.(2) The available data was insufficient to determine the number of injured patients who wore a spectacle lenses during the injury.

Based on data found, polycarbonate plastic appears to be the lens material of choice for resistance to shattering. Data shows that even with the use of safety glasses that conform to the present standards, eye injuries still exist.

Since energy delivered to the eye is often random and unpredictable, is uncertain that polycarbonate lenses can prevent eye injuries from occurring. Overwhelming evidence has shown that with out a doubt, polycarbonate is the lens of choice for impact resistance when tested against all other material on the market. Evidence suggests that impact resistance is negatively affected by a decrease in lens thickness. Current standards offer some eye protection as evident in data from USEIRS, the US Consumer Product Safety Commission, and NETS. There has been a steady increase in polycarbonate lens sales from the early 1990's and with more strict regulation of safety eyewear and the use of polycarbonate materials, the incidence of ocular injuries appear to be declining.

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