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LEVEL II

POLYCARBONATE VERSUS CR-39 LENSES: A FIELD STUDY

J. W. Miller
Benjamin Kislin, Colonel, USAF, BSC
Thomas J. Tredici, Colonel, USAF, MC
Alton J. Rahe, M.S.

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USAF SCHOOL OF AEROSPACE MEDICINE
Aerospace Medical Division (AFSC)
Brooks Air Force Base, Texas 78235

NOTICES

This final report was submitted by personnel of the Ophthalmology Branch, Clinical Sciences Division, and the Data Sciences Division, USAF School of Aerospace Medicine, Aerospace Medical Division, AFSC, Brooks Air Force Base, Texas, under job order 7755-19-08.

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The voluntary informed consent of the subjects used in this research was obtained in accordance with AFR 80-33.

This report has been reviewed by the Office of Public Affairs (PA) and is releasable to the National Technical Information Service (NTIS). At NTIS, it will be available to the general public, including foreign nations.

This technical report has been reviewed and is approved for publication.

J. W. MILLER
Project Scientist

THOMAS J. TRENCI, Colonel, USAF, MC
Supervisor

LAWRENCE J. ENDERS
Colonel, USAF, MC
Commander

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

During the Indochina hostilities, prescription-wearing U.S. military members were issued conventional spectacle lenses which were worn in the combat zone. These lenses, if shattered by impact, could produce secondary missiles which could be eye threatening. Polycarbonate (Lexan) lenses could provide significant impact protection in hazardous environments. This study explored the response by industry to a request to produce a range of prescription lenses in dress thickness and the scratch-resistance capability of a state-of-the-art

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20. ABSTRACT (Continued)

protective coating applied to the polycarbonate-lense surfaces. In their usual pursuits over a year's period in desert-type environment, 100 subjects wore prescription spectacles containing CR-39 and companion polycarbonate lenses. The polycarbonate lenses with coating protection were more scratch-vulnerable than conventional plastic spectacle lenses (CR-39). The eye-protection property of the polycarbonate lens warrants the issue of plano or prescription spectacles containing this material to military members who are likely to be in a combat area.

POLYCARBONATE VERSUS CR-39 LENSES: A FIELD STUDY

INTRODUCTION

At the height of U.S. participation in military action in Indochina, the Ophthalmology Branch at the USAF School of Aerospace Medicine (USAFSAM) received inquiries asking why military personnel requiring spectacle correction were not provided with unbreakable lenses (8). Until January 1972, prescription lenses provided by Army and Navy ophthalmic laboratories were almost exclusively crown-glass lenses that received no impact-resistance tempering. After that time, to meet a Federal Drug Administration (FDA) requirement for impact-resistance lenses (5), Army laboratories produced predominantly heat- or chemical-treated glass lenses, and the Navy fabricated plastic lenses (CR-39) almost exclusively. While the treated-glass and the CR-39 lenses could survive the free-fall drop of a 1.27-cm (0.5-in) steel ball from a 127-cm (50-in) height as specified by the FDA, the concerned citizens who contacted USAFSAM were aware of eye injuries resulting from lens fragments after breakage by higher velocity missiles. The FDA recognizes that neither "impact resistant" nor "safety" lenses recommended for occupational protection are unbreakable or shatterproof (6).

Polycarbonate was developed by the General Electric (GE) Corporation, and the material, which GE called "Lexan," demonstrated tremendous capability to withstand penetration of propelled objects of varying sizes and velocities (7). At the time of the inquiries, polycarbonate lenses in nonprescription form were entering the industrial safety-lens inventory, and the military services were procuring polycarbonate visors of reasonably good optical quality for flyer use in Vietnam (9). Prescription lenses were not available in polycarbonate, except for a few samples of 3-mm center thicknesses in isolated foci which were made to show it was possible to produce them. Scratch susceptibility of the soft polycarbonate plastic made this material questionable for ordinary spectacle-lens use, because the optics degraded very rapidly even with careful handling and cleaning. Several optical and chemical companies developed various coatings to protect polycarbonate-lens surfaces so that durability would rival the scratch resistance of CR-39 or glass lenses. Scratch resistance is usually measured by abrasion testers such as a hard-pointed stylus under weights, grit dropping on a slanted table containing the test material, or an eraser under a specific load rubbing against the lens surface.

The United States withdrew from Vietnam before it became known that several companies were exploring the production of prescription polycarbonate lenses for possible occupational vision-protection use. Since the American National Standards Institute (ANSI) Z87.1-1968, Practice for Occupational and Educational Eye and Face Protection, specifies a minimum optical-center lens thickness of 3 mm, these early lenses were made to that standard (1). The polycarbonate protective visors provided for the Air Force flyer's combat protection, measure 2.0-2.2 mm in thickness. The ANSI Z80.1-1972, Requirements for First-Quality Prescription Ophthalmic Lenses, specified a minimum

of 2.0-mm optical-center thickness, which served as the guide for dresswear-thick lenses used in most spectacles worn within or outside the military (2). The ANSI Z80.1-1979, Recommendation for Prescription Ophthalmic Lenses, changed the 2.0-mm-thickness requirement to a "recommendation" (3). We decided to use this conventional lens-center thickness in evaluating the acceptance and durability of prescription polycarbonate lenses to be compared with standard plastic, CR-39, spectacle lenses.

Before advocating that polycarbonate lenses, in plano or prescription, be furnished Air Force members who might be projected into a potential combat environment, we needed to resolve several considerations: 1) Could the optical properties be made comparable to the standard glass and CR-39 lenses? 2) Would industry provide polycarbonate lenses in the conventional center thickness of 2.0 mm over a range of prescriptions at a reasonable cost? 3) How durable would the lenses, noncoated and coated, be with respect to exposure under a range of real-world conditions?

We placed an advertisement in the Commerce Daily to pulse U.S. manufacturers that might be interested in producing dress-thickness polycarbonate lenses in a range of prescriptions with and without state-of-the-art abrasion-resistant coatings (4). Four corporations responded to the inquiry. A follow-on notice placed in the Commerce Daily requested a proposal for bid for producing lenses desired for testing. Air-Lock, Inc., Milford, Conn., was the successful bidder for the contract for lenses with the characteristics described in the Appendix.

Plano polycarbonate lenses are molded for curvatures, size, shape, and bevel so that frame mating by the manufacturer is simplified. Prescription lenses require lens sizing to match the optical lens centers with visual axes; therefore, ophthalmic laboratory handling is necessary in the sizing and edging of the lenses as well as their insertion into the frames. After receipt of the lenses from Air-Lock, Inc., trial laboratory runs with the uncoated lenses revealed that no lens completed careful processing without significant scratching. This eliminated uncoated polycarbonate lenses from the planned field test. The contract monitor approved the most promising scratch-resistant coating (Dow-Corning process) for use in this study, and the coated polycarbonate lenses presented no problems with scratching in the USAFSAM Research Ophthalmic Laboratory processing.

A previous study in which glass and plastic (CR-39) lenses were compared for replacement rates had revealed that the Nellis AFB, Nev., atmospheric environment, with a high air-particle content, was the most trying of the four facilities participating in the test (10). We decided to conduct this study under worst-case conditions, and optometric clinic personnel support at Nellis AFB was requested and obtained. The Nellis AFB Optometry Clinic screened their eye-examination records to locate prescription wearers within the range of the lenses obtained from Air-Lock, Inc. and queried the personnel concerning their willingness to participate in the study.

PROCEDURE AND FINDINGS

One hundred pairs of spectacles were dispensed with one abrasion-resistant coated polycarbonate lens and its CR-39 plastic mate. Both lenses

were made to the prescription requirements of the volunteer. The side of the frame the polycarbonate lens went on was selected at random.

The volunteers were only informed that the lenses provided were non-standard, but they could clean and handle them as they ordinarily would their customary spectacles.

Lens-scratching evaluations were conducted by 1) examination and scoring by the principal investigator, and 2) the subjective responses of the wearers to questionnaires at 4-, 8-, and 12-month intervals from test inception. Copies of the USAFSAM score sheet and a volunteer's questionnaire are displayed in Figures 1 and 2 respectively. If at any time a participant indicated that scratches in either lens were so annoying that the lens(es) had to be changed, impact-resistant glass lenses were used to replace both lenses, and this subject was dropped from the study.

NAME SSAN -0696

DATE			RIGHT P.C.				LEFT				REMARKS		
DAY	MO.	YR.	H	I	II	III	H	I	II	III	A	B	C
4-month eval.				2				1					

SAM FORM FEB 72 158 ONE-TIME PLASTIC LENS DATA CARD

Figure 1. Investigator evaluation. Scoring: 0 = no observed scratch; 1 = a few superficial scratches; 2 and 3 = successive severity of number and penetration of scratches.

OPTICAL QUESTIONNAIRE

NAME: _____ RANK: _____

DUTY PHONE: _____ HOME PHONE: _____

1. Did you wear the glasses all the time? YES _____ NO _____ If NO, did you wear the glasses: MOST OF THE TIME _____ HARDLY AT ALL _____

   Please explain _____

2. Were the glasses comfortable? YES _____ NO _____ If NO, indicate the problem _____

3. Is either of your lenses scratched or marred? YES _____ NO _____ If YES, which one? RIGHT _____ LEFT _____ BOTH _____ If both, which is worse? RIGHT _____ LEFT _____ Did any unusual event contribute to the lens damage? YES _____ NO _____ If YES, please explain _____

4. To what extent does the scratch or mar interfere with your vision?

   A GREAT DEAL _____ SOME _____ NOT AT ALL _____

5. Were there any unusual experiences noticed with spectacle wear?

   YES _____ NO _____ If YES, please explain _____

6. How do you usually clean your lenses?

   HANDKERCHIEF _____ WET _____ DRY _____

   KLEENEX _____ WET _____ DRY _____

   PAPER TOWEL _____ WET _____ DRY _____

   OTHER (Please explain) _____

7. Do you think that the lenses used in the test should be considered for standard military spectacles? RIGHT LENS: YES _____ NO _____

   LEFT LENS: YES _____ NO _____

   COMMENTS: _____

Figure 2. Questionnaire for users' evaluation of lenses.

Self-addressed postcards were mailed a week prior to the desired scratch-examination dates, notifying the subjects to report to the Nellis AFB Optometry Clinic for the lens-scratch assessment. The cards had been prepared 4 months before, at the time the test spectacles were dispensed. Also, at the 4- and 8-month examination sessions, those that came in completed the post-cards for subsequent check notification. In addition, a notice appeared in the Nellis AFB Daily Bulletin for a week prior to each of the examination periods, to remind participants still in the study to report at the date and place scheduled. The numbers that participated in each time period were: 4 months - 80; 8 months - 45; and 12 months - 22. The subjects removed due to lens replacements were 16 at 4 months and 25 at 8 months. The response rates therefore were 80/100 (80%) at 4 months; 45/84 (54%) at 8 months; and 22/59 (37%) at 12 months. The denominator indicates the total number of subjects at each of the time periods that had not been eliminated from the study and could have had their lenses checked, while the numerator denotes the number that actually responded. Some participants (3 at the 4-month check and 1 at the 12-month check) reported after the lens evaluator had departed. They completed the questionnaire, but their spectacles were not assessed for scratching.

Table 1 displays the principal investigator's scratch score over a 10-mm central-area zone for the polycarbonate and CR-39 lenses at the 4-, 8-, and 12-month evaluations for the subjects that were eligible to continue in the study. To minimize the influence of prior experience, the score sheets of previous checks were not available for reference to the investigator. Table 2 shows the investigator's scratch assessment of the test lenses on subjects that requested replacement within or at the end of the 4th and 8th months (and who thereby were eliminated from the study). If a line is drawn through the equal scratch scores for both polycarbonate and CR-39 lenses, from upper left to lower right, the figures that are displayed above the line indicate the instances where CR-39 lenses were more severely scratched than the polycarbonate mates; the values below the line demonstrate the reverse condition. Each table shows that the polycarbonate lenses suffered worse in the scratch comparisons. Over time, both types of test lenses experienced increased scratch severity.

Table 3 depicts responses to item 3 in the Optical Questionnaire where the subjects designated the worse scratched lens; participants did not have access to their previously completed questionnaires in their follow-on responses. The subjects perceived that polycarbonate lenses were scratched to a greater degree than the partner CR-39 lenses at the end of the 4-month test period (44 of the polycarbonate were considered scratched worse, and 3 of the CR-39). As the test periods progressed, while both of the lenses scratched more and the number of participants declined, the polycarbonate lenses maintained the higher scratch vulnerability (27 polycarb/8 plastic at 8 months; and 11 polycarb/6 plastic at 12 months). At 4 months, 27 reported no scratching of either lens; at 8 months, 7; and at 12 months, 4. Data was lost when subjects reported that lenses were scratched but failed to identify which lens was worse in each of the test periods.

TABLE 1. EXPERIMENTER'S SCORE[a] FOR EACH PLASTIC AND POLYCARBONATE PAIR

Polycarbonate \ Plastic	0	1	2	3	Totals
4-mo evaluation[b]					
0	4	1	0	0	5
1	11	11	0	0	22
2	1	15	7	0	23
3	0	7	14	6	27
Totals	16	34	21	6	77
8-mo evaluation[c]					
0	0	0	0	0	0
1	0	0	1	1	2
2	0	3	6	2	11
3	0	3	17	12	32
Totals	0	6	24	15	45
12-mo evaluation[d]					
0	0	0	0	0	0
1	0	0	0	0	0
2	0	3	0	0	3
3	0	0	11	7	18
Totals	0	3	11	7	21

[a]Scoring: 0 = no observed scratch; 1 = a few superficial scratches; 2 and 3 = successive severity of number and penetration of scratches.

[b]Plastic mean score = 1.221; polycarbonate mean score = 1.935; P<.001 (Chi-square test on paired data); 3 pair not evaluated.

[c]Plastic mean score = 2.200; polycarbonate mean score = 2.667; P<.001.

[d]Plastic mean score = 2.190; polycarbonate mean score = 2.857; P<.001; 1 pair not evaluated.

TABLE 2. EXPERIMENTER'S SCORE[a] FOR EACH PLASTIC AND POLYCARBONATE PAIR ON SELF-ELIMINATED WEARERS

Polycarbonate \ Plastic	0	1	2	3	Totals
4-mo evaluation[b]					
0	0	0	0	0	0
1	0	0	0	0	0
2	1	0	0	0	1
3	1	3	7	4	15
Totals	2	3	7	4	16
8-mo evaluation[c]					
0	0	0	0	0	0
1	0	0	0	0	0
2	1	1	0	0	2
3	1	3	4	15	23
Totals	2	4	4	15	25

[a]Scoring: 0 = no observed scratch; 1 = a few superficial scratches; 2 and 3 = successive severity of number and penetration of scratches.

[b]Plastic mean score = 1.81; polycarbonate mean score = 2.94; $P<.001$.

[c]Plastic mean score = 2.28; polycarbonate mean score = 2.92; $P<.01$.

TABLE 3. LENS WITH WORSE SCRATCHING COMPARED TO POLYCARBONATE LENS (Question 3)

Polycarbonate Lens \ Worse Lens	Right	Left	Totals
4-mo evaluation[a]			
Right	33	3	36
Left	0	11	11
Totals	33	14	47
8-mo evaluation[b]			
Right	21	7	28
Left	1	6	7
Totals	22	13	35
12-mo evaluation[c]			
Right	7	4	11
Left	2	4	6
Totals	9	8	17

[a] 5 subjects reported scratching but never reported as to which lens was worse; 1 subject did not respond; 27 reported no scratching; $P<.001$.

[b] 3 subjects reported scratching but never reported as to which lens was worse; 7 subjects reported no scratching; $P<.001$.

[c] 1 subject reported scratching but never reported as to which lens was worse; 4 reported no scratching; $P<.05$.

Table 4 displays responses to question 7, where the subjects considered whether the lenses should be used for standard military issue. The polycarbonate lenses scored worse in each time category (13 polycarb/3 plastic at 4 months; 13 polycarb/5 plastic at 8 months; and 5 polycarb/0 plastic at 12 months).

TABLE 4. SHOULD TEST LENSES BE CONSIDERED FOR STANDARD MILITARY SPECTACLES? (Question 7)

Polycarbonate \ Plastic	Yes	No	Totals
4-mo evaluation			
Yes	52	0	52
No	10	3	13
Totals[a]	62	3	65
8-mo evaluation			
Yes	26	1	27
No	9	4	13
Totals[b]	35	5	40
12-mo evaluation			
Yes	14	0	14
No	5	0	5
Totals[c]	19	0	19

[a] 13 subjects did not respond to the question; 2 subjects responded to only part of it; $P<.01$.

[b] 3 subjects did not respond to the question; 2 subjects responded to only part of it; $P<.05$.

[c] 3 subjects did not respond to the question; $P = .10$.

Table 5 summarizes responses to question 1, 2, 4, 5, and 6--dealing with use, comfort, unusual experiences, and cleansing of lenses. With question 5, the investigators were interested in whether the subjects became aware of distortion effects with either lens, whether coatings deteriorated from the polycarbonate lens, and whether either lens sustained an unusual impact and survived or succumbed. None of these possibilities were defined, and the subjects commented only on scratching characteristics which were adequately covered in their responses to questions 3 and 7.

TABLE 5. USE, COMFORT, AND CLEANSING OF LENSES
(Questions 1, 2, 4, 5, and 6)

Question	Responses		
	4 months	8 months	12 months
1. Did you wear the glasses all the time?	44/80 (55.0%)	30/44 (68.2%)	8/22 (36.4%)
If not, most of the time?	32/80 (40.0%)	12/44 (27.3%)	12/22 (54.5%)
Hardly at all?	4/80 (5.0%)	2/44 (4.5%)	2/22 (9.1%)
2. Were the glasses comfortable?	74/80 (92.5%)	43/45 (95.6%)	22/22 (100%)
4. To what extent does the scratch or mar interfere with your vision?			
A great deal?	3/66 (4.5%)	10/38 (26.3%)	5/20 (25.0%)
Some?	23/66 (34.8%)	10/38 (26.3%)	5/20 (25.0%)
Not at all?	40/66 (60.6%)	18/38 (47.4%)	10/20 (50.0%)
5. Were any unusual experiences noticed with spectacle wear?	15/75 (20%)	5/44 (11.4%)	2/22 (9.1%)

6. How do you usually clean your lenses?	wet	dry	both	wet	dry	both	wet	dry	both
Handkerchief	3	14	2	6	9	1	2	5	0
Kleenex	9	37	9	11	22	3	3	10	1
Paper towel	4	1	2	5	1	0	1	2	0
	16	52	13	22	32	4	6	17	1
Total responses	81[a]			58[b]			24[c]		

[a] 18 questionnaires with no response; 17 with a response on more than one cleaning method.

[b] 14 questionnaires with a response on more than one cleaning method.

[c] 3 questionnaires with no response; 3 with a response on more than one cleaning method.

CONCLUSIONS

Polycarbonate lenses can be molded in a range of prescriptions within the optical quality specified in the ANSI Z80.1 first-quality lens standards. In a mass production operation, polycarbonate lenses over a wide range of prescriptions, in dress thickness, should be commercially available at a reasonable cost.

Polycarbonate lenses without a protective scratch-resistant coating would not fare well in an ophthalmic laboratory during sizing processing and lens insertion into a spectacle frame. Coated polycarbonate lenses perform well in standard laboratory abrasion tests, demonstrating scratch hardness approaching that of a glass lens surface. In this field test, the coated polycarbonate lenses scratched worse than off-the-shelf CR-39 plastic lenses at each of the check periods: 4, 8, and 12 months.

Although the replacement cycle for coated polycarbonate lenses in this wear test was noticeably shorter than for the CR-39 plastic and, by inference, glass lenses, the impact-protection property of the polycarbonate warrants its use as an eye protector in a potentially hostile environment.

Most subjects use a dry handkerchief or Kleenex-type tissue to wipe their spectacle lenses clear. This procedure is believed to be causal in the high scratch production found in this study.

RECOMMENDATIONS

Present policy requires that every spectacle-wearing military member scheduled for overseas assignment have two serviceable pair of prescription spectacles in his/her possession prior to shipment. For personnel destined for a combat zone or a location with high risk for an outbreak of hostilities, providing coated prescription polycarbonate lenses for their backup pair would be desirable. Plano spectacles or goggles with coated polycarbonate lenses could be stocked for issue to non-spectacle-wearers where eye protection in a combat zone is indicated. When polycarbonate lenses are issued, a care sheet should be enclosed which recommends that the lenses be wiped clean with a damp cloth or tissue.

REFERENCES

1. ANSI Z87.1-1968. Practice for occupational and educational eye and face protection. American National Standards Institute, New York, N.Y., 1968.

2. ANSI Z80.1-1972. Requirements for first-quality prescription ophthalmic lenses. American National Standards Institute, New York, N.Y., 1972.

3. ANSI Z80.1-1979. Recommendation for prescription ophthalmic lenses. American National Standards Institute, New York, N.Y., 1979.

4. Commerce Business Daily, Issue No. PSA-6404, p. 17, 10 Sep 1975.

5. Federal Register 36:185:18871, 23 Sep 1971.

6. Federal Register 44:68:20678, 6 Apr 1979.

7. General Electric Report 8-26, Lexan sheet. 1 Plastics Ave., Pittsfield, Mass., undated.

8. Korb, Donald R. New England College of Optometry, Boston, Mass. Personal communication, 1972.

9. Military specification MIL-V-43511 (GL), Amendment 2. Visors, flying helmet, polycarbonate. U.S. Government Printing Office, 13 May 1968.

10. Targove, Bertram D., et al. Glass versus plastic lenses - An Air Force replacement and durability study. Am J Optom Arch Am Acad Optom 49(4):320-329 (1972).

APPENDIX

The contractor shall produce for delivery 150 pairs of polycarbonate lenses of at least 65-mm diameter in the following prescription ranges within 30 days after acquisition of production capability.

SPHERICAL		CYLINDRICAL			
-0.50	0.0	-0.25	-0.50	-0.75	-1.00
-0.75	0.0	-0.25	-0.50	-0.75	-1.00
-1.00	0.0	-0.25	-0.50	-0.75	-1.00
-1.25	0.0	-0.25	-0.50	-0.75	-1.00
-1.50	0.0	-0.25	-0.50	-0.75	-1.00
-1.75	0.0	-0.25	-0.50	-0.75	-1.00
-2.00	0.0	-0.25	-0.50	-0.75	-1.00

The contractor will coat one lens of each of the 150 pairs initially produced with an antiscratch material. Proprietary coatings available only to the contractor will be expected, and if more than one coating is offered, the USAFSAM Technical Contract Monitor shall have the option to select or not select one or more for use on lenses to be produced under this contract. In the event that a proprietary coating is not offered or if the USAFSAM Technical Contract Monitor concludes that the quality of the proprietary coating offered is not up to the hardness and appearance standards of Abcite^{R} (Dupont), the Monitor may designate Abcite^{R} or another commercially available coating to be used.

The quality of the lenses produced under this contract shall conform to the American National Standards Institute Standard Z80.1-1972, Requirements for First-Quality Prescription Ophthalmic Lenses. (A copy of this standard may be obtained from American National Standards Institute, 1430 Broadway, New York NY 10018.)

The center thickness of lenses produced under this contract shall be no more than 2.2 mm, nor less than 2.0 mm. Lenses shall be colorless and any coating applied shall not significantly change the appearance of the lens.