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A survey and experimental study of the effectiveness of lens coatings for reducing the susceptibility of plastic lenses to scratching

Dennis R. Vannatta
Pacific University

Edward J. Wayman
Pacific University

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Abstract
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Degree Type
Thesis

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A SURVEY AND EXPERIMENTAL STUDY OF THE EFFECTIVENESS 
OF LENS COATINGS FOR REDUCING THE SUSCEPTABILITY 
OF PLASTIC LENSES TO SCRATCHING

A THESIS 
PRESENTED TO THE FACULTY 
OF 
PACIFIC UNIVERSITY 
BY 
DENNIS R. VANNATTA 
EDWARD J. WAYMAN 

IN PARTIAL FULFILLMENT 
OF THE REQUIREMENT FOR THE DEGREE 
DOCTOR OF OPTOMETRY 
FEBRUARY 1980

ADVISOR

NORMAN S. STERN, O.D., Ph. D.
Accepted by the faculty of the College of Optometry, Pacific University, in partial fulfillment of the requirements for the Doctor of Optometry degree.

Thesis Advisor

Dennis R. Vannatta

Edward J. Wayman

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We would like to extend our gratitude to Dr. Norman Stern for his guidance and assistance in the course of this study. A special note of appreciation is extended to Edith Flesher for her role in completing this project. Our appreciation is also offered to all those optometrists who took time to complete the surveys. Lastly we wish to thank the following companies for their complimentary samples and/or information:

Berg Industries
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Dow Corning Corporation
Dupont
Gentex Corporation
Hoya Lens Of America, Inc.
National Lens Coating Corporation
Opti-craft, Inc.
Precision Thin Film Corporation
Owens-Illinios
Tokyo-Optical Company, Ltd.
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A SURVEY AND EXPERIMENTAL STUDY OF THE EFFECTIVENESS
OF LENS COATING FOR REDUCING THE SUSCEPTIBILITY
OF PLASTIC LENSES TO SCRATCHING

by: Dennis R. Vannatta and
Edward J. Wayman

Beginning with xylonite in 1885, plastics were plagued with the
problems of poor optical clarity, excess water absorption, and thermal
expansion, as well as excess shrinkage and warping. With the introduction
of methyl methacrylate in 1935 by Rohm and Haas Company and the intro-
duction of CR-39 in 1945 by Columbian-Southern Corporation, most of these
problems have been overcome. Modern plastic lenses generally possess
properties equal or superior to those of glass lenses except for abrasion
resistance. Borish lists the comparative advantages and disadvantages of
plastic as compared to glass lenses as follows:

Advantages

1. Impact resistance is greater than for glass, even exceeding
case-hardened glass in some types.
2. Fragmentation, when it does occur, yields larger pieces with
less jagged edges than does glass.
3. The weight is only from 40-50% that of glass.
4. Light transmission is from 5-8% better
5. Fogging tendency is reduced from 60-70%.
6. High velocity particles and welder's spatter affect plastic
less than they do glass.
7. Fewer internal reflections are apparent, especially in strong
prescriptions.
8. Molding eliminates some surfacing procedures and permits
aspherical curves.
9. A tinted lens, since it is a coated lens, has uniform trans-
mission despite having variations in thickness.

Disadvantages

1. Plastic lenses are more readily scratched unless particular
care is employed in cleaning them.
2. Thermoplastic forms may distort by sudden heat exposure, although usually most will stand any heat that the body will.

3. Chemicals affect plastic lenses much more than glass.

4. The index of refraction is less than that of glass. This variation must be noted if lens measures are used.

5. Ordinary edgers are not efficient on the softer types.

6. Plastic lenses are flammable. However, they are difficult to ignite and burn rather slowly.

7. The cost of plastic lenses is slightly more than of glass lenses in general. The difference in cost is becoming negligible since more plastic lenses are now being prescribed.

8. Drilling weakens the lenses.

With decreased scratch resistance as the major drawback of plastic lens use, researchers have sought to reduce this problem. Provines et al (1973) found that CR-39 lenses coated with Durable Antireflectant were more abrasion resistant than non-coated glass lenses.

It was the purpose of this study to determine the effectiveness of scratch resistant coatings for hard resin prescription lenses. A comparison of plastic and coated-plastic lenses was made to determine the relative scratch resistances under experimental conditions. A survey of practicing optometrists was made to evaluate their experiences with and opinion of both plastic lenses and abrasion-resistant coated plastic lenses.

Technical Information.

Columbian Bifocal of Portland, Oregon has Supercoat anti-reflection coating available. Although the coating formulation and application process was not disclosed, it is believed to be a combination of quartz and magnesium fluoride which is applied to the front surface of plastic lenses.4

ARC is a silicone resin coating developed by Dow Corning. Details of the technology behind ARC are available only to ARC secrecy agreement.
signees and licensees. The process involves dipping, spinning, spraying, or flowing the coating on the plastic followed by hours of oven curing to develop complete solvent and chemical resistance. ARC is very hard and glasslike, but also quite brittle and thus cannot be used on flexible substrates. With proper application, ARC will adhere to Acrylics, Polycarbonate, Celluloses, Styrenics, cast polyesters, and CR-39. Besides offering protection from abrasion, ARC reduces the amount of back reflectance and increases the light transmission 1-3%, depending on the type of plastic and the thickness of Dow Corning ARC film (refractive index 1.43). The cost of ARC coating are intrinsically higher than most organic coatings.

"Lucite" SAR is a crosslinked polysilicate resin that forms an abrasion resistant, cleanable surface. Applied by a dipping process, "Lucite" SAR can be cleaned by using conventional glass cleaners and is resistant to many chemicals which attack other commonly used plastics. Because of limited formability "Lucite" SAR is best suited for flat applications. With an index of refraction of 1.43, "Lucite" SAR has the properties of an anti-reflection coating. DuPont holds the patents on "Lucite" SAR and does not sell the coating separately in the United States, but has licensed Gentex Corporation and Rowland Plastics Corporation. 6,8

"The Lens"™ was developed by Gentex Corporation as the "State-of-the-Art" single vision prescription blank. The process of injection molding polycarbonate lenses and applying a hard coating to reduce scratching was pioneered by Gentex Corporation. The process and characteristics of "The Lens"™ were not disclosed by Gentex.7

Hoya Lens of America has a patented proprietary process for applying Hi-Quartz coating to lenses. The coating is not changed by sunlight
and weather, and has none of the disadvantages of polymeric coatings. It may be applied to a variety of materials, but is currently applied during a 30 minute batch process to spectacle lenses. The Hi-Quartz coating will not flake, chip, or crack when applied to a flexible substrate as is common with other coatings. The cost is relatively low because the coating materials are readily available and inexpensive, but the exact formulations are proprietary. The process is done under a vacuum and may be done as a continuous process in approximately 15 minutes, although a continuous process has not yet been firmly established. 8

National Lens Coating Corporation has perfected a new system of Anti-Reflection multi-layer quartz coating (AR/P) on hard-resin CR-39 lenses. The coating is applied under vacuum to both surfaces of the lens and increases the light transmission to over 96%. The AR/P is a durable coating which will not wear off in regular use and makes the lens 40% harder. The coating is relatively inexpensive and may be applied to pre-tinted lenses however no tinting can be added after coating with AR/P. 9

Owens Illinois offers #650 glass resin as an abrasion resistant coating for PMMA, CR-39, and Polycarbonate lenses. The coating is believed to be a thermoset polyoxymethyl siloxane, but the exact composition is proprietary. The process involves spraying, dipping, or flowing the resin on the surface followed by a 16-24 hour oven curing at temperature from 200-270°F depending on the substrate. Owens-Illinois is offering licenses in the United States and Japan. Gentex Corporation has been licensed by Owens-Illinois to apply glass resin on face masks and motorcycle helmets. 8,10

Toyko Optical Company coats their "Tomay-Lite" lenses with a mixture of a vinyl resin and a silicone compound polymerized by gamma radiation
from Radioactive Cobalt Company. Because of the precautions required for handling radioactive materials, it is believed that the costs may be somewhat higher than other coatings although no estimate was given by Tokyo Optical Company.  

METHOD

The survey consisted of 16 multiple choice or yes-no questions over three basic areas of inquiry. (See Appendix A for a survey copy). First, the percentage of plastic lenses ordered and the reasons for selecting plastic instead of glass. Secondly, the practitioners knowledge and access to abrasion resistant coatings for plastic lenses. And thirdly, the optometrists' use and experience with abrasion resistant coated plastic lenses. Comments were encouraged and space was provided for such comments.

The survey was mailed to 220 Oregon optometrists. The optometrists were randomly chosen from a computer list obtained from Pacific University after elimination of those who were presently associated with Pacific University and those who were not active practicing optometrists. A cover letter accompanied each survey explaining the experimenter's goals and encouraged the practitioner's participation. A self-addressed stamped envelope was provided for their convenience.

The device used for testing and abrasion resistance was designed and built by the experimenters. A diamond stylus (Radio Shack ST90) was centrally mounted on one end of a 5 inch long 1/4" plastic tube. A small piece of cardboard and masking tape was used to maintain proper positioning of the diamond stylus. Mounted on the opposite end of the 1/4" tubing was a small paper cup used to hold the weights during testing. A three inch long
piece of 3/8" plastic pipe was used as a sleeve over the 1/4" tube. This arrangement allowed the experimenters to use the 3/8" plastic pipe as a means of moving the stylus in the horizontal plane without hampering vertical movement of the weight and stylus assembly. The force on the stylus at the lens surface was caused by the weight of the apparatus (15 grams excluding the plastic sleeve) and any additional weights contained in the top mounted paper cup. The experimenters used United States nickels for weights. The nickels were carefully weighed and selected so as to weigh 5 ± 0.05 grams.

The abrasion tester traversed the front surface of each sample ten times for each weight trial. The weight was increased in 5 ± 0.05 gram increments until the first detectable scratch was visible under direct illumination with the unaided eye. To minimize the effects of stylus wear and weight variation, all samples were tested at a given weight level before proceeding to the next level. The tests were run once by each experimenter on two consecutive days for a total of four trials. (The number of trials was limited due to a limited sample supply.)

RESULTS

Of the 220 surveys that were distributed, 87 were returned (39.5%). One survey was incomplete due to the optometrist's retirement from practice.

The background of the responding optometrists was determined by questions I, II, and III. Forty-three (50%) of the respondents have been in practice for over twenty years and forty-two (49%) are associated with communities with populations over 50,000 people. Thirty-one (36%) of the returned surveys indicated the most common number of prescriptions order-
ed each week was from twenty to thirty prescriptions. (See Figures I, II and III)

Questions IV, V, and VI dealt with the percentage of plastic lenses each optometrist ordered and his reasons for selecting or rejecting plastic lenses for each particular prescription. Thirty-seven (43%) of the responding optometrists selected plastic lenses twenty-five to fifty percent of the time. When plastic lenses were chosen for their patients, light weight was a factor 100% of the time while the wide variety of tints available was a factor 42% of the time. When glass was preferred to plastic lenses, lens thinness was a factor 7% of the time, while scratch resistance was a factor 72% of the time. (See Figures IV, V, and VI).

The knowledge and experience of the optometrists with these coatings was also evaluated by the remaining survey questions. Eighty-five percent of the responding optometrists were aware of these coatings and fifty-three percent of the responding optometrists stated that these coatings were available from their local labs. (See Figures VII and VIII). Delays of the prescription orders with these coating were found by 62% of the reporting optometrists while 28% did not reply. (See Figure IX) Success with these coatings was reported by 29% of those who answered the question, while fifty-two percent of the survey respondents gave no reply. (See Figure XII) Sixty-five percent of the replying optometrists order 0% of their plastic prescriptions with these coatings. (See Figure XI) Fifty-four percent of the reporting optometrists indicated no change in the percentage of plastic prescriptions ordered since the introduction of these coatings. (See Figure XIV). However, 63% of the responding optometrists indicated that they would
How long have you been in practice

<table>
<thead>
<tr>
<th>Duration</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>less than 5 years</td>
<td>18.8%</td>
</tr>
<tr>
<td>5-10 years</td>
<td>14%</td>
</tr>
<tr>
<td>10-20 years</td>
<td>17.6%</td>
</tr>
<tr>
<td>20 or more years</td>
<td>49.4%</td>
</tr>
</tbody>
</table>

Figure I

What is the approximate population of your community

<table>
<thead>
<tr>
<th>Population Range</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>less than 4,000</td>
<td>3.5%</td>
</tr>
<tr>
<td>4,000-10,000</td>
<td>9.4%</td>
</tr>
<tr>
<td>10,000-20,000</td>
<td>15.3%</td>
</tr>
<tr>
<td>20,000-50,000</td>
<td>23.5%</td>
</tr>
<tr>
<td>over 50,000</td>
<td>50%</td>
</tr>
</tbody>
</table>

Figure II

How many Rx's do you order each week

<table>
<thead>
<tr>
<th>Quantity Range</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>less than 10</td>
<td>4.7%</td>
</tr>
<tr>
<td>10-20</td>
<td>9.4%</td>
</tr>
<tr>
<td>20-30</td>
<td>15.3%</td>
</tr>
<tr>
<td>30-50</td>
<td>23.5%</td>
</tr>
<tr>
<td>over 50</td>
<td>50%</td>
</tr>
</tbody>
</table>

Figure III
What percentage of plastic lenses do you order?

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>less than 10%</td>
<td>4.7%</td>
</tr>
<tr>
<td>10-25%</td>
<td>14%</td>
</tr>
<tr>
<td>25-50%</td>
<td>43.5%</td>
</tr>
<tr>
<td>50-75%</td>
<td>25.9%</td>
</tr>
<tr>
<td>75-100%</td>
<td>4.7%</td>
</tr>
</tbody>
</table>

Figure IV

Why do you select plastic?

- Light weight: 100% 85/85
- High transmittance: 1.2% 1/85
- Wide variety of tints: 42.4% 36/85
- Safety: 25.9% 22/85
- Other: 3.5% 3/85

Figure V

Why do you select glass?

- Glass is thinner: 7% 6/85
- Photochromatic tint: 80% 68/85
- Scratch resistance: 72% 61/85
- Other: 3.5% 3/85

Figure VI
Are you aware of scratch resistant coatings?

- Yes: 85% (72/85)
- No: 15% (13/85)
- No reply: 10%

Figure VII

Does your lab have these coatings available?

- Yes: 53% (45/85)
- No: 27% (23/85)
- No reply: 20% (17/85)

Figure VIII

Does ordering these coatings delay the order?

- Yes: 62.4% (53/85)
- No: 9.4% (8/85)
- No reply: 28.2% (24/85)

Figure IX

Do you order plastic lenses with these coatings?

- Yes: 28.2% (24/85)
- No: 57.6% (49/85)
- No reply: 14% (12/85)

Figure X
What % of your plastic lenses are abrasion resistance coated

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>0%</td>
<td>64.5%</td>
</tr>
<tr>
<td>1-5%</td>
<td>17/85</td>
</tr>
<tr>
<td>6-10%</td>
<td>8/85</td>
</tr>
<tr>
<td>greater than 10%</td>
<td>5/85</td>
</tr>
</tbody>
</table>

Figure XI

Have you had any success with these coatings

<table>
<thead>
<tr>
<th>Success</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>yes</td>
<td>29.4%</td>
</tr>
<tr>
<td>no</td>
<td>18.8%</td>
</tr>
<tr>
<td>no reply</td>
<td>52%</td>
</tr>
</tbody>
</table>

Figure XII

Have you ever tried these coatings

<table>
<thead>
<tr>
<th>Status</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>yes</td>
<td>43.5%</td>
</tr>
<tr>
<td>no</td>
<td>47%</td>
</tr>
<tr>
<td>no reply</td>
<td>9.4%</td>
</tr>
</tbody>
</table>

Figure XIII
Do you order more plastic lenses now that these coatings are available?

<table>
<thead>
<tr>
<th>Response</th>
<th>Percentage</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>yes</td>
<td>9.4%</td>
<td>8/85</td>
</tr>
<tr>
<td>no</td>
<td>54%</td>
<td>46/85</td>
</tr>
<tr>
<td>no reply</td>
<td>36.5%</td>
<td>31/85</td>
</tr>
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If the above problems were resolved would you probably order more coated plastic lenses instead of glass lenses?

<table>
<thead>
<tr>
<th>Response</th>
<th>Percentage</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>yes</td>
<td>63.5%</td>
<td>54/85</td>
</tr>
<tr>
<td>no</td>
<td>11.8%</td>
<td>10/85</td>
</tr>
<tr>
<td>no reply</td>
<td>24.7%</td>
<td>21/85</td>
</tr>
</tbody>
</table>
Table I

Weight Required for the First Noticeable Scratch
(expressed in grams)
Listed in Sequence of Testing

<table>
<thead>
<tr>
<th>SAMPLE</th>
<th>TRIAL I</th>
<th>TRIAL II</th>
<th>TRIAL III</th>
<th>TRIAL IV</th>
<th>AVE.</th>
</tr>
</thead>
<tbody>
<tr>
<td>non-coated CR-39</td>
<td>55</td>
<td>60</td>
<td>65</td>
<td>60</td>
<td>---</td>
</tr>
<tr>
<td>non-coated CR-39</td>
<td>65</td>
<td>55</td>
<td>55</td>
<td>60</td>
<td>59</td>
</tr>
<tr>
<td>Supercoat</td>
<td>70</td>
<td>75</td>
<td>65</td>
<td>70</td>
<td>70</td>
</tr>
<tr>
<td>The Lents™</td>
<td>45</td>
<td>25</td>
<td>30</td>
<td>35</td>
<td>34</td>
</tr>
<tr>
<td>Hoya non-coated CR-39</td>
<td>60</td>
<td>50</td>
<td>45</td>
<td>45</td>
<td>50</td>
</tr>
<tr>
<td>Hoya Hi-Quartz CR-39</td>
<td>90</td>
<td>90</td>
<td>85</td>
<td>100</td>
<td>91</td>
</tr>
<tr>
<td>Tomay-Lite™</td>
<td>90</td>
<td>120</td>
<td>105</td>
<td>100</td>
<td>104</td>
</tr>
<tr>
<td>AR/P</td>
<td>55</td>
<td>60</td>
<td>65</td>
<td>50</td>
<td>58</td>
</tr>
<tr>
<td>non-coated polycarbonate</td>
<td>25</td>
<td>25</td>
<td>30</td>
<td>25</td>
<td>26</td>
</tr>
<tr>
<td>#650 glass resin coated polycarbonate</td>
<td>40</td>
<td>50</td>
<td>65</td>
<td>65</td>
<td>55</td>
</tr>
<tr>
<td>Lucite™</td>
<td>90</td>
<td>100</td>
<td>105</td>
<td>105</td>
<td>100</td>
</tr>
<tr>
<td>SAR coated Lucite™</td>
<td>130</td>
<td>125</td>
<td>135</td>
<td>110</td>
<td>125</td>
</tr>
<tr>
<td>ARC-coated CR-39</td>
<td>80</td>
<td>65</td>
<td>70</td>
<td>75</td>
<td>73</td>
</tr>
<tr>
<td>ARC-coated acrylic</td>
<td>15</td>
<td>20</td>
<td>20</td>
<td>15</td>
<td>18</td>
</tr>
<tr>
<td>ARC-coated polycarbonate</td>
<td>20</td>
<td>35</td>
<td>35</td>
<td>35</td>
<td>31</td>
</tr>
</tbody>
</table>
probably order more plastic lenses with these coating if the problems of the
cut coatings were resolved. (See Figure XV)

From experimental tests, it was found that CR-39 lenses were abraded
by an average weight of 59 grams. Columbian Bifocal's Super Coat required an
average weight of 70 grams while Gentex Corporation's "The Lens"™ required
34 grams. The non-coated half of CR-39 lenses from Hoya Lens of America,
Inc. scratched with 50 grams of weight, while the Hi-Quartz coated side re­
quired 91 grams. "Tomay-lite" from Tokyo Optical Company required an average
104 grams for the first detectable scratch. National Lens Coating Corpor­
ation AR/P samples scratched under an average 58 grams of pressure. The non­
coated portion of the polycarbonate sheet from Owens-Illinois was abraded
with 26 grams while the glass resin coated side required 55 grams. DuPont
Lucite™ was abraded on the average by 100 grams while the SAR coated Lucite™
required 125 grams. Dow-Corning's ARC coated CR-39 sheets required 73 grams
of average weight for abrasion while ARC coated Acrylic and Polycarbonate
sheets were abraded with 18 and 31 grams respectively. (See Table I)

DISCUSSION

The experimenters noted during the lens testing that most coatings not
only increased the scratch resistance, but when the lenses did scratch, the
scratches were shallower and less noticeable than those in the non-coated
samples. This was especially true when the abrasion threshold weight was
exceeded by a substantial amount. All of the coatings tested possessed this
characteristic.

However, the sample coatings tested were not all applied to the same sub­
strate which caused some of the results to vary from what they probably would
have been if the substrate material was identical. For example, non-coated
"Lucite" was found to be more scratch resistant than most of the other coated material which could misrepresent the effectiveness of the SAR coating which was applied to "Lucite". "The Lens"™ suffered from the inverse situation. It is a coated polycarbonate lens which was found to be more scratch resistant than non-coated polycarbonate, but significantly less scratch resistant than non-coated CR-39. Some of the other samples tested did not perform as well as claimed by their manufactures, but this may be an artifact of the testing procedure.

The survey provided space for the optometrist to comment on any of the questions asked or on any of the experiences they have had with these coated lenses. This resulted in several definite areas of comment. The most common comment is the time delay required to get these coatings when they’re available as well as the added cost to the patient. It was also brought out by several optometrists that they believe these coatings to be ineffective and that the lab representatives in many reports have supported that opinion. Another area of negative comment about these coatings deals with their design or characteristics. This includes coatings that are only on the front surface, cannot be placed in a salt pan, fade or peel with time, or have an undesirable cast to them. The final negative comment is that proper instruction on the care of plastic lenses or the use of Plastic Clear™ will eliminate the need for these products. However, there is a small group of practitioners that have found this product to be satisfactory and with elimination of time delays, cost, and other problems, they will be more commonly recommended.
CONCLUSION

Although most laboratories offer coating for increasing the scratch resistance of plastic lenses, the time delays, increased costs, and poor reputations prevent their widespread use. Of the products tested, most possessed the ability to increase the scratch resistance and all products reduced the severity of the scratches when they did occur. This ability should make modern plastic lenses more durable and more widely accepted as the lens of choice. However, wider distribution and increased product awareness are necessary along with decreased delays and costs before the presently practicing optometrists will accept and prescribe such coated plastic lenses for the majority of their patients.
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5. Information provided by Dow Corning Corporation, Midland, Michigan, 48640

6. Information provided by E. I. duPont de Nemours and Company Inc., Wilmington, Delaware, 19898

7. Information provided by Gentex Corporation, Carbondale, PA. 18407


9. Information provided by National Lens Coating Corp., 380 Lafayette Street, New York, N.Y. 10003

10. Information provided by Owens-Illinois, P.O. Box 1035, Toledo, Ohio 43666
Appendix A

Pacific University
U.C. Box 36
Forest Grove, OR 97116
September 20, 1979

Dear Doctor:

We are fourth year students at Pacific University College of Optometry. For our senior research project we are testing the effectiveness of lens coatings in increasing the scratch resistance of plastic lenses.

As part of our research, we are conducting a survey of practicing optometrists. It would be greatly appreciated if you would contribute to our research by answering the following questions. A self-addressed, stamped envelope has been enclosed for your convenience.

Thank you very much for your cooperation.

Sincerely,

Dennis Vannatta

Ed Wayman

Enclosures
How long have you been practicing optometry?

- less than 5 years
- 5 - 10 years
- 10 - 20 years
- 20 or more years

What is the approximate population of your community?

- less than 4,000
- 4,000 - 10,000
- 10,000 - 20,000
- 20,000 - 50,000
- over 50,000

How many Rx’s do you order each week?

- less than 10
- 10 - 20
- 20 - 30
- 30 - 50
- more than 50

What percentage of Rx’s are for plastic lenses?

- less than 10%
- 10 - 25%
- 25 - 50%
- 50 - 75%
- 75 - 100%

When you do order plastic lenses, why do you select plastic?

- light weight
- high transmittance
- variety of tints available
- safety
- other (please specify)

When you do not order plastic lenses, why do you select glass?

- glass lenses are thinner than plastic
- photochromic tints are available
- plastic lenses scratch too easily
- other (please specify)

Are you aware of the lens coatings that are available which increase the scratch resistance of plastic lenses?

- Yes
- No

Does your laboratory have these coated lenses available?

- Yes
- No

Does ordering these coated plastic lenses delay the order?

- Yes
- No

Do you order plastic lenses with these coatings?

- Yes
- No

Approximately what percentage of your plastic Rx’s are ordered with these coatings?

- Why?

Have you had success with these coated plastic lenses?

- Yes
- No

If not, what type of problems have you experienced?

Have you ever tried these coated plastic lenses?

- Yes
- No

If yes, why don’t you order more plastic lenses with these coatings?

Do you feel that you order more plastic lenses than you did before these coatings were available?

- Yes
- No

If the above problems were resolved, would you probably order more coated plastic lenses instead of glass lenses?

- Yes
- No

COMMENTS:

(Please comment on your past experiences with these coated plastic lenses.)