10-1980

Comparison of two abrasives for rigid contact lens modification

Joanne Hendrick
Pacific University

William F. Stone
Pacific University

Comparison of two abrasives for rigid contact lens modification

Abstract

Comparison of two abrasives for rigid contact lens modification

Degree Type

Thesis

Degree Name

Master of Science in Vision Science

Committee Chair

Don C. West

Subject Categories

Optometry

COMPARISON OF TWO ABRASIVES FOR RIGID CONTACT LENS MODIFICATION

Presented to
College of Optometry
Pacific University

In Partial Fulfillment
of the Requirements for the
Degree of Doctor of Optometry

By

Joanne Hendrick
William F. Stone

October, 1980

ACKNOWLEDGEMENTS

The authors wish to express their appreciation to the companies that supplied us with contact lenses: Wesley Jessen, Inc., Syntex Ophthalmics, Inc., and Hydrocurve Soft Lenses, Inc.

Special thanks also go to Bill Beran and Don Chitwood at Tektronix, Inc. (Beaverton, Oregon) for the use of their scanning electron microscope.

The authors also wish to express their appreciation to Dr. Don C. West, Professor of Contact Lenses, for his guidance in this study.

J.H.
W.F.S.

TABLE OF CONTENTS

INTRODUCTION

Plastic (methyl methacrylate) corneal contact lenses were first introduced into the United States in 1936. By 1947, Kevin Tuohy had begun full scale manufacturing of plastic corneal lenses. These early lenses were made with total diameters of 10.8 mm. to 12.5 mm. and were generally fit 0.1 mm. to 0.2 mm. flatter than the central cornea. By 1955, Norman Bier (as well as others) was advocating use of a much smaller corneal lens fit paralleling the central cornea. (Mandell, 1974) In order for these corneal lenses to contour the central cornea, a bicurve construction was used with the additional peripheral curve usually 12.25 mm. in radius. (Bibby, 1979)

Most present-day vision care specialists still subscribe to the philosophy of an alignment fit. In order to obtain this alignment fit, many make use of standard peripheral curve radii; generally 10.5 mm., 11.5 mm., or 12.25 mm. (Bibby, 1979) Others vary the peripheral curve radius as they alter the base curve radius. As a further refinement in contact lens fitting, some practitioners make use of a tricurve or quadracurve construction.

Along with specifying a particular peripheral curve radius, most practitioners select a specific peripheral curve width. This is done in an attempt to further optimize the fitting relationship between the cornea and the contact lens.

There are many generally accepted functions attributed to peripheral curves. These functions include:

1) Provision for adequate tear circulation beneath the lens. Tear circulation functions to support corneal metabolic needs. It provides for regulation of pH and ion balance, as well as for the oxygen requirements of the cornea. (Goldberg, 1971) Adequate tear circulation is achieved by the peripheral curve providing channels for easy access to tears, by providing for lens rocking and by carrying a resevoir of oxygenated tears that traverses the cornea with lens movement. (Mandell, 1974)

2) Properly selected peripheral curves will prevent edges from damaging the corneal surface during lens movement. (Bibby, 1979)

3) Peripheral curves provide a tear meniscus at the edge of the lens which functions as a centration force. (Bibby, 1979)

Regardless of the philosophy utilized in arriving at specifications for peripheral curve width and radius of curvature, it is apparent that peripheral curves serve many important functions. The advantages of being able to modify the peripheral curves as an in-office procedure are readily apparent; in-office modifications result in improved professional service to the patient as well as contributing to better understanding and more knowledgeable fitting of corneal contact lenses. (Richardson, 1966)

At present, there are several commonly used methods for applying a peripheral curve as an in-office procedure. One method involves the use of a diamond coated brass tool to generate the additional curve. Another method involves using a brass tool that has Dermicel brand first-aid tape (Johnson and Johnson) stretched over the surface to cut on the additional curve.

There has been some controversy in the past concerning the use of Dermicel tape to put on peripheral curves. Some feel that this method does not actually remove stock from the contact lens but instead puts on a peripheral curve that is only optically present. (It has been hypothesized that the periphery is superpolished where it comes into contact with the Dermicel covered brass tool.) If this is truely the case, then generating a peripheral curve in this manner will not significantly alter the fitting characteristics of the contact lens and its utility as an in-office procedure is questionable.

This study was designed to investigate the application of peripheral curves on three different types of rigid contact lens materials; polymethylmethacrylate (PMMA), cellulose acetate butyrate (CAB), and a PMMA-silicon combination lens (Polycon).

The question to be answered by the study is whether Dermicel covered brass tools are as effective as diamond coated brass tools in removing stock from a contact lens during modification. Another point to be considered is whether a difference in lens material will alter the effectivity of either modification technique.

METHODOLOGY

Initially, there were three groups of spherical contact lens blanks.

Group I: 32 polymethylmethacrylate lenses (PMMA)

Group II: 15 PMMA-silicon combination lenses (Polycon)

Group III: 11 cellulose acetate butyrate lenses (CAB)

The lenses were individually measured for base curve, total diameter, power and center thickness. After the measurements were taken, the lenses were cleaned, dried and weighed to the nearest one-tenth of a milligram on an analytical balance.

A 0.4 mm. wide peripheral curve was then applied to half of the lenses in each sample group by the following technique:

> The lens was placed on a suction cup and then turned for approximately five to ten seconds on a diamond coated brass tool dampened with water. The radius of curvature of the brass tool was 9.50 mm. Next, the peripheral curve was polished with a 9.40 mm. brass tool covered with velveteen and moistened with Silvo(a silver polishing compound).

The lenses in the other half of each sample group had a 0.4 mm. wide peripheral curve applied by the following technique:

The lens was placed on a suction cup and then turned approximately 200-300 times on a brass tool covered with Dermicel tape and moistened with Silvo. The radius of curvature of the brass tool was 9.40 mm. The Dermicel tape has a thickness of 0.15 mm., so the radius of curvature after the tape was applied was approximately 9.55 mm. There was no need to polish the peripheral curves applied with Dermicel tape.

No additional secondary curves, blends or edge modifications were performed on any lens.

The lenses were then cleaned again, dried, and weighed.

In order to conclude that both diamond coated brass tools and Dermicel covered brass tools remove stock from a contact lens when applying peripheral curves, a significant change in the weight of the contact lens must occur subsequent to modification.

As an additional method of evaluating the effectivity of the modification techniques in removing stock from the contact lens (as compared to simply superpolishing the periphery) the lenses were viewed with a scanning electron microscope.

STATISTICAL ANALYSIS

The mean, standard deviation, and variance were calculated for the lens weight both before and after modification. The mean, standard deviation, and variance were also calculated for the change in weight for each sample group.

$$\bar{X} = \text{mean} = \frac{\Sigma X_i}{N}$$

$$S.D. = \text{standard deviation} = \sqrt{\frac{\Sigma (X_i - \bar{X})^2}{N-1}}$$

$$V = \text{variance} = \frac{\Sigma (X_i - \bar{X})^2}{N}$$

On the surface, the mean changes in weight after modification indicated that Dermicel modification was as effective in removing stock from the contact lenses as was the diamond modification. The photographs taken with the scanning electron microscope also supported this belief. To verify this superficial evaluation, a t-test for related measures was performed on each sample group at the .05 confidence level.

$$t = \frac{\bar{X} - \bar{Y}}{\sqrt{\frac{\Sigma D^2 - \frac{(\Sigma D)^2}{N}}{N(N-1)}}}$$

$\bar{X}$ = Mean lens weight before modification
$\bar{Y}$ = Mean lens weight after modification
D = Difference between X and Y
N = Number of lenses

The results indicate that at the .05 level, the Dermicel technique and the diamond technique were both effective in removing stock during modification on all three lens materials.

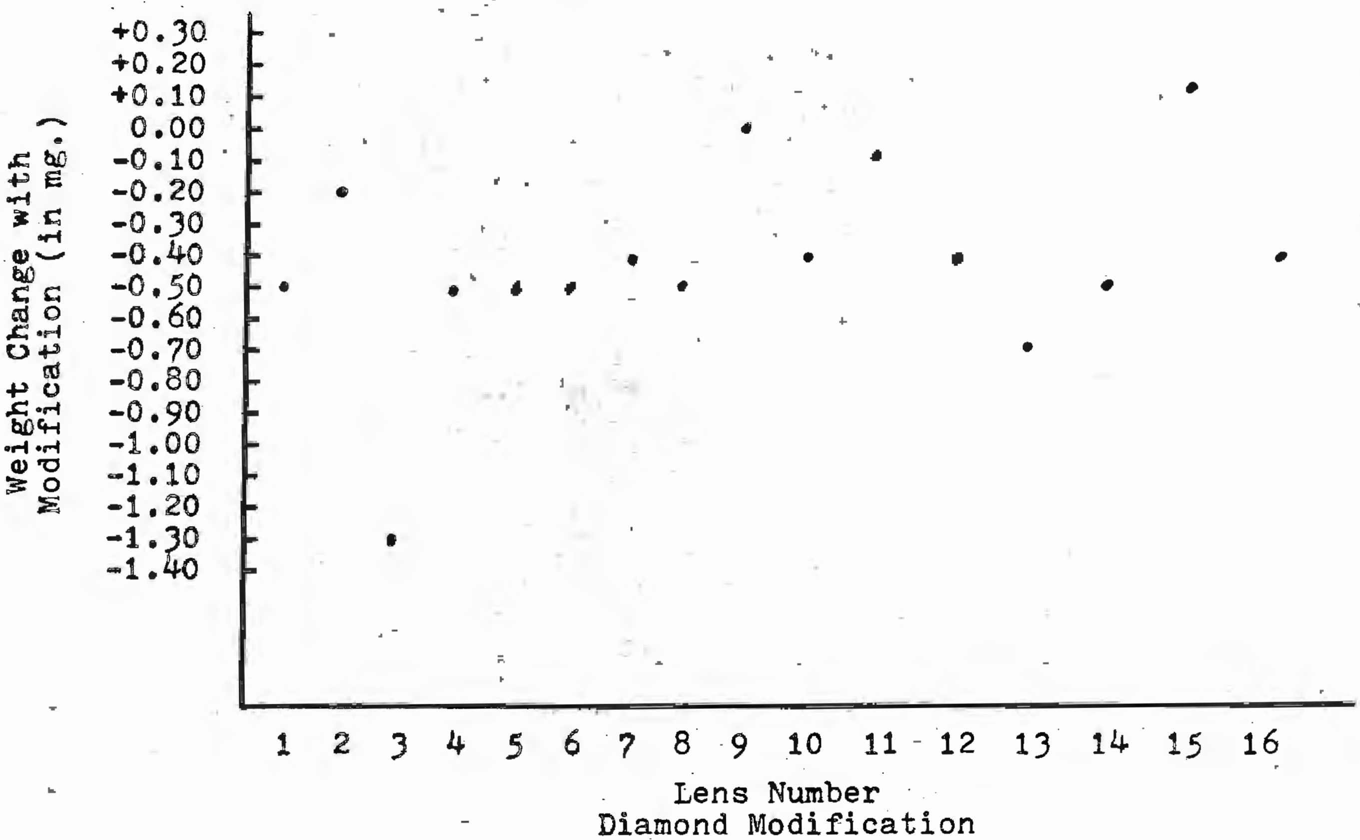
POLYMETHYLMETHACRYLATE (PMMA)

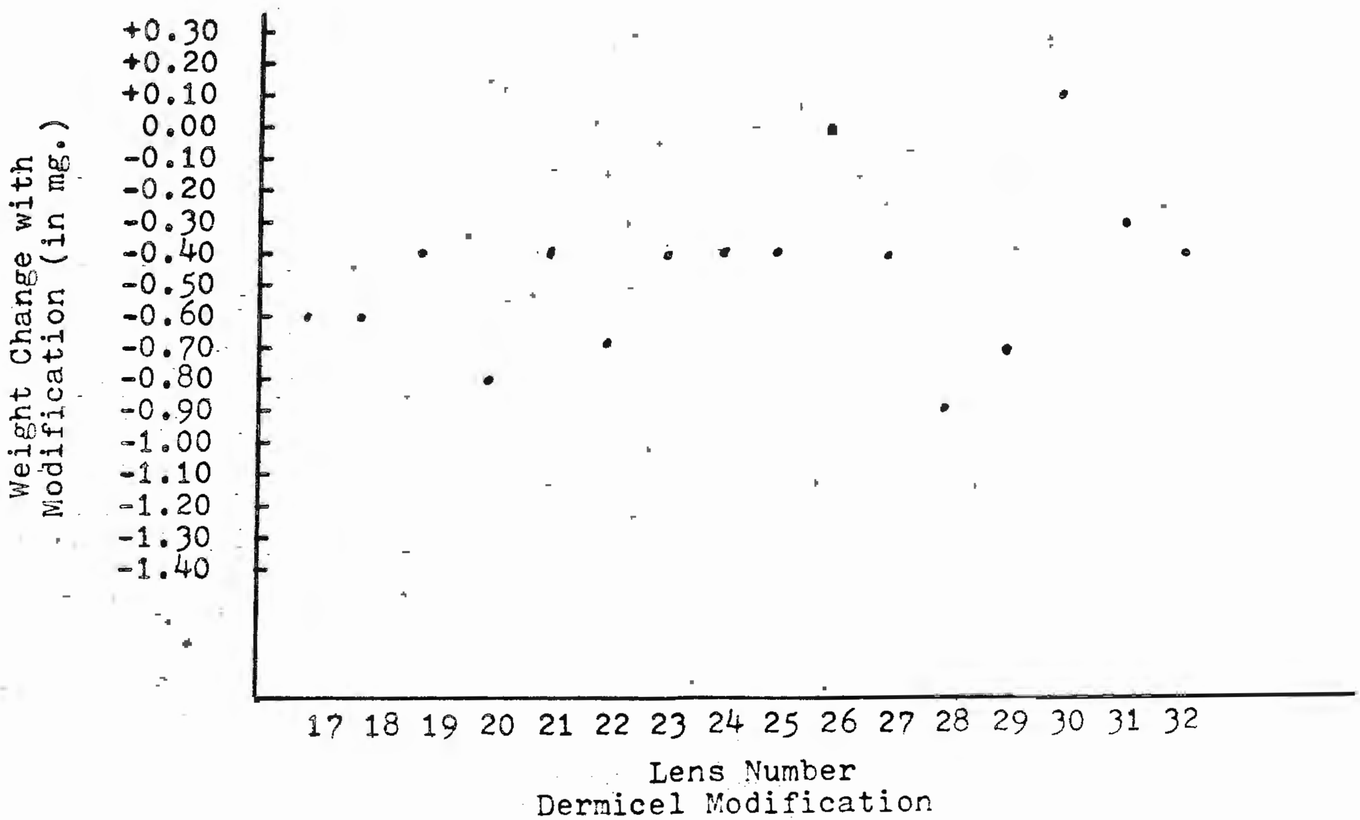
Lens Number	Base Curve (mm)	Diameter (mm)	Power (diopters)	Center Thickness (mm)	Weight Before Modification (mg)	Weight After Modification (mg)	Type of Modification Used
1	7.64	8.50	+0.37	.19	13.5	13.0	Diamond
2	7.62	8.50	+0.37	.205	14.4	14.2	Diamond
3	7.60	8.50	-0.25	.20	15.1	13.8	Diamond
4	7.63	8.50	+0.37	.20	13.8	13.3	Diamond
5	7.61	8.50	+0.37	.20	14.3	13.8	Diamond
6	7.61	8.50	-0.12	.20	14.3	13.8	Diamond
7	7.60	8.50	+0.25	.20	14.4	14.0	Diamond
8	7.60	8.50	0.00	.20	13.8	13.3	Diamond
9	7.63	8.50	+0.50	.20	13.8	13.8	Diamond
10	7.63	8.50	+0.37	.20	14.4	14.0	Diamond
11	7.63	8.50	+0.37	.20	13.9	13.8	Diamond
12	7.60	8.50	0.00	.20	14.2	13.8	Diamond
13	7.60	8.50	0.00	.19	14.5	13.8	Diamond
14	7.60	8.50	+0.37	.20	13.5	13.0	Diamond
15	7.62	8.50	0.00	.20	14.1	14.2	Diamond
16	7.64	8.50	+0.37	.20	13.8	13.4	Diamond

POLYMETHYLMETHACRYLATE (PMMA)

Lens Number	Base Curve (mm)	Diameter (mm)	Power (diopters)	Center Thickness (mm)	Weight Before Modification (mg)	Weight After Modification (mg)	Type of Modification Used
17	7.59	8.50	+0.25	.20	14.6	14.0	Dermicel
18	7.58	8.50	-0.25	.20	13.8	13.2	Dermicel
19	7.60	8.50	0.00	.20	14.1	13.7	Dermicel
20	7.62	8.50	0.00	.20	13.7	12.9	Dermicel
21	7.66	8.50	+0.50	.20	14.2	13.8	Dermical
22	7.64	8.50	+0.50	.20	14.4	13.7	Dermicel
23	7.62	8.50	0.00	.20	14.7	14.3	Dermicel
24	7.62	8.50	+0.25	.20	14.4	14.0	Dermicel
25	7.65	8.50	+0.50	.20	13.9	13.5	Dermicel
26	7.59	8.50	+0.12	.21	14.9	14.9	Dermicel
27	7.63	8.50	+0.25	.20	13.9	13.5	Dermicel
28	7.64	8.50	+0.37	.20	13.8	12.9	Dermicel
29	7.59	8.50	0.00	.20	14.3	13.6	Dermicel
30	7.61	8.50	0.00	.20	14.5	14.6	Dermicel
31	7.61	8.50	+0.25	.20	13.9	13.6	Dermicel
32	7.58	8.50	0.00	.20	14.4	14.0	Dermicel

POLYMETHYLMETHACRYLATE (PMMA)





POLYMETHYLMETHACRYLATE (PMMA)
WEIGHT CHANGE WITH MODIFICATION

DIAMOND MODIFICATION	Mean (mg)	Standard Deviation	Variance	Sample Size
Weight Before Modification	14.11	0.419	0.165	16
Weight After Modification	13.69	0.378	0.134	16
Change With Modification	-0.43	0.315	0.093	16

t = 5.46 Degrees of Freedom = 15

DERMICEL MODIFICATION

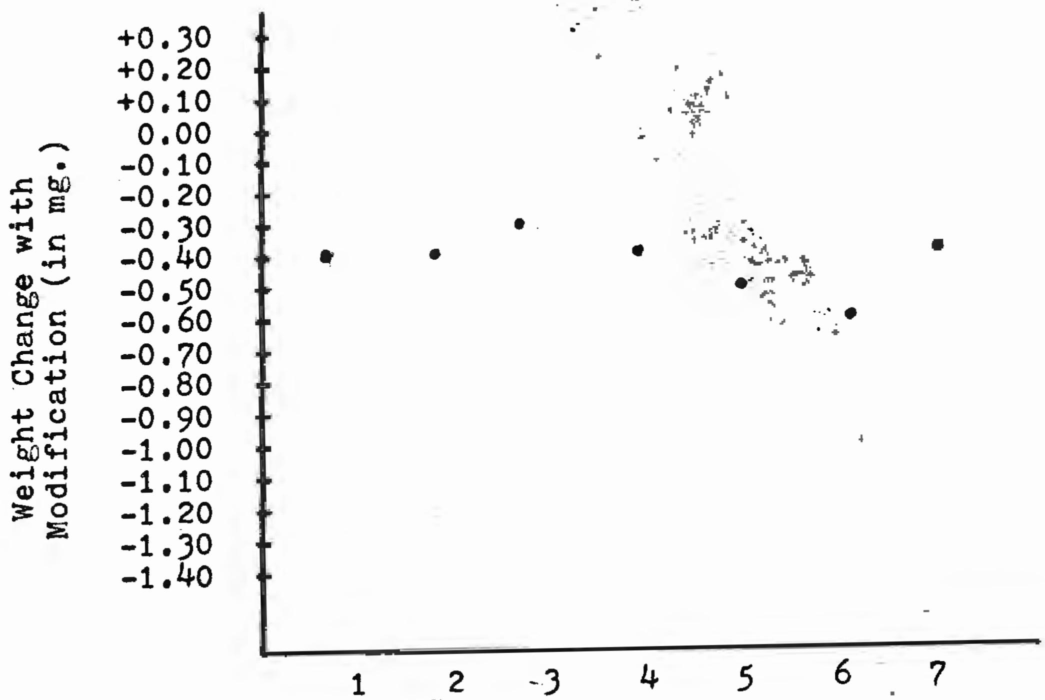
Weight Before Modification	14.22	0.362	0.123	16
Weight After Modification	13.76	0.545	0.279	16
Change With Modification	-0.46	0.263	0.065	

t = 6.98 Degrees of Freedom = 15

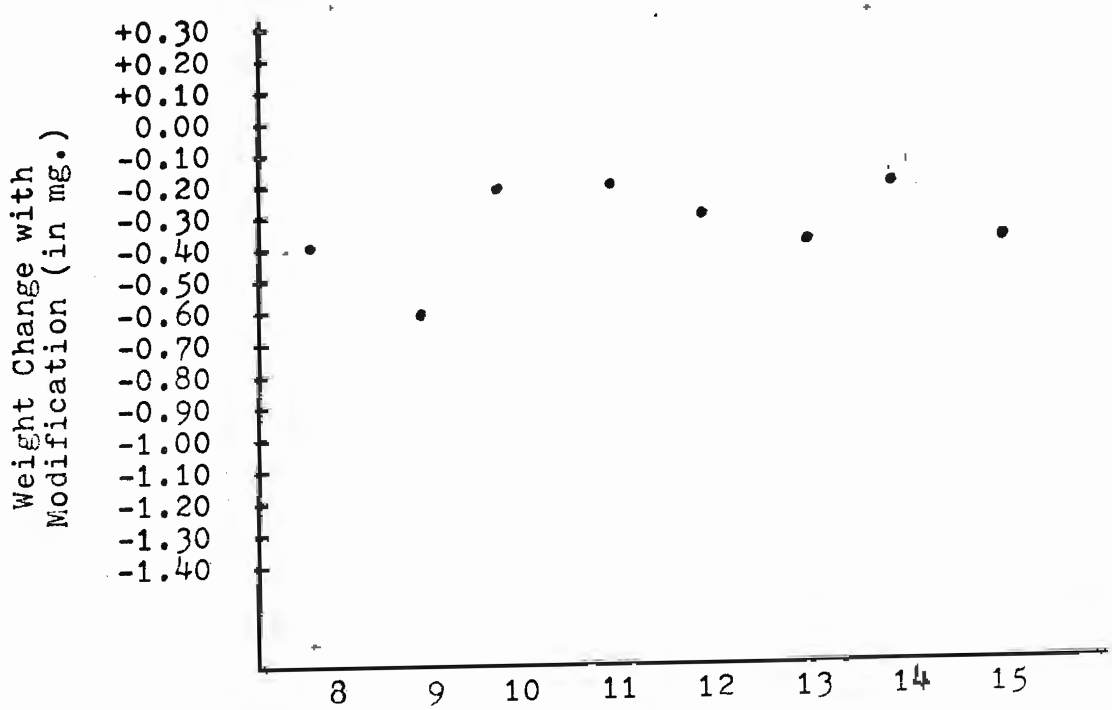
POLYCON

Lens Number	Base Curve (mm)	Diameter (mm)	Power (diopters)	Center Thickness (mm)	Weight Before Modification (mg.)	Weight After Modification (mg.)	Type of Modification Used
1	7.60	8.50	0.00	.14	10.3	9.9	Diamond
2	7.60	8.50	0.00	.14	10.0	9.6	Diamond
3	7.60	8.50	0.00	.14	8.5	8.2	Diamond
4	7.60	8.50	0.00	.14	10.0	9.6	Diamond
5	7.60	8.50	0.00	.14	10.0	9.5	Diamond
6	7.60	8.50	0.00	.14	10.0	9.4	Diamond
7	7.60	8.50	0.00	.14	9.7	9.3	Diamond
8	7.60	8.50	0.00	.14	9.4	9.0	Dermicel
9	7.60	8.50	0.00	.14	10.9	10.3	Dermicel
10	7.60	8.50	0.00	.14	9.2	9.0	Dermicel
11	7.60	8.50	0.00	.14	9.9	9.7	Dermicel
12	7.60	8.50	0.00	.14	9.1	8.8	Dermicel
13	7.60	8.50	0.00	.14	10.4	10.0	Dermicel
14	7.60	8.50	0.00	.14	9.6	9.4	Dermicel
15	7.60	8.50	0.00	.14	9.0	8.6	Dermicel

POLYCON



Lens Number
Diamond Modification



Lens Number
Dermicel Modification

POLYCON
WEIGHT CHANGE WITH MODIFICATION

DIAMOND MODIFICATION	Mean (mg)	Standard Deviation	Variance	Sample Size
Weight Before Modification	9.79	0.593	0.301	7
Weight After Modification	9.36	0.544	0.254	7
Change With Modification	-0.43	0.095	0.008	

t = 11.98 Degrees of Freedom = 6

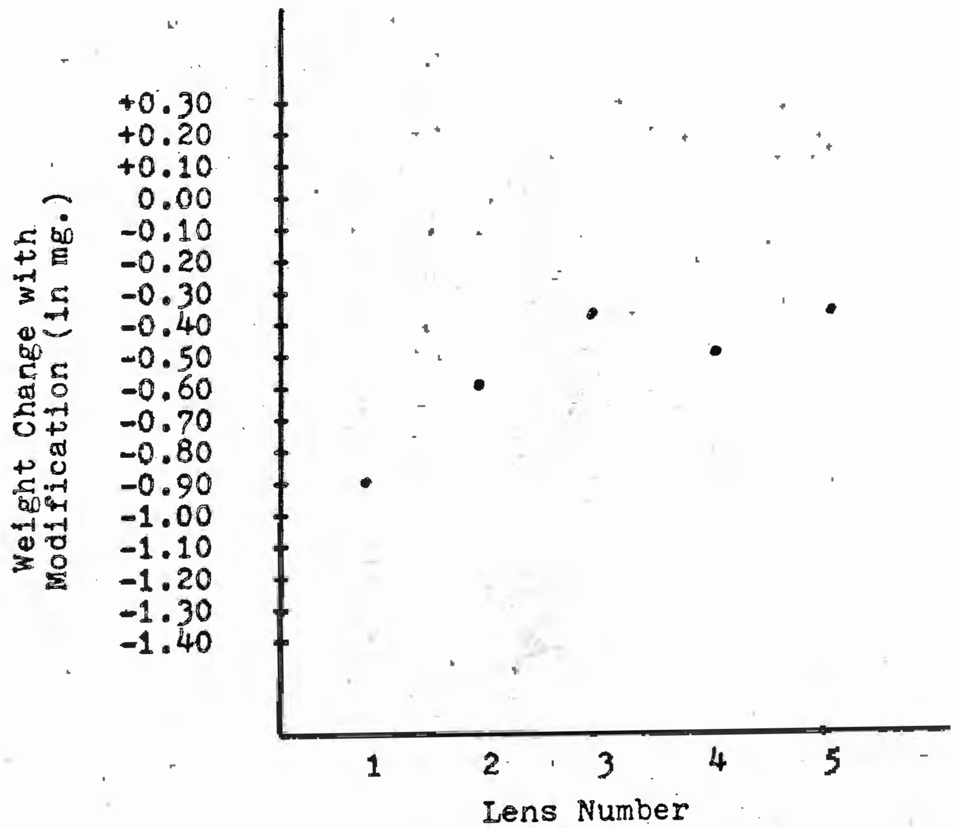
DERMICEL MODIFICATION				
Weight Before Modification	9.69	0.673	0.396	8
Weight After Modification	9.35	0.605	0.320	8
Change With Modification	-0.34	0.141	0.017	

t = 6.83 Degrees of Freedom = 7

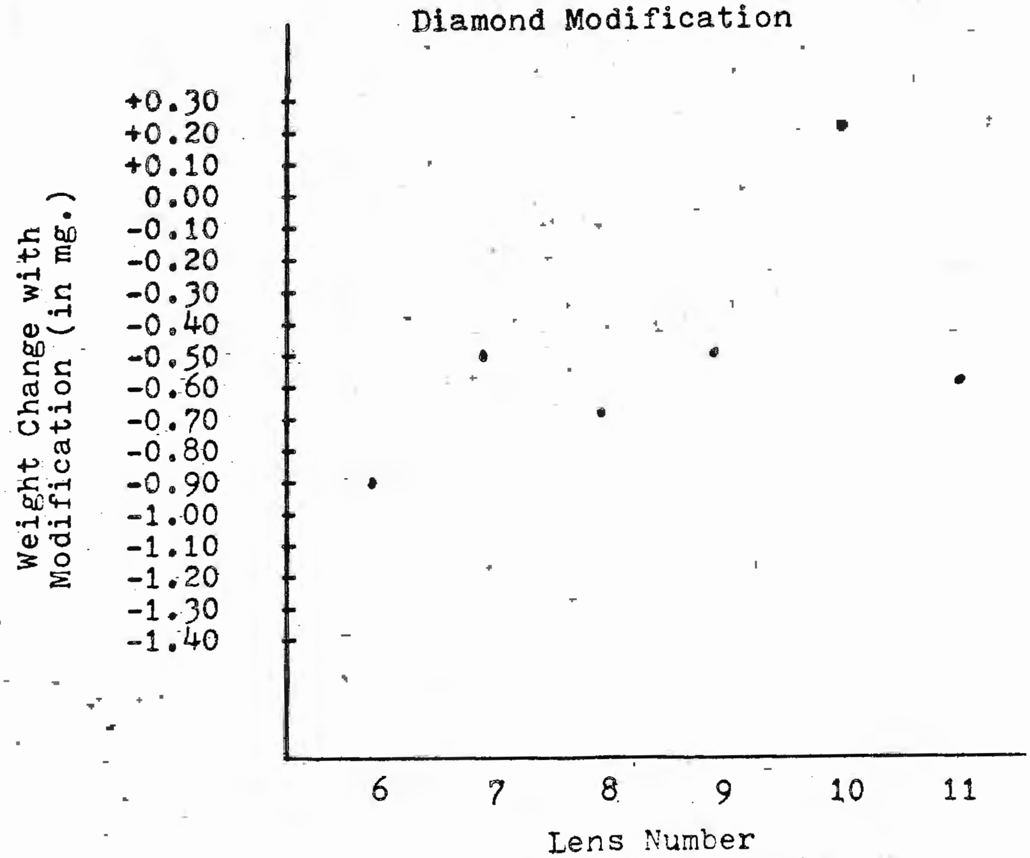
CABCURVE

Lens Number	Base Curve (mm)	Diameter (mm)	Power (diopters)	Center Thickness (mm)	Weight Before Modification (mg)	Weight After Modification (mg)	Type of Modification Used
1	7.68	8.50	+0.50	.175	12.5	11.6	Diamond
2	7.66	8.55	-0.25	.19	14.1	13.5	Diamond
3	7.68	8.60	0.00	.18	13.2	12.8	Diamond
4	7.64	8.50	-0.37	.18	13.5	13.0	Diamond
5	7.66	8.60	-0.50	.18	13.4	13.0	Diamond
6	7.62	8.65	-0.25	.18	13.5	12.6	Dermicel
7	7.62	8.60	-0.12	.19	13.5	13.0	Dermicel
8	7.60	8.70	-0.25	.18	13.4	12.7	Dermicel
9	7.60	8.60	-0.62	.18	13.7	13.2	Dermicel
10	7.66	8.60	-0.50	.175	12.3	12.5	Dermicel
11	7.62	8.65	-0.25	.18	13.4	12.8	Dermicel

CABCURVE



Diamond Modification



Dermicel Modification

CABCURVE
WEIGHT CHANGE WITH MODIFICATION

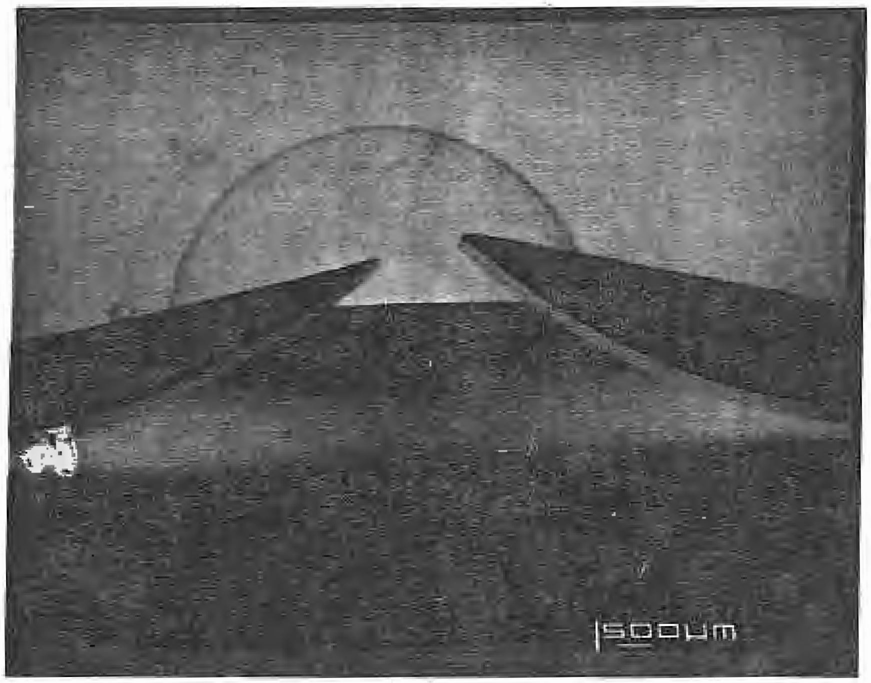
DIAMOND MODIFICATION	Mean (mg)	Standard Deviation	Variance	Sample Size
Weight Before Modification	13.34	0.577	0.266	5
Weight After Modification	12.78	0.709	0.402	5
Change With Modification	-0.56	0.207	0.034	

t = 6.75 Degrees of Freedom = 4

DERMICEL MODIFICATION				
Weight Before Modification	13.30	0.502	0.210	6
Weight After Modification	12.80	0.261	0.057	6
Change With Modification	-0.50	0.374	0.117	

t = 3.27 Degrees of Freedom = 5

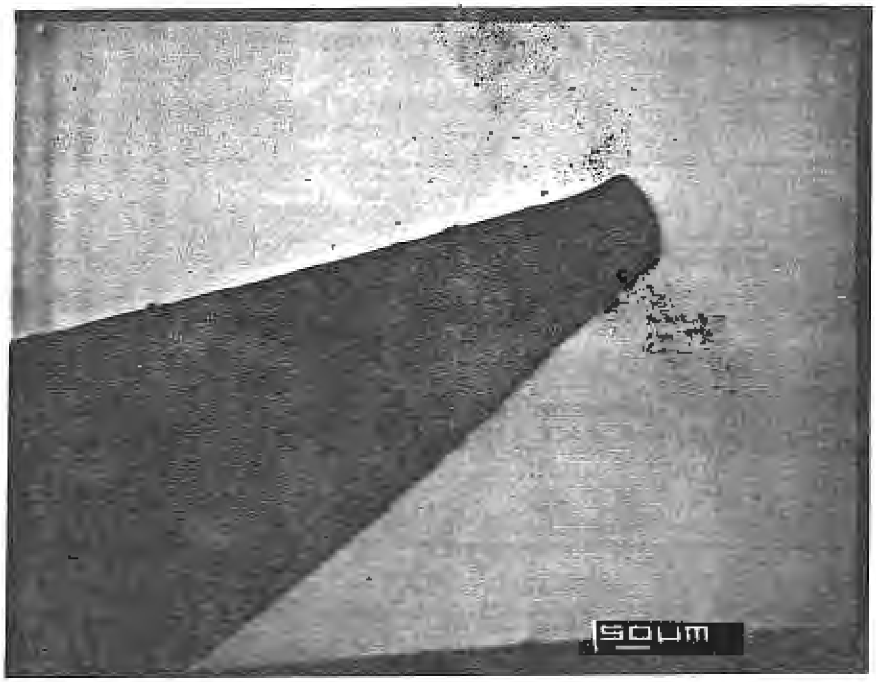
PMMA



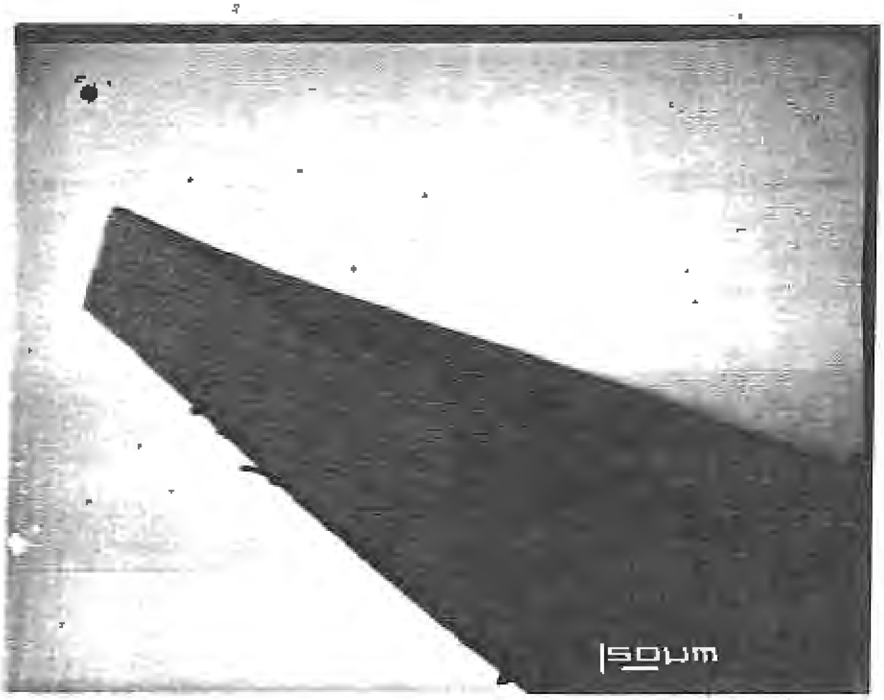
Dermicel Modified Lens

Diamond Modified Lens

20X Magnification
Scanning Electron Micrograph

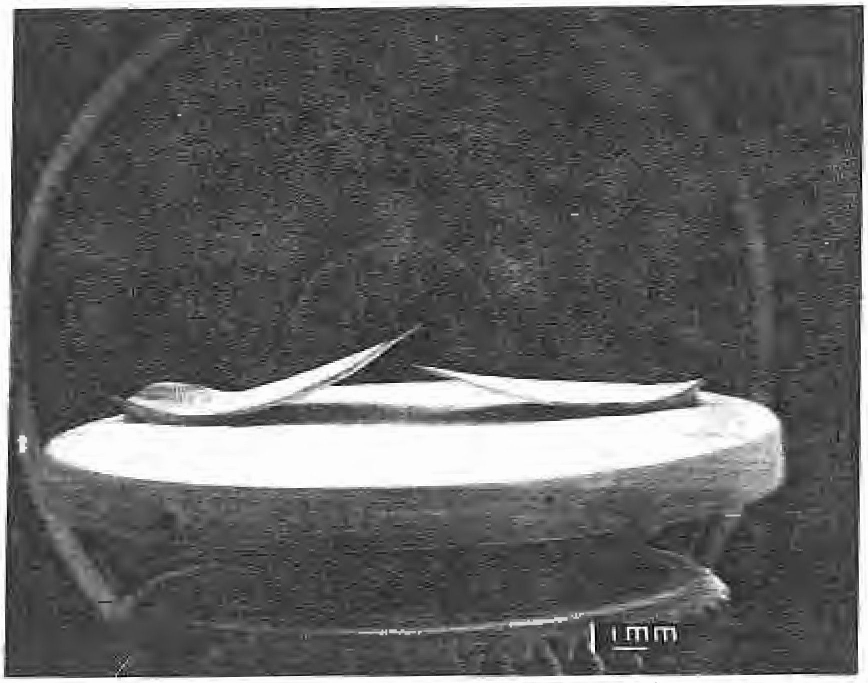


Dermicel Modified 200X Magnification



Diamond Modified 200X Magnification

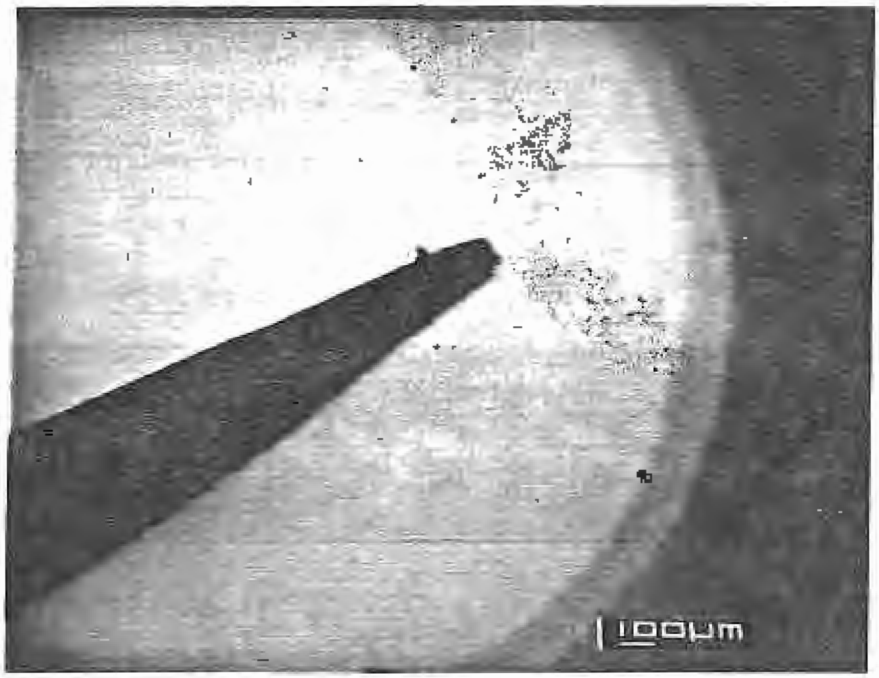
POLYCON



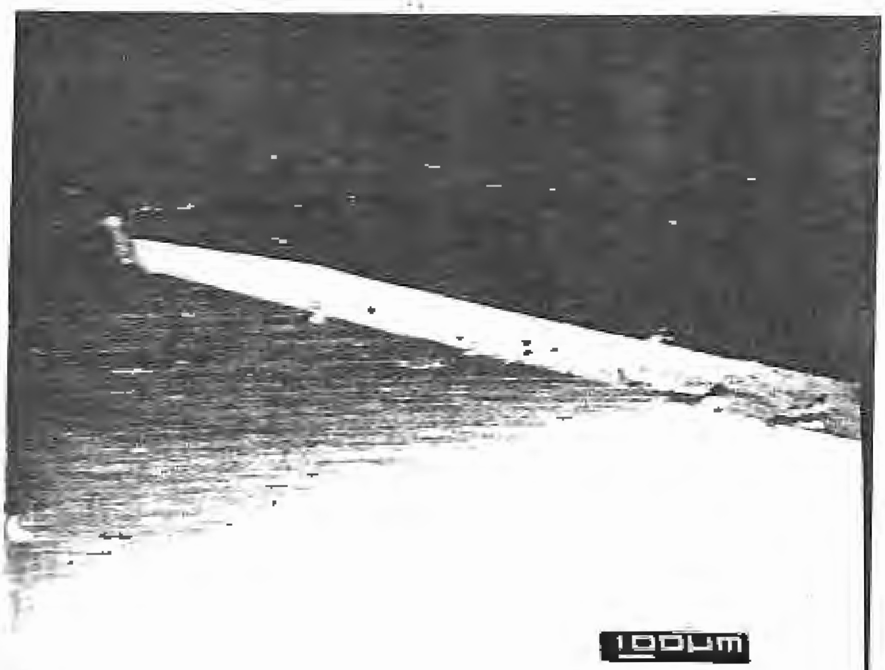
Diamond Modified Lens

Dermicel Modified Lens

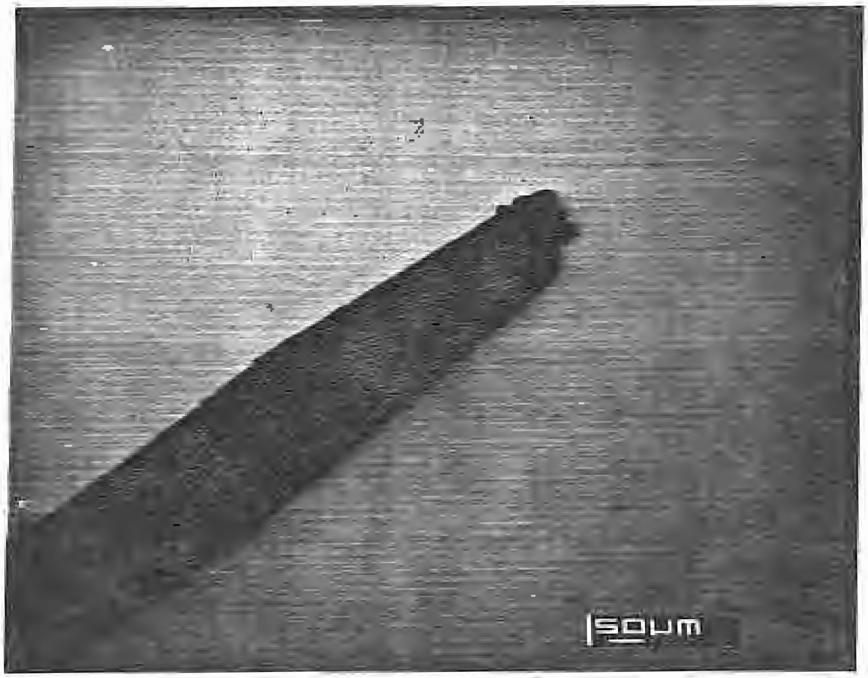
10X Magnification
Scanning Electron Micrograph



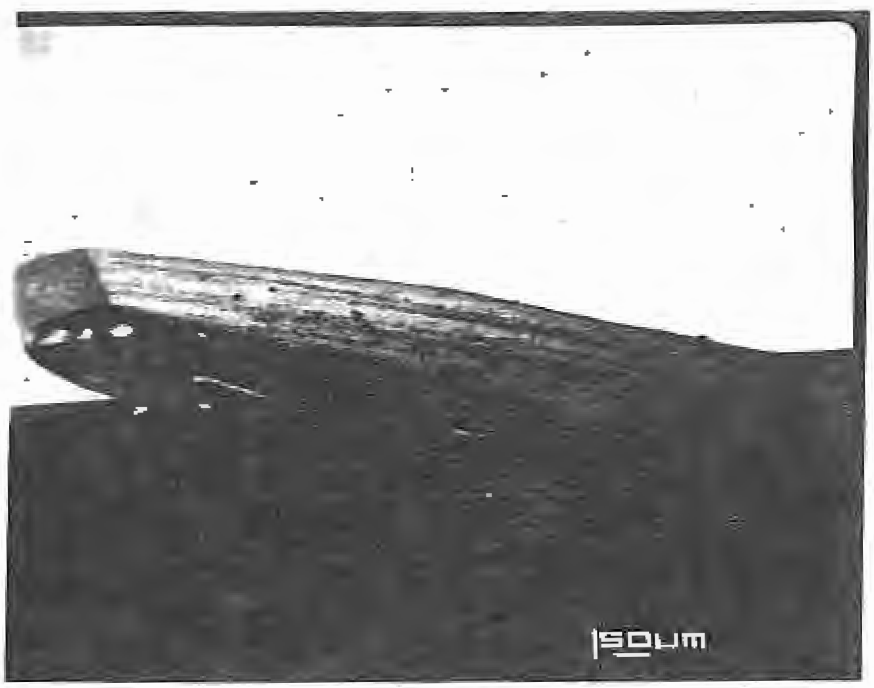
Diamond Modified 100X Magnification



Dermicol Modified 100X Magnification

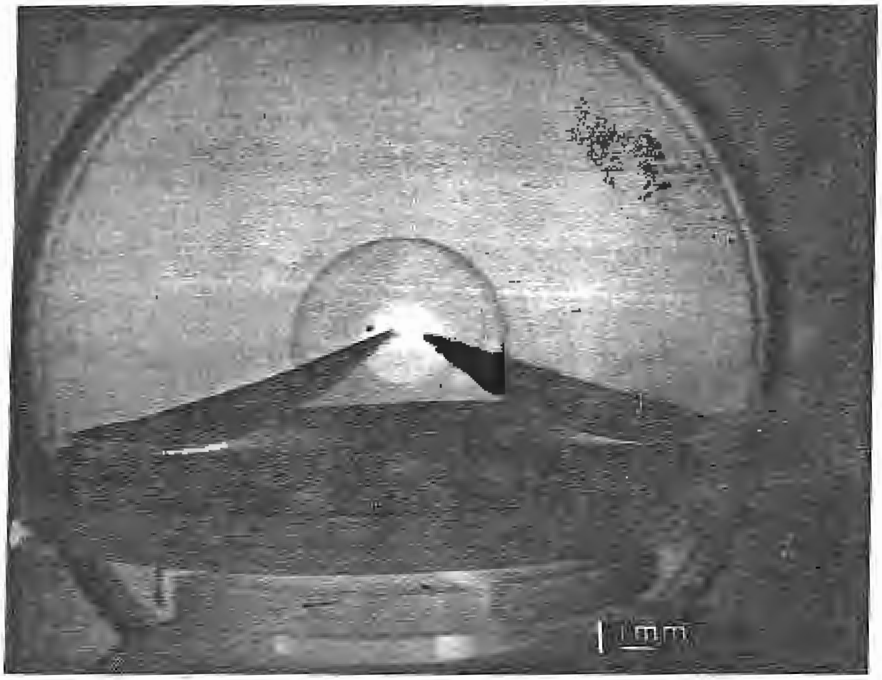


Diamond Modified 200X Magnification



Dermicel Modified 200X Magnification

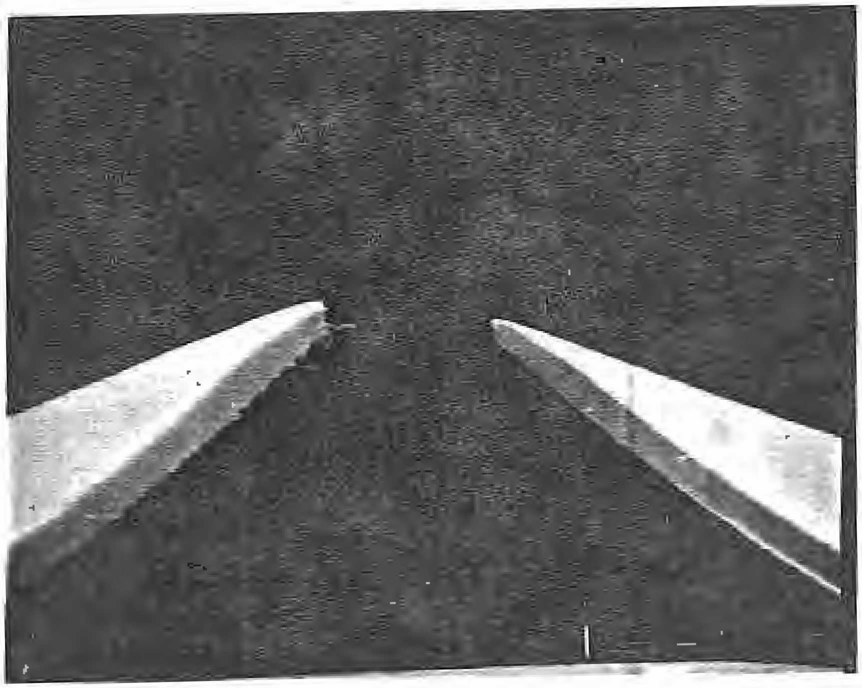
CABCURVE



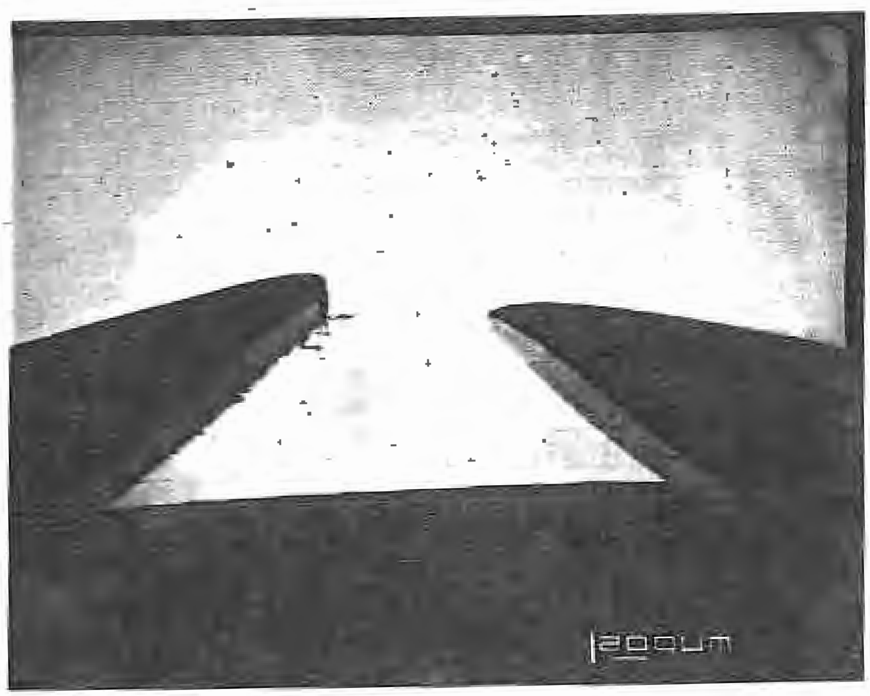
Diamond Modified Lens

Dermicel Modified Lens

10X Magnification
Scanning Electron Micrograph

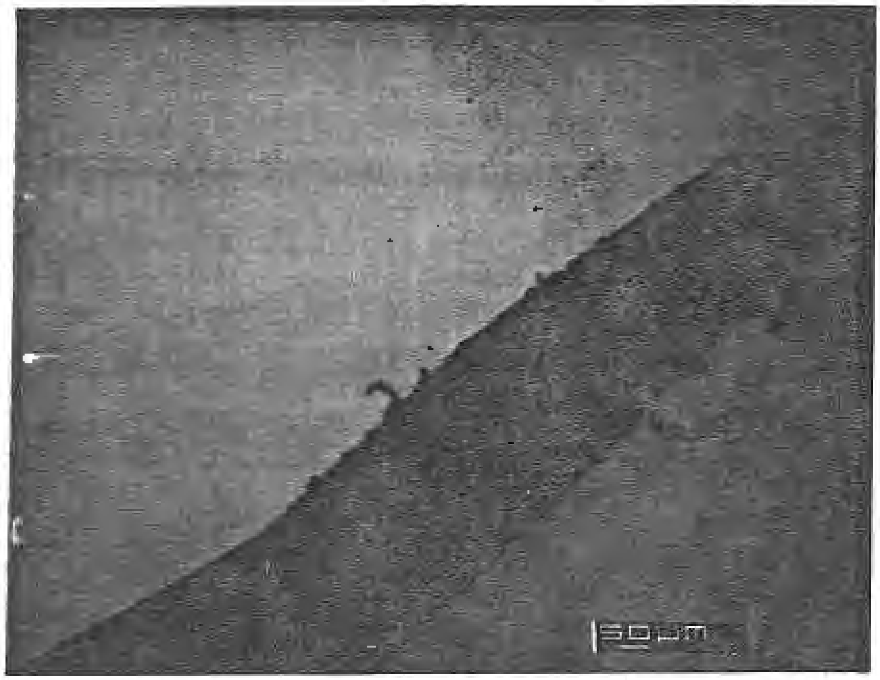


Diamond Modified Lens Dermicel Modified Lens
50X Magnification

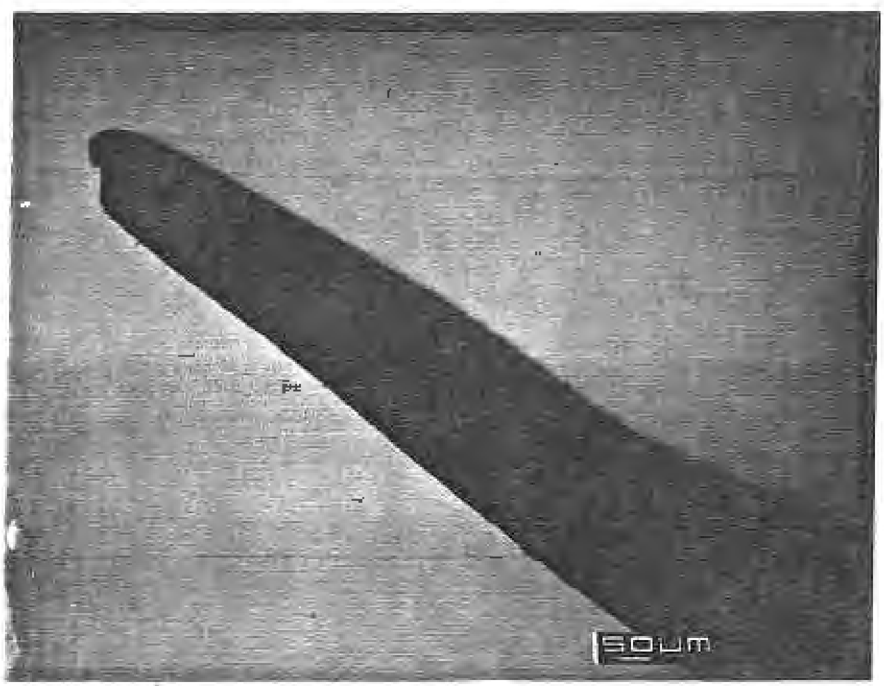


Phase Contrast Reversal

Diamond Modified Lens Dermicel Modified Lens
50X Magnification



Diamond Modified 200X Magnification



Dermicel Modified 200X Magnification

CONCLUSIONS

Based on the statistical analysis of the changes in weight of the lenses with modification and the scanning electron micrographs, it is apparent that both modification techniques were effective in removing stock from the contact lenses. The Dermicel tape covered brass tools did not cause a superpolishing of the periphery of the lenses; the technique did remove material from the lenses as stated above.

Clinical experience shows that modification of contact lenses with Dermicel covered brass tools does not always alter the fitting relationship between the contact lens and the cornea. We feel this may occur because modifications done in the office are frequently done with rapidity of service as a main objective. When this occurs, the lenses are placed on the brass tool with more force and they are not turned 200-300 times to apply the peripheral curve. This may alter the effectiveness of the Dermicel for removing stock from the contact lens. This is a project for further study.

POSSIBLE SOURCES OF ERROR

There were several variables that were not considered in the study.

The power of a contact lens, the center thickness and the total diameter will affect the edge design, thereby affecting the amount of stock removed during modification. The lens samples started with a small range in power, center thickness and total diameter, so these variables were disregarded in the statistical analysis to avoid unnecessary complications.

A few of the lenses appeared to have increased in weight during modification, rather than having weight removed. This might be accounted for by measurement error alone, yet humidity and lens hydration were also factors not considered. The lenses were cleaned, dried carefully, and stored dry before measurements, yet moisture might have contributed to slight measurement error. With measurements in tenths of milligrams, a slight change in hydration of the lens could also account for the few lenses that increased in weight during modification.

BIBLIOGRAPHY

Bibby, M.M. "Factors Affecting Peripheral Curve Design." American Journal of Optometry and Physiological Optics, 56 (Jan. 1979), pp. 2-9.

Estevez, J.M.J. "Polymethylmethacrylate for use in Contact Lenses." The Contact Lens, 1 (April 1967), pp. 19-21 and 26.

Goldberg, J.B. "Current Commentary about Contact Lenses." Optometric Weekly, April 22, 1971, pp. 366-67.

Jenkins, G. and C. Field. "The Design, Production, and Clinical Technique of a Modern Contact Lens." British Journal of Physiological Optics, 25 (1970), pp. 82-86.

Mandell, R.B. Contact Lens Practice. Springfield, Ill.: Charles C. Thomas, 1974.

Martin, W.F. and R.D. Jensen. "A Report on Size and Peripheral Curve Factors in Contact Lens Fitting." Contacto, 4 (Jan. 1960), pp. 155-58.

Richardson, E.F. "Improtance of Making Contact Lens Adjustments in the Office." Optometric Weekly,57 (Mar. 24, 1966), p. 24.

Tuohy, K. "The Birth of An Idea." Optometric World, October 1963, pp. 14-20.