THE EFFECT OF FADE-OMETER EXPOSURE AND LAUNDERING ON THE SERVICEABILITY OF MARQUISETTE CURTAINS MADE OF FOUR SELECTED SYNTHETIC FABRICS

by

LORRAINE ELEANOR GALLE

B. S., Bethel College, 1950

A THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Clothing and Textiles

KANSAS STATE COLLEGE
OF AGRICULTURE AND APPLIED SCIENCE

1955

TABLE OF CONTENTS

INTRODUCTION 1
REVIEW OF LITERATURE 2
    Fibers 3
    Exposure of Fabrics 7
METHOD OF PROCEDURE 12
    Curtain Fabrics 12
    Fade-Ometer Exposures 15
    Laundry Procedure 15
    Analyses of Fabrics................................ 15
FINDINGS AND DISCUSSION 16
    Fabrics as Purchased 19
    Analyses of Fabrics after Exposure 22
SUMMARY AND CONCLUSIONS 37
ACKNOWLEDGMENT 41
BIBLIOGRAPHY 42

INTRODUCTION

Sheer glass curtains are used extensively in homes today but the wise selection of these curtains from the retail market remains much of a problem to the consumer. The basis of this problem is found in the large variety of curtains to be had plus the lack of information for the consumer concerning the service qualities of the various fibers in the fabrics offered.

The qualities which are considered by the homemaker to be of greatest importance in the selection and use of curtains are ease of care and reasonable serviceability. The ease of care for curtains is determined by the frequency and kind of cleaning necessary to keep them attractive. The fiber's resistance to exposure to light and atmospheric conditions will indicate the amount of service to be obtained from the fabric.

The purposes for which sheer curtains are used in the home may be found in helping to beautify the rooms where used, to diffuse light and air, and to maintain the privacy of the home. A curtain fabric must possess certain practical characteristics if it is to fulfill these purposes and to give the homemaker the greatest satisfaction in use and care. The construction of the fabric must be such that it is firm and stable, and at the same time will admit light and air. The fiber content of the fabric must be of the type which will make possible the retention of its original shape, dimension, and hand. The amount and kind of care necessary to keep a curtain attractive will be dependent upon the fiber content and its ability to shed dirt and resist discoloration.

The wide variety of fabrics made of the different fibers which are on the retail market has created confusion for both the consumer and the retailer. "Over promotion of fiber names, with little regard to the functional values of the amounts of fiber put into a cloth has resulted in considerable caution on the part of the consumer" (8). More factual information concerning the service qualities of various fibers is needed to make the use of these fibers more practical.

The purpose of this study was to determine the effect of Fade-Ometer exposure and laundering on marquisette curtains made of acetate, Saran, and two textures of Fiberglas. This study is a part of a larger project which is studying the effects of natural light exposure and Fade-Ometer exposure on sheer curtain fabrics. The results of the two exposures will be compared in order to determine whether Fade-Ometer exposure can be used as an accurate laboratory method of predicting the serviceability of fibers in actual use. The breaking strength of exposed and laundered fabrics will be used as an indication of the durability of various fibers used in curtain fabrics.

REVIEW OF LITERATURE

Of the three fibers used in this study, acetate is the oldest and until recently was classified as a rayon. Saran has been known for some time as a plastic and has been developed for use as a textile only in the past few years. Fibers made from glass have been known and used for some time but the unique problems found in using glass as a textile have made it slow to be accepted as a practical textile fiber.

Fibers

Acetate was first patented in England by Cross and Bevin in 1899 after they had first obtained it by dissolving cellulose in acetic acid. The experiments and processes which finally made the production of acetate practical were carried on however, in the United States under the direction of Dr. Arthur Little (Mauer and Wechsler, 9). The first important use of acetate was during World War I when it was used as dope on airplanes. It was not until after the war that the textile fiber was developed and was then classified as a rayon along with cuprammonium and viscose (Mauersberger, 10). In 1952 the Federal Trade Commission finally separated acetate from the rayons in a ruling which defined rayon as a regenerated cellulose fiber and acetate as a derivative of cellulose (7).

Wood pulp or cotton linters supply the cellulose from which acetate is made. The process for making acetate includes the dissolving of cellulose from one or both of these two sources in acetic acid and acetic anhydride; acetate flakes are precipitated out from this solution and these flakes are then dissolved in acetone. The fiber is formed from this last solution by forcing it through the very fine openings of a spinneret. Circulating warm air evaporates the acetone from the fibers as they leave the spinneret and the fibers are then wound onto a spool or bobbin (Mauer and Wechsler, 9).

The acetate fiber has certain thermoplastic characteristics because of its low fusion and melting point. It also has low tensile strength which is even lower when the fiber is wet. It absorbs moisture quite readily, is washable, and will remain white over a long period of time. Due to the stiffness of the fiber, the laundering of acetate fabrics often results in a crackled effect which is difficult to remove completely in ironing. Chemically, acetate is not sensitive to weak solutions of acids and alkalies, but is very sensitive to strong solutions of both. Acetate is generally not affected by bacteria or insects but it has been known to discolor because of mildew and to be damaged by silverfish. The fabric has a very pleasing hand and drape and excels many others in its ability to hold a crease (Mauer and Wechsler, 9).

Glass, as a fiber, is made of the same mineral ingredients that are used in the making of ordinary glass. Silica, sandstone, and limestone with varying quantities of chemicals are the primary ingredients used. These minerals and chemicals are heated at a temperature of 2500° F. to reduce them to a molten form. Small glass marbles are formed from this molten mass in order that imperfections and impurities can be sorted out. The marbles are then melted and the resulting liquid is forced through fine orifices. The emerging streams are mechanically attenuated and drawn into fine filaments by high speed winding mechanisms. These many fine filaments are bound together into fibers by coating them with a starch or gelatin sizing. The fibers thus formed are twisted and plied, then woven into fabrics on regular textile looms (Mauer and Wechsler, 9). The fiber takes on no crimp in the weaving process and without further finishing the fabric remains stiff and difficult to handle. A heat setting finish known as "Coronizing" has been developed and used as a means of improving these characteristics. The process consists of passing the fabric through a 1200° F. oven where the fiber sizing applied during manufacturing is burned off. The yarns also become conformed to the weave of the fabric and are permanently crimped. The resulting fabric, in general, is much softer and has a more pleasing hand and drape (17). The natural characteristics of glass make the abrasion resistance of the fibers very low unless a lubricant coating is applied. It has been found that if a lubricant such as mineral oil is applied after the heat-setting process resistance to abrasion is greatly improved. However, the finish is not permanent and after the fabric has been cleaned several times the lubricant has to be renewed (Mauersberger, 10).

The characteristics which make glass fabrics particularly desirable for curtains and draperies are its complete resistance to deterioration due to light and atmospheric exposure, its very high tensile strength, and its resistance to discoloration. The fiber is very easily cleaned and is completely fireproof except for the lubricant finish. Fungi and bacteria have no effect on the fiber and it is not attacked by insects. The stretch and elasticity of glass fibers is very low but the fabrics are excellent in wrinkle resistance and dimensional stability. Chemically, it is resistant to acids and alkalies (Mauer and Wechsler, 9). The dyeing of glass fibers has been a major problem to manufacturers. They have been unable to find dyes which will give good colors and which will remain fast. Recently color has been added to glass fibers through a special process using resin-bonded pigment coatings (Mauersberger, 11). This process has proved quite satisfactory.

The Dow Chemical Company began a research program in 1936 which in 1940 brought about the production of Saran for commercial use. During the first years of production it was used only as a plastic. However, more research and increased production have brought it recently to the retail market in the form of a textile (Mauersberger, 10). Saran is a copolymer vinylidene chloride resin made from the basic raw materials of petroleum and brine. Ethylene obtained from petroleum and chlorine derived from brine are combined chemically to produce a clear, colorless liquid which has a basically crystalline structure. An amorphous structure is necessary in producing continuous filament yarns. Therefore, the liquid is heated at an extremely high temperature which changes the crystalline structure to an amorphous structure. The liquid resin is then extruded through fine orifices into a warm water bath which sets the fiber and prevents recrystallization of the structure. The textile fiber thus formed is a thermoplastic with a definite softening and distortion point. The fiber is very strong, smooth, and elastic but somewhat stiff. At present Saran is used mostly in the monofilament form but it is being introduced in staple form where good crimp and resiliency are desired. The fabric woven from the monofilament fibers has characteristics which are desirable in curtain fabrics. Among them are its excellent resistance to weather, sun and cold, its wrinkle resistance, dimensional stability, and its non-flammability. It will not absorb moisture, is unaffected by high humidity, and is resistant to bacteria and insects. Chemically, it is highly resistant to acids, alkalies, and solvents (Mauer and Wechsler, 9).

The name Saran was originally a trade name used by Dow Chemical Company. However, recently the name has been used as a generic term and companies producing vinylidene chloride have adopted other trade names to identify their fibers (Mauersberger, 10).

Exposure of Fabrics

As a result of the changed status of acetate and Saran and the unique problems of glass fibers, there is comparatively little literature available concerning the characteristics and serviceability in use of fabrics made from these fibers.

It has been known for many years that light and atmospheric exposure cause changes in textile fibers. The factors most important to the consideration of changes in properties and characteristics of fabrics exposed to light, as reported by Taylor (18), p. 201, are the

> ...intensity and spectral distribution of the radiant energy in sunlight and skylight, as well as duration of exposure. The constantly changing intensity in a 24 hour cycle may also be important. Humidity and temperature, neither of which is constant, may be further contributing factors.

The changes occurring in fibers have been found to be the result of absorption of light wavelengths by the fiber. Changes occurring when the light wavelengths are shorter than approximately 6,000 Angstrom units (Taylor, 18). This absorption of light can cause an increase in molecular activity in the fiber and thus a rise in temperature, or as in the case of the short ultraviolet wavelengths, can cause the "displacement of electrons in the atoms composing each molecule" (Fynn and Dean, 5) of the fiber. The changes brought about can be in any degree from severe scorch or burn to changes indiscernible to the eye. Prolonged or continuous exposure to light will cause a tendering action in most fibers. The rate of action being determined by atmospheric gases present and the finishes or dyes on the fiber (Cady, 2).

Attempts have been made to produce a laboratory method of exposing fibers to light and atmospheric conditions which will give accurate indications of what can be expected of fibers when exposed to natural light and use conditions. Since it is impossible to control these natural light conditions due to the constantly changing distribution and intensity of light waves, the FDA-R Fade-Ometer has become the most generally accepted commercial lamp used for these purposes. This lamp employs a high intensity carbon arc light with wavelength energy in the region of 3,000 to 5,000 Angstrom units. A thermostatically controlled temperature gauge and partially controlled humidity conditions are also used in the Fade-Ometer. The importance of temperature and humidity in producing changes in fabrics has been indicated through studies of exposed fibers. At the midwestern meeting of the American Association of Textile Chemists and Colorists in 1953 a report was given on a study of the effect of temperature and humidity on the light fastness of synthetics. It was indicated in this report that in general, fading and fiber changes were affected more by increase in temperature than by increase in humidity. These changes were found to follow a pattern of fiber groupings rather than dye groupings (15).

The Department of Agriculture's Southern Utilization Research Branch has reported a similar study of cotton fibers. The results were much the same for cottons as for synthetics, showing a close relationship between increase in temperature and loss of strength in fibers. There was little indication of change due to increase in moisture (16).

The A. A. T. C. C. conducted a study to compare Fade-Ometer exposure with natural light exposure in an effort to learn if there were any differences occurring in the fibers as a result of the two exposures. In the study, 75 synthetic fabrics were exposed to natural light, under glass as well as to direct sunlight. Some of the same fabrics were exposed in Fade-Ometers and the exposures were compared. The character of fading produced under both sunlight exposure and Fade-Ometer exposure was found to be similar. Character of fading here refers to loss of strength in the fiber as well as change in hue. In some cases the Fade-Ometer rate of fading was faster than natural light fading, particularly if the black panel temperature in the Fade-Ometer had been kept consistently over 175° F. (Babey, 1).

Fletcher (4) reported the results of a study conducted by the Bureau of Human Nutrition and Home Economics in which a group of fabrics used for glass curtains was tested for resistance to heat and light. The exposed fabrics were made of glass, cotton, linen, silk, wool, acetate, viscose rayon, and nylon fibers and five plastics. Heat exposures were made in drying ovens and light exposures were made in a Fade-Ometer. The results of these tests showed that breaking strength and elongation decreased more due to light exposure than to heat exposure. Acetate and glass seemed to be affected the least by heat while linen and nylon changed the most. The greatest changes as a result of the light exposures were found in nylon and silk, while cotton showed the least amount of change. It was concluded from these tests that because of their resistance to heat and light, curtain and drapery fabrics made of glass and acetate would prove to be the most durable. Nylon and silk fibers and the plastics being the least resistant to heat and light would be, as a result, the least durable for curtains and draperies. Fabrics made of glass and acetate proved to be the most satisfactory in retaining their whiteness.

Natural light and use tests were made on curtain fabrics made of cotton, rayon, and nylon in a study conducted by Saville (13). Results similar to the above were noted in that breaking strength decreased with exposure and use. In these tests it was found that there was greater loss of strength for filling yarns than for warp yarns. Shrinkage was also observed in this study, with crosswise shrinkage being greater than lengthwise. This was particularly true for the cottons and rayons. It was also reported that permanent finishes on cottons and rayons reduced shrinkage noticeably.

In a comparative study of glass curtain fabrics made of cotton and rayon, Petzel (12) found that the rayons lost very high proportions of their strength as a result of light exposure. It was also noted that rayons showed a decrease in strength when wet. Cellulose acetate marquisettes were listed as the least durable of the rayons and also showed the greatest change in color.

The effect of laundering on curtain fabrics has been reported in two studies. Ginter and Blue (6) in studying the effects of laundering on rayon, cotton, and nylon found that:

> ...generally the strengths of all the fabrics decreased during the series of launderings. The very inferior wet strengths of the rayon marquisettes is a factor worthy of consideration since this fault would necessitate extreme care in handling of these fabrics during launderings.

The dimensional stability of the rayons was also very low with the greatest amount of change occurring during the first laundering but continuing slightly throughout the series of launderings.

In another study by Saville (14), a comparison was made of the effect of machine laundering and hand laundering on cotton and rayon curtains. Here again rayon showed a high proportionate loss of strength when wet. However, no greater loss of strength was observed as a result of machine washing when compared with hand washing.

METHOD OF PROCEDURE

Four curtain panels made of the various fibers were purchased from retail stores in this area. The fabrics were analyzed as purchased and after they had been exposed in the Fade-Ometer and laundered. Methods specified by the American Society for Testing Materials, Committee D-13 (3) were followed throughout the analyses and exposure of these fabrics.

Curtain Fabrics

The curtains used in this study were made of acetate, Saran, coarse Fiberglas, and sheer Fiberglas. The fabrics will be referred to by letter as fabric F, acetate; fabric H, Saran; fabric I, coarse Fiberglas; and fabric L, sheer Fiberglas.

All of the fabrics were of gauze weave construction. A leno variation of the gauze weave was used in the construction of both Figerblas fabrics. All of the curtains were white or off-white in color. The prices and sizes of the curtains as purchased are shown in Table 1.

Table 1. Sizes and prices of curtain panels.

Fabrics	Size of panel in inches	Price of panel
Acetate	43 x 81	$1.59
Saran	42 x 81	3.50
Coarse Fiberglas	40 x 81	2.98
Sheer Fiberglas	42 x 81	3.25

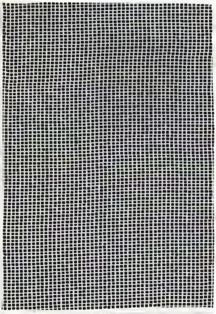
Plate I shows samples of the fabrics.

EXPLANATION OF PLATE I

Fabrics used in this study

Fabric F - Acetate
Fabric H - Saran
Fabric I - Coarse Fiberglas
Fabric L - Sheer Fiberglas

PLATE I



Fabric F

Fabric H

Fabric I

Fabric L

Fade-Ometer Exposures

Specimens of the four fabrics were exposed to the carbon arc light of an FDA-R Fade-Ometer. The exposure periods for the fabrics were 50, 100, 150, 200, 250, and 300 hours. The air inside the exposing chamber was humidified through the use of cotton wicks set in water. The temperature inside the exposing unit was controlled by a thermostat set at 100° F.

Laundry Procedure

Portions of the exposed fabrics were laundered after each 50 hours of exposure. The laundry procedure used was the same as that used in the major project. The fabrics were washed in a mesh laundry bag in a portable electric washing machine for a period of five minutes. This was followed by three two-minute rinses. Enough neutral soap was used for the washing to maintain a standing suds of more than two inches. City water of 65 ppm. hardness was used for both washing and rinsing at a temperature of 105° F., ± 2°. No softener or bleach was used. After washing, the acetate specimens were pressed lightly with a steam iron. The Saran and Fiberglas fabrics were not pressed because of their thermoplastic characteristics and in accordance with the instructions on the labels of the curtains.

Analyses of Fabrics

Fabrics as purchased were analyzed for thread count, wet and dry breaking strength (raveled strip), elongation, and dimensional stability. Twist of yarn and weight per square yard were obtained from the project data. Plate II shows the plan followed in cutting the fabric specimens for analyses and exposure.

The fabrics exposed in the Fade-Ometer were analyzed at the end of each exposure period. A portion of each exposed fabric was judged for color change by a panel of five persons. The portion of fabric which had been exposed and laundered was analyzed for thread count, wet breaking strength (raveled strip), and elongation. Wet breaking strength was obtained because curtains in actual use are not subjected to stress or strain except during laundering or cleaning when the fabrics are wet. For discussion, the exposure periods, with launderings, will be referred to as: exposure 1, 50 hours of exposure and one laundering; exposure 2, 100 hours of exposure and two launderings; exposure 3, 150 hours of exposure and three launderings; exposure 4, 200 hours of exposure and four launderings; exposure 5, 250 hours of exposure and five launderings; and exposure 6, 300 hours of exposure and six launderings.

FINDINGS AND DISCUSSION

The effects of light exposure and launderings on the selected fabrics have been determined through the analyses of the fabrics at the end of each exposure period. The results of these analyses will be used as an indication of the serviceability of the fabrics in use.

EXPLANATION OF PLATE II

Plan followed in cutting test specimens

A - Warp exposures

Numbers correspond to exposure periods

B - Filling exposures

Numbers correspond to exposure periods

C - As purchased - warp

1. dry breaking strength
2. wet breaking strength

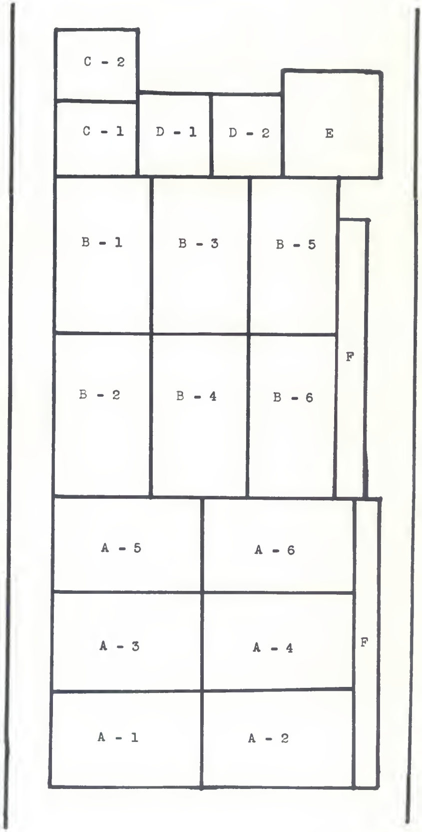
D - As purchased - filling

1. dry breaking strength
2. wet breaking strength

E - Dimensional stability

F - Color change

PLATE II



Fabrics as Purchased

The purchase prices of the curtains varied considerably. The acetate curtain, fabric F, was the lowest priced curtain with the coarse Fiberglas, fabric I, somehwat higher priced. Saran, fabric H, was the highest priced curtain of the four used, while the sheer Fiberglas, fabric L, was only slightly less expensive (Table 1).

The fabrics as purchased were generally good in hand and appearance. Fabric F was white in color, had a satisfactorily crisp hand, but lacked luster or sheen. In contrast to the other fabrics, fabric H was off-white in color and had a wiry, stiff hand. Both fabrics I and L were white in color, were satisfactorily crisp, and had a high luster.

The yarns in the four fabrics varied considerably in structure and twist. The yarns in fabric F were single yarns and had the highest twist of any of the fabrics. The warp yarns were made with "S" twist and had 24 turns per inch; the filling yarns were made with "Z" twist and had 18 turns per inch. Fabric H was constructed of monofilament yarns and so had no twist. Both fabrics I and L were constructed with two-ply warp yarns and single filling yarns. The warp yarns were made with "S" twist of 9.5 turns per inch for fabric I and 9.4 turns for fabric L; the ply twist was "Z" twist with 10 turns per inch for I and 10.6 turns per inch for L. The single filling yarns were made with a "Z" twist with only a little over one twist per inch. Fabric I had 1.5 turns per inch and fabric L had 1.6 turns per inch.

The weight per square yard of fabrics F, I, and L were similar. However, the weight of fabric H was somewhat higher than that of the other fabrics (Table 2).

The highest thread count of any of the fabrics was found in fabric H in the warp direction. Fabrics I and L had the highest filling counts of any of the fabrics. The lowest thread count was found in the filling of fabric H. The best balance of warp and filling threads was in fabrics I and L, with the filling count only slightly less than the warp count. The poorest balance was found in fabric H with the number of warp threads almost double the number of filling threads. Fabric F was somewhat better than H in warp and filling balance but the filling count was still far less than the warp count (Table 2).

The breaking strength of the fabrics did not follow the thread count consistently. Fabric F showed a satisfactory dry breaking strength in both warp and filling directions when compared with the other fabrics. However, the wet breaking strength was only about half that of the dry breaking strength. The highest dry and wet breaking strengths were found in fabric H with both the warp and filling breaking strengths higher than in the other fabrics. There was very little difference between the dry and wet breaking strengths for either the warp or filling. The warp breaking strengths of fabrics I and L were satisfactorily high when compared with the other fabrics. However, the filling breaking strengths, both wet and dry, were the lowest of any of the fabrics even though these two fabrics had the highest filling

Table 2. Analyses of fabrics as purchased.

Fabric	Fiber	Weight per sq. yd.	Threads per inch		Breaking strength in pounds				Elongation percentage				Dimensional change[1]	
					Dry		Wet		Dry		Wet		Per cent	
		Ounces	Warp	Filling	Warp	Filling	Warp	Filling	Warp	Filling	Warp	Filling	Warp	Filling
F	Acetate	1.6	48.0	29.5	22.7	15.5	11.6	8.1	16.8	19.6	23.9	25.7	8.7	8.7
H	Saran	2.0	54.0	27.7	31.4	21.0	31.7	22.5	32.3	34.2	30.9	35.0	2.3	2.5
I	Fiberglas	1.7	42.0	38.8	28.7	5.4	24.1	6.5	4.5	5.0	5.8	6.3	0.8	2.8*
L	Fiberglas	1.7	42.0	35.8	23.6	8.5	23.5	9.2	7.4	3.9	7.8	5.9	0.3	0.0

[1] Figures indicate shrinkage except when followed by an asterisk (*) which indicates stretch.

thread counts. The dry breaking strengths were similar to the wet breaking strengths in both fabrics I and L (Table 2).

Fabric F showed the greatest change as a result of the dimensional stability tests with over eight per cent shrinkage in both warp and filling directions. Shrinkage in fabric H was only a little over two per cent. Fabrics I and L showed the least amount of change of all the fabrics. There was no change discernible for the filling of fabric L and the warp showed less than one per cent shrinkage. Fabric I showed little shrinkage in the warp but showed some stretch in the filling (Table 2).

Analyses of Fabrics after Exposure

The analyses of the fabrics at the end of each exposure period indicated that light exposure and laundering affected the fabrics which were studied.

Three of the fabrics changed noticeably in hand during the exposure periods. Fabrics F, I, and L lost much of their original crispness. This was particularly true of fabric L. At the end of exposure period 1, this fabric was very soft and limp. Loss of crispness was more gradual and not as complete for fabrics F and L. Fabric H did not appear to change in hand as a result of the exposure periods.

Thread count. Fabric F was the only fabric which showed a significant increase in thread count throughout all the exposure periods. The greatest increase in thread count was noted at the end of exposure 1, in both the warp and the filling. The count remained quite consistent through exposures 2, 3, 4, and 5, but exposure 6 showed another noticeable increase. Fabric H showed only a slight increase in thread count at the end of the exposure periods. The thread count of fabrics I and L generally remained unchanged throughout all the exposure periods (Table 3).

Wet Breaking Strength. It was found that all of the fabrics had decreased in wet breaking strength at the end of the last series of exposures and launderings. The exposure periods at which losses occurred varied for the different fabrics. In all but a few instances the losses resulting at the end of exposure periods proved to be significant (Tables 4 and 5; Figs. 1, 2, 3, and 4).

Fabric F showed the greatest loss of strength of all the fabrics in both the warp and filling. A sharp decrease in strength was noted at the end of exposure 1 in both the warp and filling. The breaking strength continued to decrease gradually after exposures 2, 3, 4, and 5. After exposure 6, the breaking strength had again decreased sharply and the fabric showed an almost complete loss of strength. The percentage loss of strength for warp and filling directions was similar at the end of all the exposure periods. In general, the percentage loss in strength increased at the end of each exposure period. These losses were found to be significant when compared with the fabric as purchased.

The breaking strength of fabric H was noticeably higher than the other fabrics and remained higher throughout all of the exposure periods. The warp breaking strength increased after exposures 1 and 2, then decreased after exposure 3 to the same

Table 3. Thread count per inch.

Exposure period	Fabric F		Fabric H		Fabric I		Fabric L	
	Warp	Filling	Warp	Filling	Warp	Filling	Warp	Filling
0	48.0	29.5	54.0	27.7	42.0	38.8	42.0	35.8
1	53.0	33.2	55.0	28.3	42.0	38.5	42.0	36.5
2	53.7	34.5	55.7	28.2	42.0	39.0	42.0	36.5
3	53.3	34.8	56.0	28.7	42.0	39.0	42.0	36.0
4	53.3	34.3	54.7	28.7	42.0	39.0	42.0	37.0
5	53.7	35.7	56.0	28.7	42.0	39.0	42.0	36.0
6	56.0	36.7	56.0	28.7	42.0	39.2	42.0	37.0

Table 4. Wet breaking strength - warp.

Exposure period	Fabric F			Fabric H			Fabric I			Fabric L		
	Pounds	S.E.[2]	% change[1]	Pounds	S.E.	% change[1]	Pounds	S.E.	% change[1]	Pounds	S.E.	% change[1]
0	11.6	.094	--	31.7	.81	--	24.1	1.07	--	23.5	.96	--
1	8.3	.19	28.7	33.2	1.10	4.7*	19.6	.73	18.7	20.7	.71	12.0
2	6.4	.19	44.7	32.2	.59	1.6*	17.2	.41	28.6	17.8	1.29	24.4
3	6.3	.23	45.8	31.7	.50	0.0	16.2	.94	32.4	20.6	1.21	12.2
4	6.1	.44	47.3	30.5	.77	3.8	15.7	1.04	34.9	20.9	1.03	11.1
5	3.5	.25	69.6	28.6	.37	9.6	13.8	.51	42.7	17.1	.73	27.4
6	0.4	.12	96.6	26.2	.87	11.0	14.0	.84	41.9	16.0	.50	32.1

[1] Figures indicate percentage loss from fabrics as purchased except when followed by an asterisk (*) which indicates percentage gain.

[2] S.E. - Standard Error.

Table 5. Wet breaking strength - filling.

Exposure period	Fabric F			Fabric H			Fabric I			Fabric L		
	Pounds	S.E.[2]	% change[1]	Pounds	S.E.	% change[1]	Pounds	S.E.	% change[1]	Pounds	S.E.	% change[1]
0	8.1	.16	--	22.5	.90	--	6.5	.48	--	9.2	.96	--
1	5.8	.12	28.3	22.9	.04	1.8*	5.8	.69	10.8	9.4	.43	2.1*
2	4.8	.41	40.6	15.5	.65	31.3	7.5	.75	15.4*	7.9	.52	14.1
3	4.8	.13	40.6	19.3	1.24	14.2	8.4	.78	29.2*	7.5	.62	18.5
4	5.3	.21	34.4	23.3	.38	3.6*	6.0	.60	8.3	8.4	.07	9.1
5	3.5	.25	56.8	19.8	.63	12.0	7.2	.56	10.8*	7.1	.71	22.8
6	0.2	.12	97.5	19.5	.28	13.3	4.4	1.06	32.3	6.2	.47	32.6

[1] Figures indicate percentage loss from fabrics as purchased except when followed by an asterisk (*) which indicates percentage gain.

[2] S.E. - Standard Error.

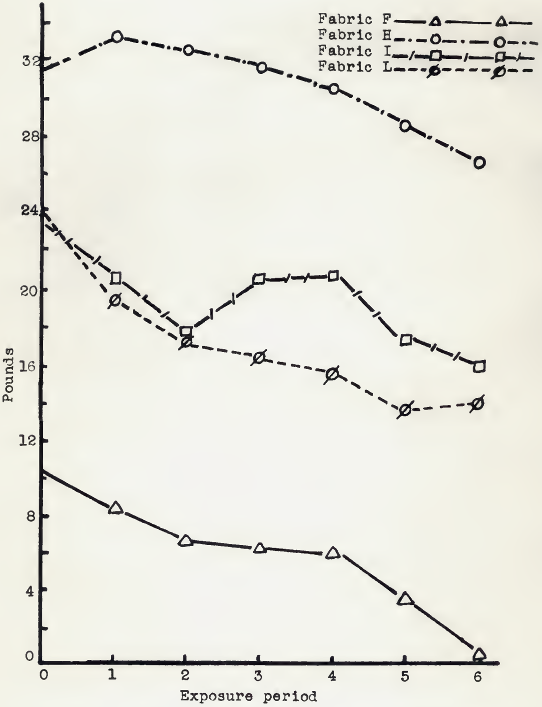


Fig. 1. Wet breaking strength, warp, of fabrics F, H, I, and L.

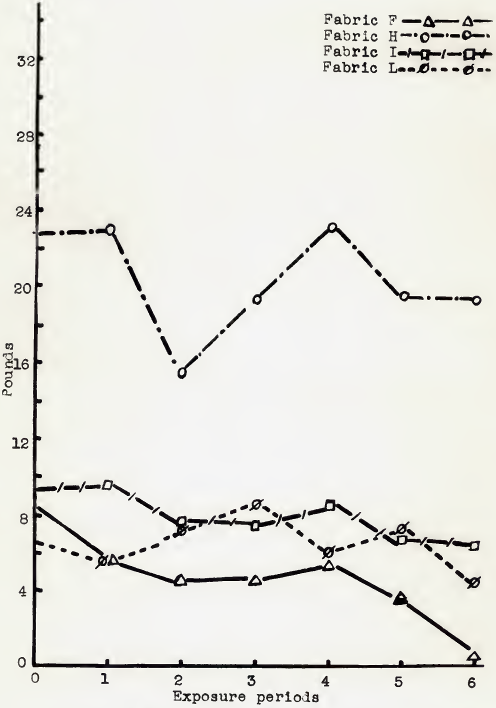


Fig. 2. Wet breaking strength, filling, of fabrics F, H, I, and L.

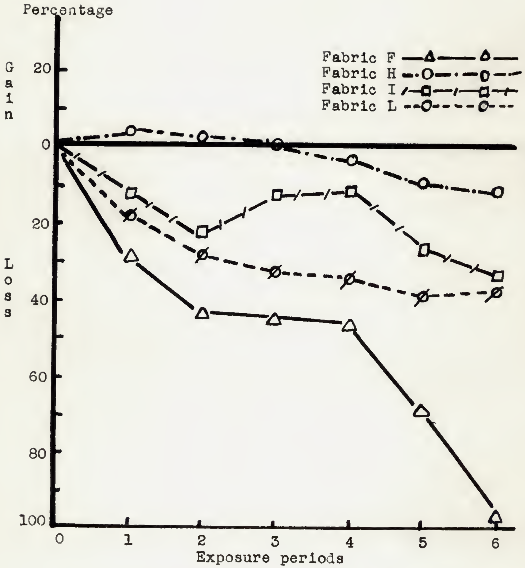


Fig. 3. Percentage change in warp breaking strength of fabrics F, H, I, and L.

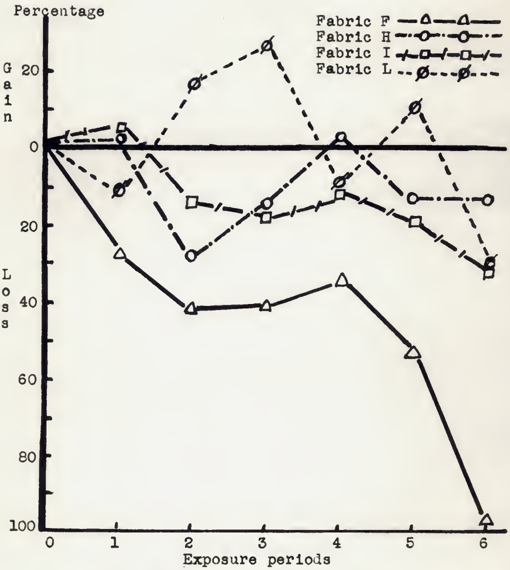


Fig. 4. Percentage change in filling breaking strength of fabrics F, H, I, and L.

as the fabric as purchased. A small percentage loss in strength was found after exposure 4 and this loss continued to increase after exposures 5 and 6. Loss of strength was noted at the end of exposure 2 in the filling. This was the greatest percentage loss noted in the filling after any exposure period. Exposures 1 and 4 showed slight gains in breaking strength over the fabric as purchased. The percentage loss of breaking strength for warp and filling was similar at the end of exposure 6. The losses in wet breaking strength at the end of each exposure period were significantly high when compared with the breaking strength of the fabric as purchased.

In fabric I, the percentage loss of strength in the warp increased consistently with each exposure period except after exposure 6 when a small increase in strength over exposure 5 was noted. The filling breaking strength of fabric I varied considerably after the different exposure periods. Exposures 2, 3, and 5 showed slight increases in strength over the fabric as purchased. Exposures 1 and 4 showed slight losses. However, at the end of exposure 6 the largest percentage loss in the filling was noted.

The losses in warp breaking strength for fabric L varied for different exposure periods with the smallest loss occurring at the end of exposure 4 and the greatest loss occurring at the end of exposure 6. There was a slight increase in filling breaking strength after exposure 1, followed by varying losses at the end of the other exposure periods. Both warp and filling breaking strengths of fabric L were generally higher than fabric I throughout the exposure periods.

The breaking strengths of fabrics I and L were similar in the fabrics as purchased and at the end of the last exposure period. The greatest percentage loss of strength for both fabrics was found in the warp even though the warp remained comparatively high through all exposure periods. The filling breaking strength of fabrics I and L was low as compared with those of the other fabrics studied. The losses in filling breaking strength for both fabrics were not significant when compared to the fabrics as purchased except in fabric L, exposures 5 and 6. All losses in the warp were significant for both fabrics when compared with the fabrics as purchased.

Percentage Elongation. The percentage elongation at the breaking point of all of the fabrics varied considerably throughout the different exposure periods (Table 6). Fabric F showed a greater decrease in percentage elongation than any of the other fabrics at the end of the last exposure period. The percentage elongation of fabric F remained similar during all exposure periods except in the filling which was somewhat higher than the warp at the end of exposure 6. A sharp decrease was noted at the end of exposure 1. A more gradual decrease was found at the end of exposures 2 and 3. Exposure 4 showed a slight increase but this was followed by a sharp decrease again at the end of exposures 5 and 6.

The percentage elongation of fabric H as purchased was much higher in comparison with the other fabrics and remained higher through all exposure periods. There was no consistent decrease

Table 6. Percentage elongation.

Exposure period	Fabric F		Fabric H		Fabric I		Fabric L	
	Warp	Filling	Warp	Filling	Warp	Filling	Warp	Filling
0	23.9	25.7	30.9	35.0	5.8	6.3	7.8	5.9
1	20.3	20.2	31.1	29.9	4.8	4.6	7.1	5.7
2	19.9	19.6	32.6	25.4	4.3	4.7	7.1	5.4
3	18.6	18.7	34.2	30.4	3.1	3.9	6.4	5.0
4	19.1	19.7	29.9	32.7	3.4	4.0	6.8	5.2
5	15.6	13.9	29.5	29.2	5.0	5.6	5.7	5.3
6	9.3	12.6	27.1	28.8	4.1	3.8	5.5	5.5

in the percentage elongation during the exposure periods, however, a definite decrease was noted at the end of exposure 6.

Fabrics I and L were very low in percentage elongation as compared with the other fabrics. There was no consistent decrease in the percentage elongation for fabric I, warpwise or fillingwise, but at the end of exposure 6 a definite decrease was noted. The percentage elongation for fabric L, in both the warp and filling, remained higher than fabric I during all exposure periods even though there was a definite decrease with each exposure period in the warp of fabric L. Fillingwise, fabric L showed only a small decrease in percentage elongation through all the exposure periods up to exposure 4. A slight increase was noted in exposure periods 4, 5, and 6 (Figs. 5 and 6).

Color Change. Two of the fabrics showed some color change as a result of exposure when judged by a panel of five persons.

Fabric F was judged as satisfactory in color through 250 hours of exposure. However, at the end of 300 hours of exposure, change in color was designated as unsatisfactory. The color of fabric H was noted as satisfactory at the end of 50 hours of exposure but was judged as unsatisfactory at the end of each 50 hours thereafter up to and including 300 hours of exposure. Fabrics I and L were judged satisfactory in color at the end of each 50 hours of exposure through 300 hours.

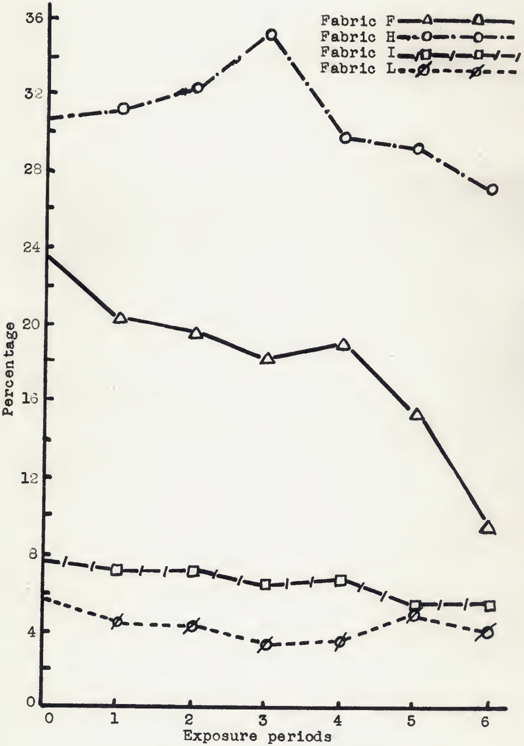


Fig. 5. Percentage elongation, warpwise, of fabrics F, H, I, and L

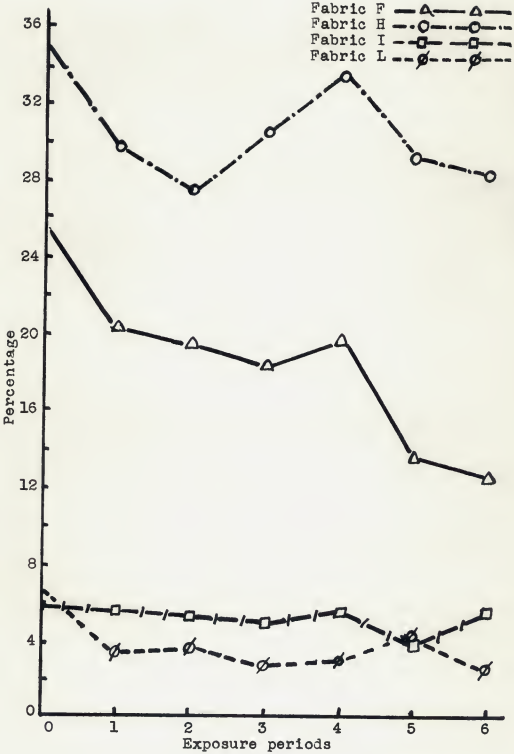


Fig. 6. Percentage elongation, fillingwise, of fabrics F, H, I, and L

SUMMARY AND CONCLUSIONS

The purpose of this study was to determine the effect of Fade-Ometer exposure and laundering on the serviceability of curtain fabrics made of acetate, Saran, and two textures of Fiberglas.

The fabrics as purchased were similar in color and construction. The analyses of the fabrics at the end of the different exposure periods indicated that exposure and laundering affected the serviceability of the fabrics studied in varying degrees.

1. The prices of the curtain panels varied. The acetate panel was the least expensive of the four with the two Fiberglas panels next. The sheer Fiberglas was considerably more expensive than was the coarse Fiberglas. Saran was the most expensive of the four panels used in this study.

2. The color and construction of the fabrics were much alike. The acetate and two Fiberglas fabrics were white and Saran was off-white in color. The acetate and Saran fabrics were made with gauze weave construction while both Fiberglas fabrics were made with a leno variation of the gauze weave.

3. The weight per square yard did not seem to have an effect on the serviceability of the fabrics since the acetate and the two Fiberglas fabrics were almost identical in weight. The Saran fabric was somewhat heavier.

4. The two Fiberglas fabrics showed the least dimensional change of the four fabrics. Saran showed slightly more change

but was still satisfactory. Acetate showed the greatest dimensional change and would be considered unsatisfactory in this characteristic.

5. The thread count of the fabrics as purchased was similar for all the fabrics. The Saran showed the highest warp thread count but the poorest balance of warp and filling threads. The two Fiberglas fabrics had the highest filling thread count and had the best warp and filling balance. The acetate fabric changed the most in thread count during exposure and laundering. Saran changed only slightly and the two Fiberglas fabrics remained generally unchanged.

6. The only fabric which showed a noticeable difference between dry and wet breaking strength, as purchased, was the acetate with the wet breaking strength only about half that of the dry. The dry breaking strength of all the fabrics was good in both warp and filling except for the two Fiberglas fabrics, fillingwise, where the breaking strength was comparatively low. The warp and filling breaking strength of Saran was the highest of the four fabrics.

7. The wet breaking strength of the fabrics was determined after exposure because curtain fabrics are not subjected to strain except during cleaning when the fabrics are wet. The wet breaking strength of Saran showed the lowest percentage loss in both warp and filling, as a result of exposure and laundering. The acetate showed the greatest percentage loss in both warp and filling, with almost complete loss of strength at the end of the last exposure period.

8. The percentage elongation of Saran was much higher than any of the other fabrics, as purchased. Both Fiberglas fabrics were noticeably low in percentage elongation. Acetate was about midway between these two fabrics. After exposure and laundering, the two Fiberglas fabrics had decreased less than the other fabrics in percentage elongation. The percentage elongation of Saran decreased noticeably more than the Fiberglas fabrics but still remained much higher than any of the other fabrics. Acetate decreased the most in percentage elongation.

9. The Fiberglas fabrics maintained satisfactory color even after 300 hours of exposure. The acetate fabric was judged satisfactory throughout the exposures until after 300 hours, when the color change was designated as unsatisfactory. The Saran fabric was judged unsatisfactory in color change at the end of 100 hours of exposure and the fabric continued to show color change up to and through 300 hours of exposure.

The results of this study indicate that: the acetate fabric, the least expensive of the four fabrics used, because of the comparatively rapid and high percentage change in the characteristics studied, would possibly be classified as unsatisfactory; the rapid and unsatisfactory change in color of Saran, the most expensive of the four fabrics, would make this fabric undesirable even though it remained satisfactory in other areas; and the comparatively low filling breaking strength and percentage elongation of the Fiberglas fabrics, the medium priced fabrics in this group, might make these fabrics undesirable.

In conclusion, although all of these fabrics possess certain highly satisfactory serviceability characteristics, all of them are unsatisfactory in other characteristics. This is particularly true after the fabrics have been exposed in the Fade-Ometer and laundered.

ACKNOWLEDGMENT

Most sincere appreciation is expressed to Miss Esther Cormany, Associate Professor of Clothing and Textiles, for her time and untiring efforts in directing this study.

BIBLIOGRAPHY

(1) Babey, Mathew J.
Report on comparative sunlight and Fade-Ometer tests of selected dyed manufactured fiber samples. American Dyestuff Reptr. 42:478-79. Nov. 9, 1953.

(2) Cady, William H.
Tendering action of light on textile fibers. American Dyestuff Reptr. 27:325-26. June 13, 1938.

(3) Committee D-13.
A.S.T.M. standards on textile materials. Philadelphia: American Society for Testing Materials. 1953.

(4) Fletcher, Hazel.
Fabrics for glass curtains and draperies. American Dyestuff Reptr. 38:603-07. Aug. 22, 1949.

(5) Fynn, James P., and James D. Dean.
Effect of light on cotton textiles. U. S. Agr. Yearbook. 1950-51. 436-440 p.

(6) Ginter, Adella, and Bernice Blue.
A study of curtain marquisettes. Missouri Agr. Exp. Sta. Res. Bul. 495. 1952.

(7) Here is the Full Text of New FTC Trade Rules for Rayon and Acetate. Modern Textiles. 33:44-46. Jan., 1952.

(8) Man-Made Fiber Roundup.
Modern Textiles. 35:40. September, 1954.

(9) Mauer, Leonard, and Harry Wechsler.
A Modern Textiles Handbook: Man-Made Fibers. New York: Rayon Publishing. 1953.

(10) Mauersberger, Herbert R., Editor.
Matthew's Textile Fibers. Sixth Edition. New York: John Wiley and Sons. 1954.

(11) Mauersberger, Herbert R.
American Handbook of Synthetic Fibers. New York: Textile Book Publishing. 1952.

(12) Petzel, Florence E.
A comparative study of cotton and rayon glass curtain fabrics. Ohio Agr. Exp. Sta. Bul. 645. 1943.

(13) Saville, Dorothy.
Marquisette curtains: a comparison of various fibers and finishes. Okla. Agr. Exp. Sta. Bul. B334. 1950.

(14) Saville, Dorothy.
Washing and stretching marquisette curtains. Okla. Agr. Exp. Sta. Bul. B378. 1952.

(15) A study of the effect of temperature and humidity on the light fastness of synthetics in the Fade-Ometer. American Dyestuff Reptr. 43:497-50. Aug. 3, 1954.

(16) Study shows effect of heat and moisture on cotton fibers. Textile Age. 18:110. September, 1954.

(17) Symposium on fiberglas textiles: the finishing, dyeing, and printing of glass decorative fibers. American Dyestuff Reptr. 43:327-28. May 24, 1954.

(18) Taylor, A. H.
Natural and artificial sunlight; their application in testing materials. Illuminating Engineering. 44:201-03. April, 1949.

THE EFFECT OF FADE-OMETER EXPOSURE AND LAUNDERING ON THE SERVICEABILITY OF MARQUISETTE CURTAINS MADE OF FOUR SELECTED SYNTHETIC FABRICS

by

LORRAINE ELEANOR GALLE

B. S., Bethel College, 1950

AN ABSTRACT OF A THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Clothing and Textiles

KANSAS STATE COLLEGE
OF AGRICULTURE AND APPLIED SCIENCE

1955

INTRODUCTION

The wide use of sheer glass curtains in homes today has emphasized the importance of knowing the effects of light exposure and laundering on the fibers used in curtain fabrics. This study was conducted in an effort to determine the effects of Fade-Ometer exposure and laundering on the serviceability of selected curtain fabrics.

FABRICS AND PROCEDURE

The curtain fabrics were made of acetate, Saran, and Fiberglas fibers. Two textures of Fiberglas fabrics were used. All fabrics were similar in appearance and construction being white or off-white in color and made with a gauze weave or leno variation.

The fabrics, as purchased, were analyzed for dimensional stability, dry and wet breaking strength, elongation, thread count, weight per square yard, and twist of yarns. The fabrics were exposed to the carbon arc of the FDA-R Fade-Ometer for periods of 50, 100, 150, 200, 250, and 300 hours. At the end of each exposure a portion of each fabric was judged for color change. The other portion of each fabric was laundered after each 50 hours of exposure. After each series of exposures and launderings, hereafter referred to as an exposure period, the fabrics were analyzed for wet breaking strength, thread count, and elongation.

SUMMARY AND CONCLUSIONS

The fabrics as purchased appeared to be similar in serviceability qualities. However, the analyses of the fabrics after each exposure period showed differences resulting from exposure and laundering.

The analysis of the acetate fabric, the least expensive fabric, compared favorably with the others except for low wet breaking strength and excessive shrinkage. Exposure and laundering produced a greater change in this fabric than in any of the others. The greatest amount of change was observed after the first and last exposure periods when the wet breaking strength and percentage elongation decreased sharply. After the last exposure period almost complete loss of breaking strength was noted. The color of the acetate fabric was satisfactory throughout the exposures until the last exposure when it was judged unsatisfactory.

The Saran fabric, the most expensive of the four, was highly satisfactory except for color change when compared with the other fabrics. The warp thread count, breaking strength, and the percentage elongation were higher than in any of the other fabrics. Shrinkage was less than for the acetate but higher than for the other two fabrics. The effects of exposure and laundering on Saran were less noticeable than for the other fabrics except for color change. Unsatisfactory color change was noted at the end of 100 hours of exposure and the fabric continued to show color change through 300 hours of exposure. The breaking strength and percentage elongation decreased less and remained much higher than for any of the fabrics.

The two Fiberglas fabrics were similar as purchased and remained so throughout the exposure periods. There was a close balance between warp and filling threads in both fabrics and the count remained generally unchanged. Both fabrics showed comparatively good warp breaking strength but low filling breaking strength. The percentage loss in breaking strength for both fabrics during exposure and laundering was less than for the acetate but greater than for the Saran. The percentage elongation was low as purchased but then showed little change. Both fabrics remained satisfactory in color even after 300 hours of exposure.

The results of this study indicate that all of the fabrics had characteristics which would make them satisfactory. However, the characteristics which would make them unsatisfactory were: 1) the rapid and high percentage of change of the acetate fabric after exposure and laundering; 2) the decided change in color of the Saran fabric after only 100 hours of exposure; and 3) the low percentage elongation and low filling breaking strength of the two Fiberglas fabrics.