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Evaluating UV Absorbers

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Evaluating UV Absorbers and Antioxidants for Topical Treatment of Upholstery Fabrics*

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ABSTRACT

UV absorbers and antioxidants topically applied to upholstery fabrics to reduce fading, separately and in conjunction with soil repellent finish formulations containing UV absorbers, were evaluated in this study. Over fifty upholstery fabrics were initially evaluated and fourteen were selected for further study. The fabrics were then topically treated with commercially available soil repellent finishes (a fluorocarbon and a silicone finish) containing UV absorbers or immersion-treated with one of thirteen UV absorbers or antioxidants. Following light exposure, color changes were evaluated visually and instrumentally. The results showed that neither the fluorocarbon nor silicone-based soil repellent finishes containing UV absorbers significantly reduced fading in the upholstery fabrics. Furthermore none of the UV absorbers and antioxidants applied to the upholstery fabrics improved lightfastness properties substantially, so they cannot be recommended as additives to soil repellent finish formulations.

Upholstery and carpeting for residential and contract interiors are expected to be attractive, comfortable, durable, safe, and reasonably priced. Attractiveness and durability, particularly as they relate to color, are often the most important factors, because color is usually the first aspect of a textile product the consumer notices. Color also is often the most influential factor in the salability of a product, whether clothing, upholstery, or carpeting [12]. Unfortunately, the loss of or change in color during use and laundering is one of the most frequent causes of consumer complaints [11, 19, 20, 21, 28, 32]. Powers [21] found that fading was the most frequently mentjoned problem with upholstery (38% of the respondents reported fading), and 25% of the respondents reported some carpet fading.

Improving the colorfastness properties in consumer textiles products has been approached in a variety of ways, including development and use of after-treatments for better fastness properties. Most recently marketed are soil and stain repellent finishes containing ultraviolet (UV) absorbers that may be topically applied by the consumer, retail furniture store, carpet/upholstery cleaner, or fiber coatings and maintenance service company. The distributors of these multifunctional topical finishes claim in their promotional literature that treated fabrics and carpets resist fading as well as soiling [5, 22], but there is no published research on the ability of multifunctional topical finishes to reduce fading.

One objective of our research was to evaluate the ability of two commercially available soil and stain repellent topical finishes containing UV absorbers to reduce fading in upholstery fabrics. Another objective was to evaluate the effectiveness of selected UV absorbers and antioxidants applied by immersion baths to reduce fading of uphblstery fabrics. Most earlier research [9, 15, 16, 18,24,29, 31] focused on the ability of ultraviolet absorbers to prevent yellowing of undyed wool and cotton, rather than on the reduction of fading in dyed textiles. Some researchers [7, 8, 10] have shown that UV absorbers improved the lightfastness of selected dyes from 10% to 600%, while others [6] found that ultraviolet absorbers provided little protection. The discrepancies in these findings have not been thoroughly explored, in part because most of the compounds are not washfast. However, the lack of washfastness is not a concern for their use as topical finishes for items such as draperies, upholstery, and carpeting, which are seldom, if ever, laundered.

To date there has been little research on the effectiveness of other types of ultraviolet stabilizers (ultra-violet screeners, excited state quenchers, and ultraviolet-stable antioxidants) in reducing fading and degradation of fabrics. Antioxidants are of special interest because they are probably the most effective photostabilizers [1].

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Antioxidants represent many chemical classes including amines, phenols, phosphites, and thiodipropionates [17]; most function as free radical scavengers while some function as hydroperoxide decomposers [13]. Antioxidants have been used in a wide variety of products including food, feeds, paints, plastics, and textile polymers. They are usually added to textile products as polymer additives rather than topical finishes. Research regarding the effectiveness of antioxidants in reducing polymer degradation has been well summarized in some excellent reviews of the subject [13, 17, 23, 25, 26]. Most research described in the reviews examined the effectiveness of antioxidants as polymer additives rather than as topical finishes for fabrics, but the use of antioxidants as polymer additives is applicable only to synthetic fibers. Fabrics from natural fibers must be treated topically by spray or immersion procedures. Recently, Asche and Crews [4] found that phosphite antioxidants applied by an immersion technique to undyed fabrics of cotton, linen, silk, and wool reduced yellowing and slightly reduced strength losses in fabrics exposed to light.

A combination of antioxidants is often used to satisfy all requirements for a given application, including effectiveness, aesthetics, and price. Many antioxidants when applied in combination with ultraviolet absorbers or other antioxidants reduce fading and strength losses far more effectively than either compound does when applied alone [14, 17, 23, 30]. The synergism between UV absorbers and antioxidants is presumed to be due to the ability of antioxidants to react with free radicals or other oxidation products that may be formed even in the presence of UV absorbers [23] .

Because of,the potential for synergism between absorbers and antioxidants, evaluation of them in multifunctional soil and stain repellent finishes for residential textiles and contract interiors merits further investigation. Despite advances in understanding the basic mechanisms of antioxidant and UV absorber behavior, authorities [17, 30] in the field contend that empirical testing remains necessary for evaluating their performance in end-use applications.

Experimental

FABRICS

Fourteen upholstery fabrics representing a range of fiber types, fabric constructions, dyes, and lightfastness properties (see Table I) were selected for this study from over fifty initially considered. The fabrics were selected by the research director of a fabric maintenance service company (Fiber-Seal International, Inc., Dallas, TX) as representative of fabrics they frequently treat, and they were purchased from retail sources in Dallas. Preliminary lightfastness tests determined which of the fifty fabrics exhibited appreciable fading after 80 AFUs of xenon light exposure [3]. Fourteen fabrics faded appreciably during the light exposure. These were then selected for further study on the rationale that only those that faded appreciably during that length of exposure would exhibit a reduction in fading if the multifunctional finishes were effective.

Table I.
Construction characteristics of the upholstery fabrics.

Fabric no.	Fabric content	Fabric name/weave	Dye[a]	Hue
1	100% cotton	bengaline	S	grey
2	100% cotton	dobby	S	lt. orange
3	100% cotton	basket (2 x 1)	S	dk. red
4	100% cotton	basket (2 x 1)	S	blue-green
5	100% cotton	velvet	S	dk. green
6	100% silk	taffeta	S	blue
7	100% silk	shantung	S	pink
8	54% linen/46% cotton	basket (4 x I)	S	dk. red
9	50% cotton/50% acetate	moire taffeta	S	pink
10	75% polyester/25% cotton	chintz	S	green
11	85% wool/15% nylon	flannel	S	blue
12	52% rayon/28% cotton/ 20% olefin	matelasse	S	grey
13	70% silk/30% cotton	cotton shantung	N	orange
14	70% silk/30% cotton	cotton shantung	N	dk. green

[a] N = natural, S = synthetic.

TREATMENTS—PHASE I

Two commercially available soil repellent finishes containing ultraviolet absorbers were evaluated: a fluorocarbon product (Tectron fabric protector, Blue Magic Products, Inc., Stockton, CA) and a silicone product (Pro-Sunblock, Pro-Tection National Inc., Dallas). The fluorocarbon product was distributed for consumer and retailer spray application. The silicone product was available only from a fiber sealant service company who applied the treatment for customers.

We applied the fluorocarbon product in our laboratory using an aerosol spray unit (Preval spray gun). To ensure uniform application, the spray pattern consisted of parallel strokes in the warp direction, which were slightly overlapped. Each stroke extended 5 centimeters beyond the edge of the fabric in an effort to ensure uniform application. We followed the same procedure in the weft direction and the two true bias directions. We calculated the percentage of the fluorocarbon product add-on from the before and after weights of the fabric yardage. Fabric construction and existing finishes (napping, glazing, calendaring) affected the add-on to some extent, but add-on was approximately 1% for most fabrics.

To verify that the fluorocarbon protector contained an ultraviolet absorber, we made a UV spectrum of a sample of the liquid using a Perkin Elmer 552 UV-visible spectrophotometer. The spectrum of the sample showed a strong absorption band in the UV region (220–240 nm), indicating that a UV absorber was a component of the formulation.

The silicone product was applied to the fabrics by Pro-Tection National Inc. at locations in Dallas, Tulsa, OK, and San Francisco, CA. Upholstery fabrics were supplied to each service center with the request that they treat them with their fabric sealant product containing ultraviolet inhibitors. To verify that the fabrics had been treated with a finish containing a UV absorber, we made a UV reflectance spectrum of each treated fabric and its control using a Varian OMS 200 UV-visible spectrophotometer with a diffuse reflectance accessory. The spectra of all treated fabrics exhibited reduced reflectance throughout the ultraviolet region (190–380 nm) when compared to their controls. We observed no differences in fabric appearance or color changes of fabrics treated at the different locations, so the data are not reported by site.

TREATMENTS—PHASE II

In addition to the topical spray application of soil repellent formulations containing UV absorbers in Phase I, upholstery fabrics were impregnated with UV absorbers or antioxidants or both using immersion baths in Phase II. The objective of Phase II was to evaluate UV absorbers, antioxidants, and combinations of them as potential additives to soil and stain repellent formulations. We selected the UV absorbers and antioxidants on the basis of previous work showing that they modestly reduced color loss or yellowing [4, 8]. We evaluated combinations of UV absorbers and antioxidants for potential synergism: four UV absorbers, two antioxidants, six combinations, plus untreated controls (see Tables II and III).

Table II.
Ultraviolet absorbers and antioxidants used for experimental treatments.

Code[a]	Chemical name	Tradename and manufacturer
UV1	2-hydroxy-4-dodecyloxybenzophenone	Inhibitor DOBP, Eastman Chemical
UV2	2-hydroxy-4-octyloxybenzophenone	Cyasorb UV 531, American Cyanamid
UV3	2-hydroxy-4-methoxybenzophenone	Uvinul M-40, BASF
UV4	N-(p-ethoxycarbonylphenyl)-N'-ethyl-N'-phenylformamidine	Givsorb UV-2, Givaudan
A5	poly-phenolic phosphite (proprietary)	Mark 260, Witco
A6	tris (2,4-di-t-butylphenyl) phosphite	Mark 2112, Witco

[a] UV designates a UV absorber, A designates an antioxidant.

Table III.
Summary of UV absorber/antioxidant combination treatments.

Code	UV absorber/antioxidant tradename
UVl/AS	Inhibitor DOBP/Mark 260
UVl/A6	InhibitorDOBP/Mark2112
UV2/AS	Cyasorb UV 531/Mark 260
UV2/A6	Cyasorb UV 531/Mark 2112
UV3/AS	Uvinul M-40/Mark 260
UV3/A6	Uvinul M-40/Mark 2112

There were three replications for each of the thirteen treatments. Specimens (6.5 x 9.5 cm) of the upholstery fabrics were immersed in 2% solutions of UV absorbers and 1% solutions of antioxidants as recommended by their respective manufacturers. Solutions were prepared by dissolving the stabilizers in perchloroethylene (perc). Solutions of the combinations of UV absorbers and antioxidants were prepared by dissolving 2 grams of UV absorber plus 1 gram of antioxidant in 97 ml of perc, making a 3% (wt/vol) solution. The solution was set aside for at least 5 minutes to ensure that the stabilizer fully dissolved in the perc. It was then placed in a Pyrex container, and specimens were added and gently agitated in a back-and-forth motion for 1 minute on each side. Specimens were allowed to air dry at room temperature for 24 hours on Teflon®-coated, fiberglass screening.

LIGHT EXPOSURE AND COLOR EVALUATION

Treated and untreated (control) specimens were exposed to light in an Atlas 6500 watt xenon-arc Weather-Ometer for 80 AFUs, based on the xenon reference fabric. Exposure conditions were in accordance with procedures described in AATCC test method 16-E, colorfastness to light: water-cooled xenon-arc lamp continuous light [3]. Borosilicate inner filters and soda lime outer filter glasses were used with the xenon lamp to simulate light exposure behind glass.

Color losses or changes in the specimens were evaluated visually and instrumentally. Instrument evaluations were made with a Hunter Lab-

Scan II Spectrocolorimeter using a 2.54 cm viewing aperture according to AATCC test method 153-1985, color measurement of textiles: instrumental [3]. Three readings were averaged for each specimen. Total color difference was calculated using the CIE LAB system, 10° observer data, and illuminant D65. Total color difference was calculated as $\Delta E = [(\Delta L)^2 + (\Delta a)^2 + (\Delta b)^2]^{1/2}$.

Visual evaluations of color change were made by three raters using the AA TCC gray scale for color change. The evaluations of the three raters were averaged for each replication within a fabric treatment group. The means for each replication were averaged for each of the 210 (14 x 15) fabric and treatment combinations for statistical analysis.

RESEARCH DESIGN AND STATISTICAL ANALYSIS

The randomized factorial experiment design consisted of two phases: in Phase I fabric specimens were topically treated with soil repellent formulations containing ultraviolet absorbers and in Phase II specimens were treated by immersion baths with ultraviolet absorbers, antioxidants, and combinations of both. Phase I was a factorial design of fourteen fabrics and three treatments. Phase II was a factorial design of fourteen fabrics and thirteen treatments.

A general linear model analysis of variance was performed on the data. If treatment significantly affected the dependent variables of color difference and AA TCC gray scale rating, Tukey's HSD test was used to separate the means. The level of significance was 0.01 rather than 0.05 for all statistical tests, because significant differences in color differences and AA TCC gray scale ratings at the 0.01 level better correspond with visually perceptible differences.

Results and Discussion

PHASE I—SOIL REPELLENT FINISHES CONTAINING UV STABILIZERS

Both gray scale (GS) ratings and color difference readings were used to assess color change in the upholstery fabrics treated with soil repellent finishes containing UV stabilizers. Neither visual nor instrumental evaluations showed significant reductions in color change attributable to finish (see Table IV). The overall average GS rating for the untreated controls was 3.2, while the overall average rating for the finished fabrics was very similar but slightly lower at 3.1, representing greater color change (Table IV). The soil repellent finishes containing UV absorbers therefore appear to have slightly increased color changes (fading) but these changes were not statistically significant.

Table IV.
Color changes in the upholstery fabrics treated with soil repellent finishes containing UV absorbers.

	Treatments					
	Control		Silicone		Fluorocarbon	
Fabric	GS[a]	ΔE	GS[a]	ΔE	GS[a]	ΔE
1	3.2	4.95	3.2	4.86	2.9	5.42
2	2.3	5.33	2.1	6.02	2.3	5.93
3	4.2	2.95	3.7	2.91	4.0	3.48
4	4.1	3.13	3.7	3.31	3.9	3.61
5	4.0	3.27	4.0	2.99	4.2	2.54
6	3.2	7.17	2.6	6.79	2.9	7.07
7	1.7	8.33	1.7	8.44	1.7	9.77
8	3.4	3.97	3.7	4.23	3.3	4.45
9	3.0	4.72	3.2	2.54	3.1	3.79
10	4.2	3.84	4.1	3.74	4.2	4.02
11	2.5	3.89	2.6	3.87	2.2	3.95
12	5.0	1.55	5.0	1.08	5.0	1.31
13	1.5	21.52	1.5	21.21	1.5	23.50
14	2.2	16.47	2.0	14.91	2.0	16.64
Overall average	3.2	6.51	3.1	6.21	3.1	6.82

[a] A gray scale rating of 5 = negligible or no change while a gray scale rating of 1 = much changed. Note: Analysis of variance performed on mean gray scale (GS) ratings and color difference (ΔE) readings for each fabric produced no significant F values.

These findings differ from those reported by the AATCC Delaware Valley Section [2], who found that the presence of finish generally improved the lightfastness of acid-dyed nylon. Their evaluations of color change in the lightfastness tests were visual using a gray scale. Our findings showed that the fluorocarbon finish decreased lightfastness according to both visual and instrumental evaluations (overall color difference readings were controls = 6.57 CIELAB units versus fluorocarbon = 6.82 CIELAB units). Closer examination of the Delaware Valley Section results showed that the silicone finish used in their study improved the light-fastness in five of the six acid dyes evaluated, but only by a half step on the AATCC gray scale for color change. The fluorocarbon finish improved the light-fastness of only three of the six acid dyes, again only by a half step on the gray scale. We found that the silicone finished containing a UV absorber improved lightfastness when based on color difference readings rather than as ratings, but the overall improvement was slight (controls = 6.51 CIELAB units versus silicone finish = 6.21 CIELAB units). The differences in findings between the two studies may be attributable to the different fibers, dyes, and finishes used.

Our findings not only differed from the AATCC Delaware Valley Committee findings, but our visual evaluations also differed slightly from our instrumental evaluations. These data illustrate that human perceptions of color change do not always agree with instrumental measurements, an observation reported by others [27] and the reason the AATCC recommends that visual rather than instrumental evaluations be used in assessing colorfastness properties [3] .

PHASE II-UV ABSORBERS AND ANTIOXIDANTS FOR IMPROVED LIGHT FASTNESS

Table V shows the mean as ratings and color difference readings for the upholstery fabrics immersion-treated with UV absorbers or antioxidants or both. In many instances, the human visual perceptions of color change did not correspond as well as desired with instrument evaluations. In some instances, fabrics with the highest as ratings did not have the lowest color difference readings, e.g., fabrics 2, 3, 4, 5, 9). These data clearly illustrate the problems encountered with instrument evaluations, which is one of the reasons that AATCC recommends visual rather than instrument evaluations of color change [3].

Table V.
Color changes in the upholstery fabrics immersion-treated with UV absorbers and/or antioxidants.

	Fabric 1		Fabric 2		Fabric 3	
Treatment	GS	ΔE	GS	ΔE	GS	ΔE
Control	2.8	4.95	1.8	5.33	3.8	2.95
UV1	3.0	4.05	2.2	4.69	3.8	1.92[1]
UV2	3.0	4.20	2.0	4.85	3.8	1.24[1]
UV3	3.0	5.00	2.2	4.94	4.0	2.42
UV4	3.0	3.87	2.2	4.60	4.3	1.64[1]
A5	3.0	4.39	1.8	5.50	4.0	1.90[1]
A6	3.0	4.77	2.0	5.46	3.8	2.44
UV1/A5	3.0	4.00	2.2	4.47	3.8	1.97[1]
UV1/A6	3.3	3.28[1]	2.2	4.71	4.2	1.80[1]
UV2/A5	3.0	3.81	2.0	3.87[1]	4.2	1.75[1]
UV2/A6	3.3	3.11[1]	2.2	4.39	4.2	1.51[1]
UV3/A5	3.0	4.90	2.0	5.25	4.0	2.26[1]
UV3/A6	3.0	3.91	2.2	4.61	4.0	3.06

	Fabric 4		Fabric 5		Fabric 6	
Treatment	GS	ΔE	GS	ΔE	GS	ΔE
Control	3.5	3.13	4.5	3.27	2.3	7.17
UV1	3.5	2.74	3.51	4.15	2.3	6.02
UV2	3.5	2.71	4.0	3.58	2.3	5.64
UV3	3.5	3.10	3.51	2.75	2.3	6.79
UV4	3.5	2.33[1]	3.8	3.36	2.3	5.27
A5	3.7	2.31[1]	3.31	5.55[1]	2.3	6.13
A6	3.7	2.48	3.7	3.44	2.3	6.01
UV1/A5	3.8	2.46	3.51	3.08	2.7	5.27
UV1/A6	3.5	2.291	3.7	3.63	2.5	5.30
UV2/A5	3.8	2.52	4.0	2.55	2.3	5.71
UV2/A6	3.5	2.62	3.51	2.60	2.8	4.43[1]
UV3/A5	3.7	2.58	3.51	4.98[1]	2.3	6.18
UV3/A6	3.5	2.95	3.8	2.37	2.3	5.70

[1] Denotes UV absorbers and antioxidants that significantly ($p \le .01$) affected gray sca1e ratings for color change or color difference readings.

Table V. (cont.)

	Fabric 7		Fabric 8		Fabric 9	
Treatment	GS	ΔE	GS	ΔE	GS	ΔE
Control	1.5	8.33	3.0	3.97	4.0	4.72
UV1	1.7	8.23	3.2	3.58	4.3	2.74[1]
UV2	1.7	7.58	3.2	3.63	4.3	4.87
UV3	1.5	8.68	3.0	3.96	4.2	2.31[1]
UV4	1.5	6.47	3.0	3.42	4.2	3.63
A5	1.5	7.90	3.0	3.82	4.3	2.96[1]
A6	1.5	8.92	3.2	3.88	4.0	3.57
UV1/A5	1.7	6.93	3.2	3.06[1]	4.7	2.68[1]
UV1/A6	1.5	7.54	3.2	3.46	4.3	2.55[1]
UV2/A5	1.7	7.95	3.2	3.27[1]	4.3	2.60[1]
UV2/A6	1.5	7.76	3.2	3.06[1]	4.5	2.50[1]
UV3/A5	1.5	8.76	3.2	3.68	4.5	3.12[1]
UV3/A6	1.5	8.24	3.0	3.46	4.0	3.06[1]

	Fabric 10		Fabric 11		Fabric 12	
Treatment	GS	ΔE	GS	ΔE	GS	ΔE
Control	3.2	3.84	2.0	3.89	5.0	1.55
UV1	3.5	3.08	2.0	3.38[1]	5.0	1.09
UV2	3.2	3.40	1.8	3.61	5.0	1.34
UV3	3.3	3.32	2.0	3.14[1]	5.0	1.25
UV4	3.5	3.39	2.0	3.41[1]	5.0	1.35
A5	3.3	3.64	2.0	3.64	5.0	1.10
A6	3.2	3.51	2.0	3.01[1]	5.0	0.95
UV1/A5	3.3	3.36	2.2	3.10[1]	5.0	0.91
UV1/A6	3.3	3.33	2.0	3.05[1]	5.0	1.02
UV2/A5	3.2	3.15	2.0	3.45[1]	5.0	1.09
UV2/A6	3.3	3.18	2.2	3.01[1]	5.0	0:83
UV3/A5	3.2	3.56	2.2	3.12[1]	5.0	0.91
UV3/A6	3.2	3.42	2.2	2.73[1]	5.0	0.42[1]

[1] Denotes UV absorbers and antioxidants that significantly ($p \le .01$) affected gray sca1e ratings for color change or color difference readings.

Table V. (cont. 2)

Treatment	Fabric 13 GS	Fabric 13 ΔE	Fabric 14 GS	Fabric 14 ΔE
Control	1.0	21.52	1.5	16.47
UVI	1.0	19.72	1.7	14.59[1]
UV2	1.0	21.15	1.7	14.73
UV3	1.0	20.50	1.7	16.33
UV4	1.0	18.27[1]	1.7	13.12[1]
A5	1.0	21.17	1.7	15.32
A6	1.0	21.01	1.7	17.07
UVI/A5	1.0	19.82	1.7	13.39[1]
UVI/A6	1.0	21.18	1.7	14.37[1]
UV2/A5	1.0	19.83	1.7	14.94
UV2/A6	1.0	20.69	1.7	15.48
UV3/A5	1.0	21.89	1.7	16.41
UV3/A6	1.0	19.58	1.7	14.55[1]

[1] Denotes UV absorbers and antioxidants that significantly ($p \leq .01$) affected gray sca1e ratings for color change or color difference readings.

None of the UV absorber or antioxidant treatments significantly reduced fading in the fourteen upholstery fabrics evaluated visually using a gray scale. Furthermore, fabric 5, a dark green cotton velvet, exhibited significantly more color change (lower GS ratings) when treated because it was yellowed by the treatments.

Although humans could not visually detect any reduction in fading of the UV absorber/antioxidant treated specimens, a color difference meter did detect differences instrumentally that were statistically significant (see Table V). For example, fabrics 3 (100% cotton) and 9 (cotton/acetate blend) exhibited up to a 50% reduction in fading when treated with selected stabilizers (fabric 3 control, ΔE = 2.95 versus UV2/ A6 ΔE = 1.51; fabric 9 control, ΔE = 4.72 versus UV2 / A6 ΔE = 2.50). Other cotton fabrics (fabrics 2 and 4) showed only a 30% reduction in fading, and one, the cotton velvet, exhibited almost a 50% increase in color change (darkening and yellowing). From the variations in the test results, it appears that no one treatment was more effective than another and no one fiber was more responsive to treatment with stabilizers than another.

Rather, the effectiveness of a particular UV absorber, antioxidant, or combination depended on the total fabric system (fibers/construction/dyes) to which it was applied. Although many researchers [14, 17, 23, 30] have shown that ultraviolet absorbers and antioxidants frequently exhibit beneficial synergistic effects, the UV absorber/antioxidant combinations we evaluated did not exhibit any marked synergism.

While the reduction in size of some of the color difference readings of fabrics treated with the UV absorbers/antioxidants was statistically significant, it is doubtful that the findings have practical significance. Of over fifty upholstery fabrics initially selected, preliminary lightfastness testing showed that only fourteen faded rapidly enough (at least a step 4 color change after 80 AFUs of xenon light exposure) to exhibit treatment effects in a reasonable period of light exposure. This demonstrates that most fabrics on the market are colored with dyes of good lightfastness properties that would benefit little by UV stabilizer treatments. Most of the fourteen fabrics that faded perceptibly in 80 AFUs of light exposure did not exhibit reductions in fading when treated with the stabilizers. Only four fabrics (fabrics 3 – cotton, 9 – cotton/acetate, 11 – wool/nylon, and 14 – silk/cotton) exhibited reductions in fading attributable to more than two or three of the stabilizers. Consequently, the probability that a UV absorber or antioxidant in any given soil repellent formulation would reduce fading on a given fabric is very low.

Earlier studies of the effectiveness of UV absorbers in reducing fading resulted in conflicting reports. Some researchers [7, 8, 10] saw improvements in lightfastness of 50% to 600%, while others [6] found that ultraviolet absorbers provided little protective effect. The findings reported here demonstrate how conflicting results can arise with various dyes and fibers, because the effectiveness of the UV absorbers and absorber/antioxidant combinations depend on the dye/fiber combination and perhaps other factors as well (color of dye within class, fabric construction, and other finishes present). Furthermore, these findings support the contentions of several authorities [17, 30] that interactions between stabilizer, fiber, dye type and color, construction, and other finishes are so complex that evaluating their performance in end-use applications is still necessary.

Conclusions

Neither the fluorocarbon nor silicone-based soil repellent finishes containing UV absorbers significantly reduced fading in the array of upholstery fabrics evaluated. While it may be possible to identify some fabrics that would benefit from treatment with these multifunctional finishes, we did not find any in the array of upholstery fabrics we examined in this study. Furthermore, none of the UV absorbers, antioxidants, or combinations applied to the upholstery fabrics improved lightfastness properties substantially, so they did not show promise as additives to soil repellent finishes or as topical finishes for improving lightfastness properties. Consequently, these UV absorbers and antioxidants cannot be recommended to textile service companies as additives to their finish formulations nor to consumers as a means of minimizing fading in their residential textiles.

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