



Organic Chemicals INTERMEDIATES information bulletin

February 16, 1962

BIPHENYL

The attached paper by A. F. Strobel, entitled "Improvement of Light-fastness of Dyeings on Synthetic Fibers by Ultraviolet Absorbers", that appeared in the February 5, 1962, AMERICAN DYESTUFF REPORTER, describes the superior properties of Biphenyl as a dye carrier in comparison with ortho-Phenylphenol, where an ultraviolet light absorber is present in the polyester fiber dyed to prevent color fading.

The conclusions of the author are as follows:

"The effectiveness of UV absorbers in improving the fastness to light of level-dyeing dyes, such as the Celliton disperse and Genacryl basic types on Dacron, is distinctly increased using Biphenyl as carrier. On Nylon, Biphenyl employed as carrier does not appreciably increase the effectiveness of UV absorbers in improving the lightfastness of Celliton and Genacryl dyes."

These results are very interesting and should be an added incentive for your customers to use Biphenyl instead of ortho-Phenylphenol. The following are advantages of using Biphenyl over ortho-Phenylphenol.

1. The already established fact that for achieving the same color shade, Biphenyl is a much cheaper dye carrier than ortho-Phenylphenol. Your customer can realize a savings of approximately $\frac{1}{3}$ of the cost of the carrier by basing it on Biphenyl rather than ortho-Phenylphenol.
2. Any traces of Biphenyl left over in the fiber after dyeing, do not affect the color fastness of the fiber, in contrast to the fading of the fiber when ortho-Phenylphenol is used.
3. The trend is for more and more dye houses to use UV absorbers to prevent color fading. No doubt, Biphenyl is far superior to ortho-Phenylphenol, as was proved by the authors.

Recently, we have been working with the Sonneborn Chemical Company on the evaluation of various emulsifiers for Biphenyl in the preparation of a suitable dye carrier. Their recommendation, based on dye house trials, indicated that a mixture of Biphenyl and Sonolene 3753 in the ratio of 2:1 by weight is a cheap carrier with excellent dyeing properties.

You may pass this information on to your customers and request them to direct sample requests to the Sonneborn Chemical Company, Hancox Avenue, Belleville 9, New Jersey.

B. Y. ABADIR

ORGANIC CHEMICALS DIVISION

• SAINT LOUIS 66, MISSOURI

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1961 Convention

IMPROVEMENT OF LIGHTFASTNESS OF DYEINGS ON SYNTHETIC FIBERS BY ULTRAVIOLET ABSORBERS

Part II*

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INTRODUCTION

IN Part I (1) it was seen that well-leveling dyes of the Celliton disperse and Genacryl basic types could be co-dyed with certain UV absorbers to improve the lightfastness of the dyeings. The efficiency of exhaust of the absorbers was seen to be little better than 50%. Since these compounds are relatively costly, it became of practical importance to attempt new means of getting improved exhaust while also continuing the endeavor to develop new absorbers of intrinsically better exhaust and efficiency.

In this paper we shall be dealing principally with the relative performances of absorbers described as in Part I. As before, Absorbers A and C are new substituted acrylonitrile compounds synthesized at the Rensselaer (New York) laboratories of General Aniline & Film Corp. Absorber B is Uvinul D-49 of General Aniline & Film Corp.

There is especial interest in cationic (eg, Genacryl) dyes on the "60" series Dacron, which can be dyed with cationic dyes. The "50" series Dacron is not dyed by the cationics. Thus woven mixtures of the two types of Dacron give patterns from a single dyeing operation, the "60" series threads being dyed and the "50" threads being undyed by cationics. The "50" and "60" series are both dyed by disperse (eg, Celliton) colors.

EXPERIMENTAL

USE OF CARRIERS—In Part I we had experimented with the use of carriers to possibly improve the dyeing of UV absorbers on synthetic fibers.

We synthesized and compared on nylon and Dacron a series of compounds derived from Absorbers A, B, C, D, E. It was found by dyeing the exhaust liquor on a second piece of cloth that the hydrocarbon substituents do improve the exhaustion. More will be said about this tech-

The effectiveness of UV absorbers in improving the fastness to light of level-dyeing dyes, such as the Celliton disperse and Genacryl basic types on Dacron, is distinctly increased using biphenyl as carrier. On nylon, biphenyl employed as carrier does not appreciably increase the effectiveness of UV absorbers in improving the lightfastness of Celliton and Genacryl dyes.

Spun nylon challis—Test Fabrics #354A—showed better penetration of dyes than did nylon filament taffeta Test Fabrics #302A. A correspondingly greater improvement in lightfastness of certain wool colors resulted from employing UV absorbers on spun nylon over nylon taffeta. With other level-dyeing wool colors applied to nylon, however, no improvement in lightfastness was obtained using UV absorbers.

The washfastness of the ultraviolet absorbers described is superior on Dacron 64 to their washfastness on nylon.

nique of structural variation to improve exhaust later. The unsubsti-

tuted compounds are more economical to make than the long-chain substituted absorbers, so we attempted improvement of exhaust of Absorbers A and B using carriers.

Disperse and cationic dyes are often applied to Dacron using carriers anyway: one commonly used carrier is o-phenylphenol. This carrier produces fair exhaust of absorber as well as dye. However, a great loss of lightfastness of the dyeing occurs when the o-phenylphenol is present. This is illustrated in Exhibit 1. The dyeing at the right is a dyeing on Dacron 54 of ¼% CI Disperse Blue 3 + ¼% Absorber A + 5% o-phenylphenol, exposed to Fade-Ometer 20 hours in upper section. At the left is the same dyeing heat-set at 200°C. This treatment removes the o-phenylphenol carrier. The dyeing then becomes fast to light. Without absorber the dyeing would look much like the dyeing at the right after light exposure.

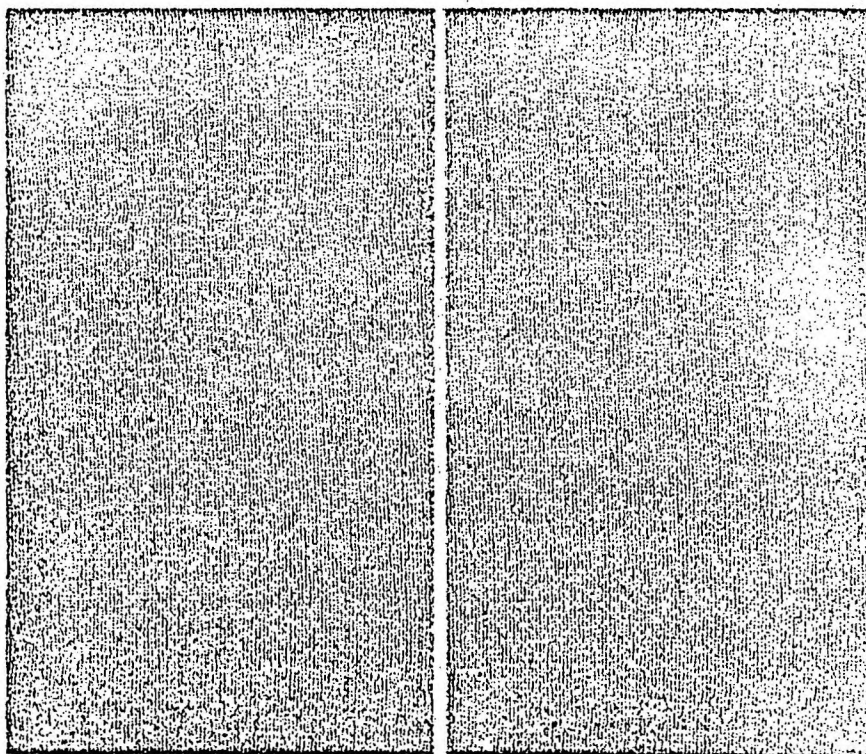


Exhibit 1

*Presented September 27, 1961 during the AATCC Convention at Buffalo, NY

In an article on carrier dyeing, Friedman (2) describes the evaluation of a number of organic materials as carriers. We experimented with the effects of a group of these organic materials, on their efficiency in transferring the absorber from an aqueous bath to Dacron. Table I shows the order of effectiveness of a series of organic carriers in transferring Uvinul D-49 and in transferring 2-hydroxy-5-methylphenylbenzotriazole. No dye was used here. The most effective carrier was found to be biphenyl for each of these absorbers. The trade prefers to use *o*-phenylphenol over biphenyl because of easy dispersibility, solubility in caustic, and reliability which includes freedom from spotting of the Dacron by the dye.

In Table II we have compared the relative effectiveness of biphenyl and 2-hydroxybiphenyl as carriers for applying Uvinul D-49 and Absorber A to Dacron 64, using no dye with the absorber. To understand the significance of these figures let us look for a moment at the design of our UV reflectometer shown schematically in Figure 1. The UV light from the Hg tube, called "black light", is filtered free of visible light by F-3. The UV light goes through the Pyrex window and impinges on the white Carrara glass; it is reflected back to the photocell through filter F-1, which screens out any visible fluorescence. The photocell current is adjusted to read 100 mv on the galvanometer. Then the white Dacron cloth treated with UV absorber is inserted over the Pyrex window, and the photocell current is again read. The mv reading with 1/4% absorber on the cloth is, say, 23 mv. Thus 23% as much light is reflected back as with the Carrara glass. To find out what reading would be obtained with total absorption at the window, a black can was mounted over the pyrex window (to give black body absorption). A reading of 19 mv was obtained. Also, 19 mv was obtained with a black cloth mounted over the Pyrex window in a conical form. This 19 mv is then due to background radiation reflected from the black walls of the box. (Black paper over the Pyrex window read 23 vs). 23 mv is also read on 1/4% absorber on Dacron 64. Therefore, $23 - 19 = 4$ mv is due to the cloth with 1/4% absorber present. The total mv reading from the Carrara glass is $100 - 19 = 81$ mv. The percentages given in Table II are the residual % reflectances of the Dacron 64 using this

UV REFLECTOMETER

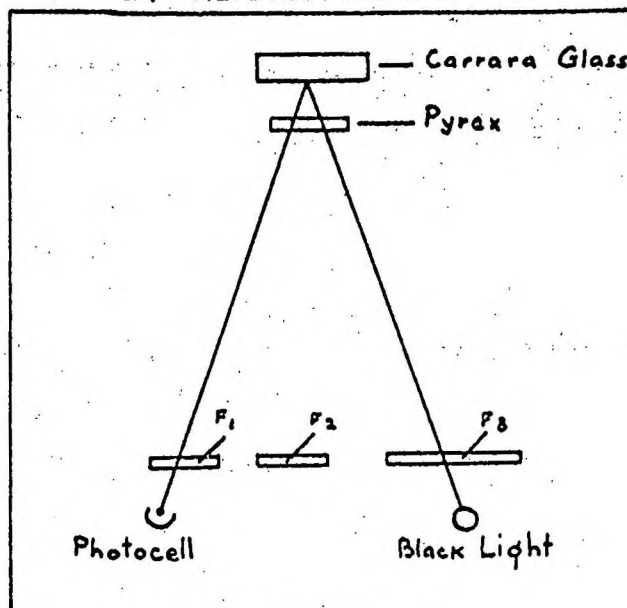


Figure 1

TABLE I
Order of effectiveness of organic carriers

Uvinul D-49	2-Hydroxy-5-methylphenylbenzotriazole
1) Biphenyl	1) Biphenyl
2) Trichlorobenzene	2) Methyl salicylate
3) Methyl salicylate	3) Trichlorobenzene
4) Dichlorobenzene	4) Dichlorobenzene
5) <i>o</i> -Phenylphenol	5) <i>o</i> -Phenylphenol

TABLE II
Comparison of affinity of UV absorbers on Dacron 64 using carriers
Reflectance* of UV light

		5% Carrier on	
		Biphenyl	2-Hydroxybiphenyl
Absorber A	1/8% Absorber on	8%	11%
	1/4% Absorber on	4%	6%
Uvinul D-49	1/8% Absorber on	11%	11%
	1/4% Absorber on	6%	8%

*Reflectances here have been calibrated to eliminate extraneous reflectance from black walls of reflectometer.

TABLE III
Comparison of affinity of UV absorbers with and without carriers on Dacron 64
Reflectance* of UV light
1/4% Absorber

Absorber A	5% Absorber		
	No carrier	5% Biphenyl	5% 2-Hydroxybiphenyl
Uvinul D-49	7%	4%	6%
	7%	6%	7%

*Reflectance here has been calibrated to eliminate extraneous reflectance from black walls of reflectometer.

method of calculation.

The conclusion from Table II is that 1/4% of UV absorber can absorb 96% of the UV radiation which falls on the swatch. Further, biphenyl is a more effective carrier than 2-hydroxybiphenyl, especially for Absorber A, less so for Uvinul D-49.

In Table III we have compared the efficiencies of absorption of Absorber A, using no carrier, with its efficiency using 5% biphenyl. It is seen to reduce the UV emission to 4% from 7% without biphenyl.

Notice that Absorber B (Uvinul D-49) is not helped much by bi-



Exhibit 2

phenyl, and not any more or less efficiently exhausted using 2-hydroxybiphenyl than with no carrier.

The high absorption of UV light brought about by $\frac{1}{4}\%$ absorber accounts for our previous observation that $\frac{1}{2}\%$ absorber (or more) gave little improvement over $\frac{1}{4}\%$. One is approaching absorption of all UV light even at the $\frac{1}{4}\%$ level. It is true

that $\frac{1}{8}\%$ gives distinctly less protection than $\frac{1}{4}\%$, but $\frac{1}{2}\%$ does not improve a great deal over $\frac{1}{4}\%$.

Since biphenyl is cheap and available commercially, we then investigated the co-dyeing of a group of UV absorbers with dyes in the presence of biphenyl. With biphenyl as carrier it was found not necessary to heat-set the fabric to get good light-

fastness, as had been found with 2-hydroxybiphenyl.

On Dacron 64, a spun challs, dyeing $\frac{1}{4}\%$ absorber + $\frac{1}{4}\%$ Genacryl dye together with 5% biphenyl, a definite improvement of lightfastness resulted using carrier over the results obtained using absorber and dye alone, as seen in Table IV. The effectiveness of Absorber A is greater with biphenyl carrier than without. The effectiveness of Uvinul D-49 is improved in one case, and not improved in the others. This agrees with the dyeings on white Dacron 64 of the absorbers alone.

Exhibit 2 shows the lightfastness of CI Basic Red 13 + $\frac{1}{4}\%$ Absorber A + 5% biphenyl to be improved over CI Basic Red 13 + 5% biphenyl without absorber on Dacron 64.

Exhibit 3 shows the lightfastness of Genacryl Blue 6G + $\frac{1}{4}\%$ Absorber A + 5% biphenyl to be improved over Genacryl Blue 6G alone + 5% biphenyl, on Dacron 64. (See editor's note at end of article).

Table V compares the stabilizing power of $\frac{1}{8}\%$ Absorber A, $\frac{1}{8}\%$ Uvinul D-49, and $\frac{1}{8}\%$ 2'-hydroxy-5'-methylphenylbenzotriazole absorber using basic dyes on Dacron 64; with Absorber A being superior to Uvinul D-49 in this comparison, and the triazole absorber being inferior to both; again 5% biphenyl is used.

Figure 2 compares the UV absorption curves of Absorber A, Uvinul D-49, the triazole and the 2,2'-dioxo-4-octyloxy absorber 2* in alcohol.

TABLE IV
Level-dyeing dyes on Dacron 64; % loss on light fading**
(20 hrs Fade-Ometer) 0.25% dye and
0.25% UV absorber, owf

Dyestuff	Carrier	Blank*	Absorber A	Absorber B (Uvinul D-49)
CI Basic Red 13	5% Biphenyl	70	30	40
	No carrier	90	45	50
Genacryl Blue 3G	5% Biphenyl	25	10	15
	No carrier	30	15	15
CI Basic Yellow 13	5% Biphenyl	35	10	15
	No carrier	40	15	15

TABLE V
Level-dyeing dyes on Dacron 64; % loss on light fading**
(20 hrs Fade-Ometer) 0.25% dye and
0.125% absorber, owf

Dyestuff	Blank*	Absorber A	Absorber B (Uvinul D-49)	2-Hydroxy-5-methylphenylbenzotriazole
CI Basic Red 13	80	40	45	60
Genacryl Blue 3G	25	10	15	20
CI Basic Yellow 13	20	10	10	15
Genacryl Red 4B	80	40	45	60
CI Basic Blue 1	60	20	30	40

*Blank here refers to a dyeing using 0.25% dye, 5% biphenyl and no absorber.
**All percentage fading of colors were visually estimated in north light and therefore are to be taken as relative only. All Fade-Ometer exposures were made at the same elevation with respect to the arc.

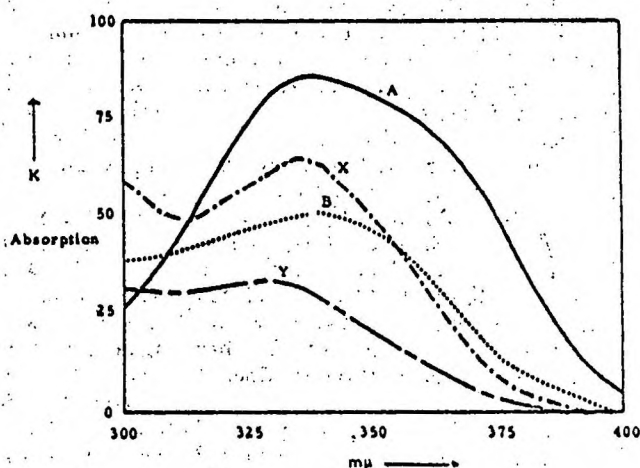


Figure 2
UV absorption curves

A — Absorber A
B — Uvinul D-49
X — 2-Hydroxy-5-methylphenylbenzotriazole
Y — 2,2'-Dioxo-4-octyloxybenzo-phenone

TABLE VI

Level-dyeing dyes on nylon 66; % loss on light fading**
(20 hrs Fade-Ometer) 0.25% dye and
0.25% UV absorber, owf

Dyestuff	Carrier	Blank*	Absorber A	Absorber B (Uvinul D-49)
CI Disperse Blue 7	5% Biphenyl	30	15	20
	No carrier	25	10	18
CI Disperse Red 1	5% Biphenyl	60	40	25
	No carrier	55	30	30
CI Disperse Blue 3	5% Biphenyl	60	30	40
	No carrier	50	15	25

*Blank here refers to a dyeing using 0.25% dye and no absorber.

**All percentage findings of colors were visually estimated in north light and therefore are to be taken as relative only. All Fade-Ometer exposures were made at the same elevation with respect to the arc.

TABLE VIII

Level-dyeing dyes on Dacron 62; % loss on light fading**
(20 hrs Fade-Ometer pink and yellow, 40 hrs on blue)
0.25% dye and 0.25% absorber, owf

Dyestuff	Blank*	Absorber A	Absorber B (Uvinul D-49)	Absorber C (Cf Part I)
CI Basic Red 13	90	40	5	50
CI Basic Yellow 13	40	15	8	10
Genacryl Blue 3G	40	15	25	30

*Blank here refers to a dyeing using 0.25% dye and no absorber.

**All percentage findings of colors were visually estimated in north light and therefore are to be taken as relative only. All Fade-Ometer exposures were made at the same elevation with respect to the arc.

TABLE VII

Level-dyeing dyes on spun nylon (#354A);
% loss on light fading**
(20 hrs Fade-Ometer) 0.25% dye and
0.25% UV absorber, owf

Dyestuff	Blank*	Absorber A	Absorber B (Uvinul D-49)	2,2'-Dioxy-4- octyloxybenzo- phenone
CI Disperse Red 1	70	15	25	35
CI Disperse Orange 3	40	15	35	—
CI Disperse Blue 7	55	15	25	35

***See footnote under Table IV.

TABLE IX

Level-dyeing dyes on nylon taffeta;
% loss on light exposure**
(20 hrs Fade-Ometer) 0.25% dye and
0.25% UV absorber, owf

Dyestuff		Blank*	Absorber A	Absorber B (Uvinul D-49)
CI Disperse Blue 7	Before Washing		20	30
	Wash Test II	70	40	50
CI Disperse Red 16	Before Washing		20	30
	Wash Test II	80	40	60

*Blank here refers to a dyeing using 0.25% dye and no absorber.

**All percentage findings of colors were visually estimated in north light and therefore are to be taken as relative only. All Fade-Ometer exposures were made at the same elevation with respect to the arc.

The dyeing methods used in this work were essentially the same as in Part I:

Dacron 64—spun challis—Test Fabrics #758 was used. Liquor to cloth ratio was 40:1, with additions of 4% Na₂SO₄, 0.1% Emulphor ON-870 owf, followed by 5% biphenyl owf, the biphenyl being first prepared as a 5% solution in methanol. A mechanical stainless-steel agitator to which the cloth was attached was employed. After addition of a 1% acetone solution containing 1/8% absorber and 1/4% dye, owf, the bath was brought to the boil and kept at 200°-210°F for one hour with agitation. The dyed cloth was removed, rinsed, and dried.

Since the absorbers did not exhaust with much better than 50% efficiency on nylon 66 taffeta (Test Fabrics # 302A), the effect of using biphenyl with disperse dyes on nylon was tested. Some results are given in Table VI. The use of biphenyl does not help these dyeings on nylon over the use of absorber alone. The biphenyl helps Dacron only.

In Exhibit 4 we have a dyeing of 1/4% Celliton Fast Blue Green BP + 1/4% Absorber A on nylon. No biphenyl is used in this test. All light tests were carried out in the Fade-Ometer. (See Editor's note).

The results in Part I refer to the use of nylon filament taffeta (Test Fabrics #302A) and Dacron 64—spun challis—Test Fabrics #758.

More recently we have studied the effects of absorbers on the lightfastness of spun nylon challis (Test Fabrics #354A), and on Dacron 62 Twill (#72) the latter a material of considerably higher luster than the Dacron 64 used in Part I. Some results illustrated in Table VII and subsequent Table VIII show comparable protection by the absorbers on the new fiber modifications to the protection obtained previously.

In Table VII on spun nylon, Absorber A improves lightfastness more than does Uvinul D-49, which improves more than the absorber 2,2'-dioxy-4-octyloxybenzo-phenone.

In Table VIII on Dacron 62, Absorber D-49 improves lightfastness more than Absorber A on the pink and yellow, and less than A on the Blue 3G.

Exhibit 5 illustrates dyeing of 1/4% of Genacryl Blue 3G + 1/4% Absorber A on Dacron 62 compared with Genacryl Blue 3G without absorber. It is seen that the absorber again improves lightfastness on Dacron 62. (See Editor's note).

Exhibit 6 shows the protection of a disperse dye, CI Disperse Red 1, on Dacron 64 using Absorber A. Again the disperse dye without absorber, mounted on the right has poorer lightfastness than the dyeing on the left which employs 1/4% Absorber A.

The cationic (Genacryl) dyes include methine types from indole bases among the reds and yellows, and triphenylmethane dyes among

the blues. The disperse (Celliton) dyes include azos among the oranges, reds, and yellows and anthraquinones among the blues. Thus, here we are stabilizing a wide variety of dye or chemical structures with these absorbers.

Only a small change in color is imparted by these absorbers at 1/4% to these dyeings examined visually. Little loss in brightness of dyeing results, especially with Absorber A, even though fluorescence disappears. Thus, fluorescence of the cationic dyes is apparently not responsible for their brightness.

One question that arises is how permanent are the absorbers to washing and drycleaning after being applied to the fiber by the co-dyeing method.

The effect of washing by AATCC Wash Test #2 of Dacron co-dyed with absorber + Celliton (or Genacryl) dye was good, showing about 15% loss in effectiveness of absorber after washing compared with before washing. However, on nylon taffeta both Absorber A and Uvinul D-49 lose considerably in effectiveness as light stabilizers after AATCC Wash Test #2, as shown in Table IX. It responds to light as if about 50% were lost in Wash Test #2 on nylon. In Table X, wash tests of dyeings of 1/8% Absorber A and Uvinul D-49 on two white nylon fibers and three white Dacron fibers are illustrated. The loss on the nylons is definitely greater than on the Dacron, especially

TABLE X
Washfastness of UV absorbers on undyed cloth
1/2% Absorber

Absorbers	A	Uvinul D-49
Nylon 200	44 → 48	48 → 53
Spun nylon #75M	44 → 48	47 → 53
Dacron 54	47 → 49	46 → 49
Dacron 62	47 → 48	50 → 51
Dacron 64	45 → 45	44 → 45

+Numbers represent % reflectance of UV light from cloth. (AATCC Wash test #2.)

TABLE XI
Drycleaningfastness of UV absorbers on undyed cloth
Perchloroethylene—1/2% Absorber

Absorbers	A	Uvinul D-49
Nylon 200	44-46	48-53
Spun nylon #75M	44-47	47-53
Dacron 54	47-57	46-51
Dacron 62	47-53	50-59
Dacron 64	45-49	44-46

+Numbers represent % reflectance of UV light from cloth.

Dacron 64. Here again the higher numbers indicate greater reflectance, therefore, less absorber present.

The drycleaning fastness of the absorbers from perchloroethylene solvent is illustrated in Table XI. It is not very good for either absorber, but is better for Uvinul D-49. The absorbers themselves are much less soluble in hydrocarbon solvents than in perchloroethylene, and their drycleaning fastness would be expected to be much better with Stoddard's solvent.

Absorber A and Uvinul D-49 can be evenly applied to Dacron 64 from perchloroethylene containing 1/2%, for example, of Absorber A by padding pre-dyed Dacron 64 evaporated to dryness. The resultant application of absorber gives more lightfastness to the dyeing than the same amount of absorber co-dyed on the fabric. However, at least half of the absorber applied to Dacron 64 by the drycleaning solvent padding method was lost in AATCC Wash Test #2, whereas only about 15% was lost after AATCC Wash Test #2 on co-dyed absorber. These data on drycleaning solvent application refer to disperse and cationic dyes on Dacron.

MECHANISM OF THE EFFECT

In Figure 3 the UV absorption curves of several of the dyes are given.

In Table XIII are compared the total UV absorption (by measuring the area under the curve) between 310 mμ and 400 mμ of a number of

disperse and basic dyes under discussion. It is seen that the total absorption varies over a range of approximately eightfold. It was seen from the stabilization afforded by the UV absorbers that the CI Basic Red 13 and Genacryl Blue 3G, as well as the CI Disperse Blue 3, all of which have low UV absorption, were in most cases stabilized just as much as the others with much higher absorption. Thus there appears to be no correlation between large UV absorption of the dye and large stabilization by the absorber. It appears then, rather remarkably, that the dye is not directly activated and destroyed by the UV. Since UV light does play a large part in breaking down these cationic and disperse dyes, we suggest that the UV light is initiating some other reaction, forming a radical which attacks the dye and decomposes it. Thus, it may be a radical from the polymer itself, or from impurities in the polymer, or it might be an attack on the dye by a UV-activated oxygen radical.

As far as sensitization of dyes by UV absorbers is concerned, we would like to describe an experiment wherein we were trying to determine the protection afforded Scotch tape by UV absorbers: on top of the Scotch tape was placed a series of filters of cellulose acetate side by side. The first filter had no absorber, the second had Absorber A, the third Absorber B, the fourth had Absorber C, the fifth D and the sixth E. The most decomposed, in 50 hours of Fade-Ometer exposure was Absorber

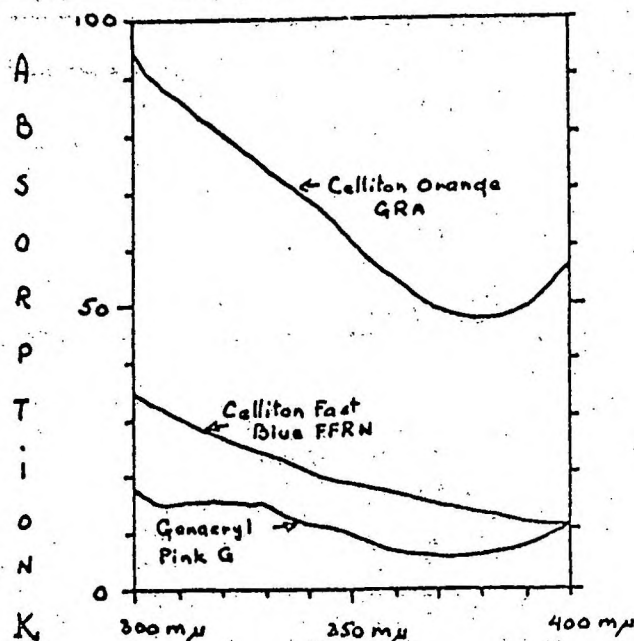


Figure 3
UV absorption of Celliton and Genacryl dyes

A, the least decomposed was blank containing no absorber, the others being intermediate and more decomposed the more the absorption. If the absorber had been in the Scotch tape resin, one would have been inclined to say the resin was "sensitized" by the absorber. Since the absorber was placed in a separate film above the resin, a simple explanation is that the acetate sheet containing the absorber has absorbed more energy from the light source than blank, thus the temperature of the Scotch tape has been higher and, therefore, more subject to light degradation at this temperature. Absorber E is actually a sensitizer for some dyes.

WOOL COLORS ON NYLON AND WOOL

As to other dyes besides the cationics and disperse colors which we have been considering to this point, we will take up the effect of UV absorbers on wool colors on nylon.

In the first paper it was reported that a number of classes of wool dyes: premetallized (Supralan), acid dyes such as CI Acid Red 4, CI Acid Blue 90—all of which gave relatively unlevel (compared with Cellitons) dyeings on nylon 66 taffeta (#302A), also were not improved in lightfastness by co-dyeing with UV absorbers. It appeared of interest to determine whether use of a more easily dyed nylon would show any improvement.

In Table XII appears the largest improvement in lightfastness we

TABLE XII

Wool colors on spun nylon (#758); % loss on light fading**
(20 hrs Fade-Ometer) 0.25% dye and
0.25% UV absorber, owf

Dyestuff	Blank*	Absorber A	Absorber B (Uvinul D-50)	2-Hydroxy-5- methylphenyl- benzotriazole
CI Acid Green 41	25	15	10	15
CI Acid Blue 78	30	10	20	20
CI Acid Red 73	60	40	45	40

*Blank here refers to a dyeing using 0.25% dye and no absorber.

**All percentage findings of colors were visually estimated in north light and therefore are to be taken as relative only. All Fade-Ometer exposures were made at the same elevation with respect to the arc.

have found afforded by UV absorbers on acid colors on spun nylon (#758). It is seen that CI Acid Green 41 is definitely improved in lightfastness by absorbers, CI Acid Blue 78 is markedly improved also, while CI Acid Red 73 is little improved. From Table XII it is seen that the triazole absorber is relatively a better stabilizer with these wool colors than it was with the Celliton colors.

The lightfastness of the dyes shown in Table XII was not improved using nylon taffeta (Test Fabrics #302A). The dyes are distinctly better penetrated and stronger on the spun nylon than on nylon taffeta. This suggests that sufficient penetration of the fiber by the dye is a prerequisite to satisfactory stabilization of dyes by UV absorbers.

The method of applying the wool colors which are not premetallized types was to dye in the presence of 1% owf Igepon T-51 and 2%, owf, sodium sulfate, dyeing temperature 200°F, one hour. Liquor to cloth ratio 40:1. The premetallized dyes were applied to nylon using 5%, owf, ammonium acetate and 2%, owf, Diazopon SS-837.

The results obtained are erratic and difficult to put in table form, but include the following observations:

CI Acid Yellow 7 ¼%, owf, applied to spun nylon gave a very level dyeing. Co-dyeing with ¼% Absorber A, as well as with ¼% Uvinul D-49, gave a slight improvement in lightfastness; however, a definite color change toward brown occurred on exposure to light. CI Acid Blue 118 dyed unlevel on nylon taffeta, but a slight improvement in lightfastness resulted from Absorber A. Wool Fast Blue BA gave a level dyeing on spun nylon; its lightfastness was only slightly improved by Uvinul D-50† and not by other

absorbers. CI Acid Red 97 gave a rather unlevel dyeing at ¼% on spun nylon, but its lightfastness was a trace improved using 2'-hydroxy-5'-methylphenylbenzotriazole. CI Acid Yellow 25 gave a very level dyeing on spun nylon, and the lightfastness of this dye was very much improved using UV absorbers, especially Uvinul D-50. Again CI Acid Violet 11 was level dyeing and only slightly improved in lightfastness by Uvinul D-50. Brilliant Indocyanine G was rather unlevel on spun nylon, and not improved by UV absorbers.

It was found in several instances to be effective in stabilizing colorings. However, it is sensitive to basic media, changing color and losing strength. Absorber A and Uvinul D-49 have considerably better fastness to washing by AATCC Wash Test #2.

No Supralan (premetallized) dye was improved in lightfastness by UV absorbers on spun nylon: in fact Supralan Orange NR and Supralan Red NR were poorer in lightfastness with UV absorbers present than in their absence. Supralan Blue NB and Red NB showed no improvement with UV absorbers.

It is interesting that Absorber A and Uvinul D-49 can be dyed on wool with exhaust of 40% to 50%. However, CI Acid Yellow 36 at ½% gave a level dyeing on wool which was not improved in lightfastness by any UV absorber. On the other hand, CI Acid Red 4 at ½%, owf, also dyed level on wool and did show improved lightfastness in the presence of ½% Absorber A.

It is seen from the above that wool dyes on nylon and on wool respond quite differently to UV absorbers than Celliton and Genacryl dyes on synthetic fibers.

Absorber A has been sampled in the field and we have received reports from outside laboratories of its superior performance to other absorbers. This experimental product is still under process development before manufacture.

TABLE XIII

UV Absorption of disperse and basic dyes
Relative values

	Total absorption
CI Disperse Orange 3	5.2
CI Disperse Blue 7	5.2
CI Disperse Blue 3	1.4
CI Basic Yellow 13	6.5
CI Basic Blue 1	3.5
Genacryl Red 4R	2.1
Genacryl Blue 3G	1.2
CI Basic Red 13	.75

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FUTURE WORK

Future work in this field will include evaluation of light protection afforded dyes by UV absorbers in resin finishes on natural and synthetic fibers, as well as study of performance of absorbers in Dacron/cotton and Orlon/wool blends. In a resin finish the UV absorber will be where it can do the most good: that is between the dye and the light. Further in resin finish the drycleaning fastness of the absorbers should be improved.

LITERATURE CITED

- (1) Strobel, A F, "Improvement of Lightfastness of Dyeings of Synthetic Fibers by Ultraviolet Absorbers, Part I," *Am Dyestuff Repr* 50, No. 16, 583-8 (1961).
- (2) Friedman, H M, "Some Aspects of Carrier Dyeing", *ibid* 49, 946-51 (1960).
- (3) Coleman, R A, and Peacock, W H, "Ultraviolet Absorbers", *Textile Research J* 28, 784 (1958).

TRADEMARKS

The following trademarks have been used in this paper:

Carolid—Tanatex Chemical Corp
Celliton—General Aniline & Film Corp
Dacron—E I duPont de Nemours & Co, Inc
Diazopon—General Aniline & Film Corp
Emulphor—General Aniline & Film Corp
Fade-Ometer—Atlas Electric Devices Co
Genacryl—General Aniline & Film Corp
Igepon—General Aniline & Film Corp
Orlon—E I duPont de Nemours & Co, Inc
Pyrex—Corning Glass
Sulphon—General Aniline & Film Corp
Supralan—General Aniline & Film Corp
Supramine—General Aniline & Film Corp
Tanavol—Tanatex Chemical Corp
Uvinul—General Aniline & Film Corp

EDITOR'S NOTE

Exhibits 1 through 6 referred to in this paper were shown as colored slides. Fading appears mainly in the blue element. As this does not show up sufficiently in black-and-white illustrations, we have shown only two examples to point up the effect.

†Uvinul D-50 is 2,2',4,4'-tetrahydroxybenzophenone:

