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FORM 1
REGULATION 9

COMMONWEALTH OF AUSTRALIA

PATENTS ACT 1952-1973

APPLICATION FOR A PATENT

APPLICATION ACCEPTED AND AMENDMENTS

I/We IOLAB CORPORATION ALLOWED.....20.6.90.....

of 500 Iolab Drive, Claremont, CA 91711, U.S.A.

hereby apply for the grant of a Patent for an invention entitled:

2-(2'-HYDROXYPHENYL)-5(6)-(ACRYLOYLOXYALKOXY)-BENZOTRI
AZOLE AND ULTRAVIOLET ABSORBING POLYMERS THEREFROM

which is described in the accompanying complete specification. This Application is a Convention Application and is based on the Application(s) numbered: 21,096 for a Patent or similar protection made in U.S.A. on 3 March 1987.

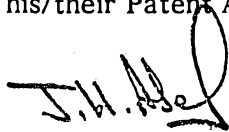
My/Our address for service is:

GRIFFITH HASSEL & FRAZER
71 YORK STREET
SYDNEY N.S.W. 2000
AUSTRALIA

DATED this 29th day of February, 1988.

IOLAB CORPORATION

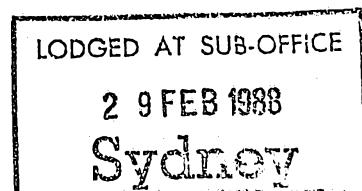
By his/their Patent Attorneys



GRIFFITH HASSEL & FRAZER

TO: THE COMMISSIONER OF PATENTS
COMMONWEALTH OF AUSTRALIA

0070A:rk



B — APPLICATION BY ASSIGNEE OF INVENTOR

COMMONWEALTH OF AUSTRALIA
PATENTS ACT 1952

DECLARATION IN SUPPORT OF AN APPLICATION FOR A PATENT

(Name of applicant)

In support of an application made by: ..IOLAB CORPORATION.....

(Title)

for a patent for an invention entitled: 2-(2'-HYDROXYPHENYL)-5(6)-(ACRYLOYLOXYALKOXY)-BENZOTRIAZOLE AND ULTRAVIOLET ABSORBING POLYMERS THEREFROM.....

(Full name and address of signatory)

I, Michael Q. Tatlow.....
of Iolab Corporation.....
500 IOLab Drive, Claremont, CA 91711, U.S.A.....

do solemnly and sincerely declare as follows:

1. I am authorised by the above mentioned applicant for the patent to make this declaration on its behalf.

(Full name and address of inventor(s))

2. The name and address of each actual inventor of the invention is as follows: Gary B. Dunks; Akira Yamada; Charles D. Beard and Namassivaya Doddi

of 1100 Emerson Street, Upland, CA 91786; 261 Ferris Street, Claremont, CA 91711, U.S.A.; 55 Guyencourt Road, Box 560, Montchanin, DE 19710, U.S.A. and 1658 Erin Avenue, Upland, CA 91786, U.S.A., respectively.....

(State whether by assignment or contract of employment)

and the facts upon which the applicant is entitled to make this application are as follows:

The applicant is the assignee of the said invention from the said inventors.....

(Delete paragraphs 3 and 4 for non-Convention application)

3. The basic application(s) as defined by Section 141 of the Act was (were) made as follows:

Country U.S.A. on 3 March 1987
Gary B. Dunks; Akira Yamada; Charles D. Beard
in the name(s) and Namassivaya Doddi.....

and in on

in the name(s)

and in on

in the name(s)

4. The basic application(s) referred to in the preceding paragraph was(were) the first application(s) made in a Convention country in respect of the invention the subject of this application.

(Place and date of signing)

Declared at New Brunswick this 9th day of November.. 19 87

Signed: 

Position: ... Assistant Secretary.....

GRIFFITH HASSEL & FRAZER
G.P.O. BOX 4164 SYDNEY, AUSTRALIA

(12) PATENT ABRIDGMENT (11) Document No. AU-B-12381/88
(19) AUSTRALIAN PATENT OFFICE (10) Acceptance No. 601024

(54) Title
**2-(2'-HYDROXYPHENYL)-5(6)-(ACRYLOYLOXYALKOXY)-BENZOTRIAZOLE AND
ULTRAVIOLET ABSORBING POLYMERS THEREFROM**

International Patent Classification(s)
(51)⁴ **C07D 249/20 C08F 226/06 G02C 007/04**

(21) Application No. : **12381/88** (22) Application Date : **29.02.88**

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(43) Publication Date : **01.09.88**

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(71) Applicant(s)
IOLAB CORPORATION

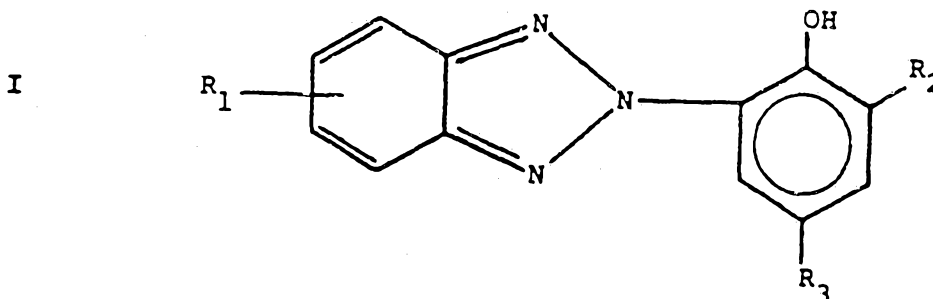
(72) Inventor(s)
GARY B. DUNKS; AKIRA YAMADA; CHARLES D. BEARD; NAMASSIVAYA DODDI

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(56) Prior Art Documents
AU 27535/88 C07D 249/20; C08K 005/34; G03C 001/06
AU 592241 81937/87 C07D 249/20; C08F 020/36; C09D 005/32
AU 565491 30476/84 C07D 249/20; C08F 020/36; C08F 220/14

(57) Claim

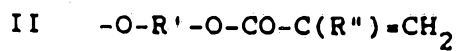
1. A benzotriazole compound of the formula:



wherein R₂ represents hydrogen or alkyl of from 1 to 6 carbon atoms, R₃ represents hydrogen, halogen, alkyl of 1 to 5 carbon atoms, or alkoxy of 1 to 8 carbon atoms, and R₁ represents a group of the formula:

(11) AU-B-12381/88
(10) 601024

-2-



wherein R' is C₂ to C₁₀ alkylene, which may be straight chain or branched, and R'' represents hydrogen, methyl, or halomethyl.

4. The compound of Claim 1 wherein said compound is 2-(3'-t-butyl-2'-hydroxy-5'-methoxyphenyl)-5-(3''-methacryloyloxypropoxy)benzotriazole.

5. An ultraviolet absorbing compound comprising a polymer of the compound of Claim 4.

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COMMONWEALTH OF AUSTRALIA

PATENTS ACT 1952

Form 10

COMPLETE SPECIFICATION

FOR OFFICE USE

Short Title:

Int. Cl:

Application Number:
Lodged:

Complete Specification-Lodged:
Accepted:
Lapsed:
Published:

Priority:

Related Art:

This document contains the amendments made under Section 49 and is correct for printing

TO BE COMPLETED BY APPLICANT

Name of Applicant: IOLAB CORPORATION
Address of Applicant: 500 Iolab Drive, Claremont, CA 91711, U.S.A.
Actual Inventor: Gary B. Dunks; Akira Yamada; Charles D. Beard and Namassivaya Doddi
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AUSTRALIA

Complete Specification for the invention entitled:

2-(2'-HYDROXYPHENYL)-5(6)-(ACRYLOYLOXYALKOXY)-BENZOTRIAZOLE AND ULTRAVIOLET ABSORBING POLYMERS THEREFROM

The following statement is a full description of this invention, including the best method of performing it known to me/us:-
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2-(2'-HYDROXYPHENYL)-5(6)-(ACRYLOYLOXYALKOXY)-
BENZOTRIAZOLE AND ULTRAVIOLET ABSORBING
POLYMERS THEREFROM

5

The invention relates to novel 2-(2'-hydroxyphenyl)-
5(6)-(acryloyloxyalkoxy)benzotriazoles, to ultraviolet
absorbing polymers produced therefrom, and to ocular
10 devices, particularly intraocular lenses and contact
lenses, prepared from such polymers.

Background of the Invention

15 The absorption of radiation in the ultraviolet range by
polymeric materials is a major cause of the light-induced
degradation therein. It is standard practice to add a low
molecular weight UV "stabilizer" to light-sensitive
polymers to absorb the light in the destructive range or
20 to quench the energy generated as a result of the
excitation of the light-absorbing functional groups in the
polymer.

Although low molecular weight UV absorbers or quenchers of
25 various types are effective in inhibiting or retarding the
destruction of the polymers to which they are added, their
extractability in various media and/or their volatility
during the processing or fabrication of the polymers at
elevated temperatures place a limitation on their utility.

30

This problem has been remedied to a considerable extent by
the synthesis of copolymerizable monomers containing
structural moieties capable of functioning as UV absorbers
or quenchers. The copolymerization of such monomers
35 results in the formation of copolymers with increased

stability, i.e., resistance to degradation upon exposure to UV light, with decreased extractability and volatility. The addition of such polymers to a suitable matrix polymer imparts these properties to the latter.

5

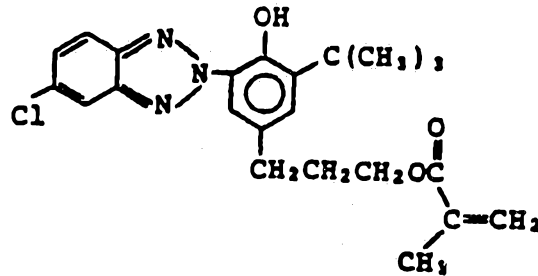
U.S. Patent No. 4,304,895 discloses the use of 2-hydroxy-4-methacryloyloxybenzophenone and mixtures thereof as a monomeric ultraviolet light absorber copolymerizable with acrylic monomers and useful in the preparation of UV
10 absorbing hard contact lenses.

Similarly, the copolymerization of an allyl-2-hydroxybenzophenone with an acrylate ester such as methyl methacrylate is described in U.S. Patent No. 4,310,650,
15 and, the copolymerization of ethylenically unsaturated derivatives of 2,4-dihydroxybenzophenone with other vinyl type comonomers is broadly disclosed in U.S. Patent No. 3,162,676.

20 Copolymers of methyl methacrylate and 4-(beta-acryloyloxyethoxy)-2-hydroxybenzophenone have been used as UV-absorbing intraocular lenses.

U.S. Patent No. 4,528,311 discloses certain benzotriazole
25 monomers which are copolymerizable with vinyl monomers such as methyl methacrylate to yield optically clear polymers useful in the preparation of intraocular and contact lenses. Representative of the disclosed benzotriazole monomers and a particularly preferred
30 compound is 2-[3'-t-butyl-2'-hydroxy-5'-(3"-methacryloyloxypropyl)phenyl]-5-chloro-2H-benzotriazole, which has the structure:

35



5

10 UV absorbing lenses are particularly desirable for use by
persons who have had their natural lenses surgically
removed owing to cataracts or other deterioration of the
lens. The visual correction of aphakia resulting from
such lens removal requires the use of high plus corrective
15 lenses, which may be in the form of spectacles, contact
lenses, or intraocular lenses.

In the normal eye, a portion of incident light entering
the eye is absorbed by various parts of the eye so that
20 only the unabsorbed or transmitted portion strikes the
retina. Incident light may comprise the entire spectrum
of wavelengths including the ultraviolet, visible, and
infrared.

25. The cornea preferentially absorbs the ultraviolet portion
of the light with wavelengths up to about 300 nm
(nanometers). The crystalline lens preferentially absorbs
ultraviolet light with wavelengths from about 300 up to
about 400 nm. The crystalline lens also absorbs a
30 significant portion of the visible light at wavelengths of
from 400 to about 450 nm, particularly as the lens ages
and develops a yellow tint. In the aphakic eye, where
there is no crystalline lens, light from 300 to 450 nm
will be transmitted directly to the retina, and the total
35 spectrum of the light striking the retina in the aphakic

eye will be different from that in the normal eye. As a consequence, aphakic patients are very sensitive to light in the ultraviolet range and may experience discomfort or color confusion when exposed to natural light or
5 artificial light having high levels of ultraviolet wavelengths.

Intraocular lenses and hard contact lenses are presently produced from methyl methacrylate polymers, which exhibit
10 a combination of properties desirable for such products, particularly optical clarity, the capability of being cut and polished to specific optical powers, and chemical inertness. UV absorbing lenses of poly(methyl methacrylate) (PMMA) are required to maintain the
15 above-mentioned desirable properties, while achieving at least 85% absorption of light at 400 nm, based on a polymer film thickness of 1 mm (millimeter). In addition, light absorption above a wave length of 450 nm should be minimal, in order to avoid excessive yellowing of the lens.

20 Soft contact and intraocular lenses may be fabricated of silicone or fluorocarbon polymers, or hydrogels such as polymers of hydroxyethyl methacrylate and N-vinylpyrrolidone.

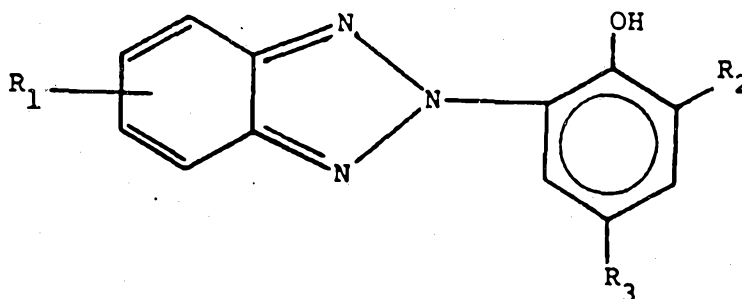
25 The benzotriazole monomers described in U.S. Patent No. 4,528,311 are effective UV absorbers, and they form chemically stable copolymers with, for example, methyl methacrylate. However, a concentration of about 3 percent
30 of the monomer in the copolymer is required to provide the desired degree of absorption at 400 nm. Also, the absorption of such copolymers cuts off sharply above 400 nm, so that very little light in the 400 to 450 nm range is absorbed. As a consequence, lenses of such PMMA
35 copolymers do not demonstrate the same absorption

characteristics as the natural lens of an elderly person, who is the most frequent recipient of an intraocular lens.

5 It is an object of this invention to provide a copolymer composition with improved UV absorption characteristics. It is a further object to provide a novel UV absorbing monomeric material which is copolymerizable with vinyl monomers and which may be incorporated in silicone polymers. A still further object is to provide a new
10 composition of matter which, when copolymerized at low concentrations with other monomers, effectively absorbs at least 85% of incident light below 420 nm at a 1 mm polymer film thickness. These and other objects of the present invention will be apparent from the ensuing description
15 and claims.

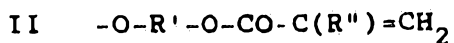
20 The novel 2-(2'-hydroxyphenyl)-5(6)-(acryloyloxyalkoxy)-benzotriazoles provided by the invention are represented by Formula I:

25 I



30

wherein R_2 represents hydrogen or alkyl of from 1 to 6 carbon atoms, R_3 represents hydrogen, halogen, alkyl of 1 to 5 carbon atoms, or alkoxy of 1 to 8 carbon atoms, and
35 R_1 represents a group of the formula:



wherein R' is C₂ to C₁₀ alkylene, which may be
5 straight chain or branched, and R'' represents hydrogen,
methyl, or halomethyl.

The above defined benzotriazoles are copolymerizable with
vinyl monomers such as methyl methacrylate to yield
10 polymers that are stabilized against degradation by UV
radiation, and which, when optically clear, are
particularly useful in the preparation of intraocular,
contact, and spectacle lenses. From 0.01 to about 20% by
weight, and preferably from 0.1 to 10% by weight of the
15 benzotriazole compound is incorporated in the copolymer,
the minimum effective amount for 85% absorption at 420 nm
and 1 mm film thickness depending upon the particular
structure of the benzotriazole compound. High molecular
weight homopolymers of the benzotriazole monomers may also
20 be prepared and incorporated into a variety of organic
materials to impart UV absorption properties thereto. The
benzotriazoles of the invention may also be incorporated
in silicone polymers by the reaction of the acrylic or
methacrylic groups with Si-H moieties.

25

Description of Drawings

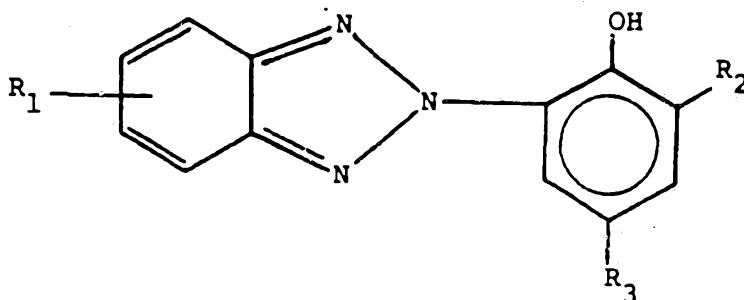
Fig. 1 is a plot of transmittance versus wavelength for a
polymer of the invention (Curve C), in comparison with a
30 polymer of copending application Serial No. 937,171, filed
December 1, 1986, and assigned to the same assignee as
this application (Curve B), and a human lens (Curve A); and

Figs. 2a and 2b show a sequence of reactions that can be
35 used to produce the benzotriazole monomers of the

invention from readily available, known compounds.

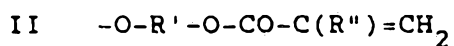
5 The benzotriazole monomers of the present invention are those compositions that are represented by Formula I:

10 I



15

wherein R₂ represents hydrogen or alkyl of from 1 to 6 carbon atoms, R₃ represents hydrogen, halogen, alkyl of 20 1 to 5 carbon atoms, or alkoxy of 1 to 8 carbon atoms, and R₁ represents a group of the formula:



25 wherein R' is C₂ to C₁₀ alkylene, which may be straight chain or branched, and R'' represents hydrogen, methyl, or halomethyl.

Particularly preferred compositions within the scope
30 of Formula I are those wherein R₁ is in the 5 position and wherein R' in R₁ is ethylene or propylene and R'' is methyl, wherein R₂ is t-butyl, and R₃ is methoxy. A particularly preferred benzotriazole monomer of the invention is 2-(3'-t-butyl-2'-hydroxy-5'-
35 methoxyphenyl)-5-(3''-methacryloyloxypropoxy)benzotriazole.

The preparation of this particularly preferred benzotriazole monomer is illustrated in the Examples below.

5 A summary of the sequence of reactions that is displayed in Fig. 2a and 2b, and which can be employed to prepare the benzotriazole monomers of the invention is the following:

10 4-Aminophenol (I) is reacted with a haloalkanol to produce a hydroxyalkoxy-aniline (II), which is then acetylated with a mixture of acetic anhydride and acetic acid to produce an acetoxyalkoxy-acetanilide (III). The reaction is here illustrated with 3-chloropropanol as the
15 chloroalkanol. Other haloalkanols having from 2 to 10 carbon atoms may be employed. Specific illustrative examples of such other haloalkanols include 2-chloroethanol and 4-chlorobutanol.

20 III is nitrated with nitric acid, and then hydrolyzed with aqueous alkali to produce a hydroxyalkoxy-2-nitroaniline (V).

 V is diazotized by reaction with HONO (which may be
25 derived from an acidified nitrite salt), and is then reacted with a substituted phenol, such as 2-t-butyl-4-methoxyphenol (which may be obtained from commercial t-butyl-hydroxyanisole), to produce an azo compound, VI. The azo compound VI is then cyclized and
30 reduced to produce a hydroxyalkoxy-benzotriazole, VII. In place of the 2-t-butyl-4-methoxyphenol, there may be employed other compounds, such as 4-methoxyphenol, 2-methyl-4-methoxyphenol, 2-t-butyl-4-methylphenol, 2-methyl-4-chlorophenol, and 2-t-butyl-4-chlorophenol.

35

The hydroxyalkoxy-benzotriazole, VII, is then esterified by acrylic or methacrylic acid to produce a monomer of the invention, VIII.

5

The following experiments illustrate this sequence of reactions:

EXAMPLE 1

10

Synthesis of 4-(3'-Acetoxypropoxy)-acetanilide
(III)

A 3000 mL (milliliter), 3-neck flask fitted with
15 mechanical stirring, an inert gas inlet-topped reflux condenser, and a thermocouple was charged with potassium hydroxide (70.4 g (grams), 1.1 mol, 88% pure pellets), METHYL CELLOSOLVE (1250 mL), 4-aminophenol (I) (109.1 g, 1.0 mol), and 3-chloropropanol (113.5 g, 1.2 mol). The
20 mixture was heated to 100°C and maintained at that temperature for 3 hours, and was then heated to the reflux temperature (about 118°C) and maintained at that temperature for 3 hours. The mixture was allowed to cool, with stirring, overnight, was filtered to remove potassium
25 chloride, and was then stripped on a rotary evaporator to an oil. The oil was taken up with acetic acid (300 mL) and was transferred to a 2000 mL, 3-neck flask fitted with mechanical stirring, an inert gas inlet-topped reflux condenser, and a thermocouple. The solution was cooled to
30 0°C, then acetic anhydride (280 mL, 3 mol) was added over 100 minutes. The mixture was heated to 100°C and maintained there for 3.5 hours, and was then allowed to cool slowly to 40°C. The mixture was filtered and then stripped on a rotary evaporator (mechanical pump, 70°C) to
35 a semi-solid (314 g). The semi-solid was dissolved in hot

toluene (1000 mL). The toluene solution was filtered, washed first with 2% aqueous potassium hydroxide (400 mL), and then with water (500 mL). The toluene solution was dried over anhydrous sodium sulfate, filtered, and then
5 cooled to -4°C for 30 minutes. The solid precipitate was isolated by filtration and dried in vacuo to yield 113.2 g of III (76% pure by g.c.). The postulated structure was confirmed by IR and ^1H NMR analyses.

10

EXAMPLE 2

Synthesis of 4-(3-Hydroxypropoxy)-2-nitroaniline (V)

15 A 1000 mL Erlenmeyer flask fitted with magnetic stirring and a thermocouple was charged with III (25.2 g, 0.10 mol), acetic anhydride (32.1 g, 0.31 mol), and methylene chloride (50 mL). The mixture was stirred at ambient temperature for 15 minutes to effect solution, and was
20 then cooled to -3°C in an ice-salt bath. Nitric acid (19.7 g, 0.22 mol, $d=1.41$, 70% acid) was added in one portion. When the exothermic reaction was complete (maximum temperature 8.5°C), the cooling bath was removed. The temperature of the reaction mixture
25 increased to 39.5°C , then slowly decreased over the next 60 minutes. A solution of potassium hydroxide (65.0 g, 1.02 mol of 88% base) in water (435 mL) was added. The dark mixture was heated to distill off volatile components. The final overhead temperature was 96°C after
30 approximately 2.2 hours. The resulting mixture ($\text{pH} = 13$) was chilled in an ice bath to initiate crystallization, and was then stored at 0°C overnight. The solid precipitate was isolated by filtration, dissolved in hot methanol (250 mL), and then water (1800 mL) was added.
35 The mixture was heated to distill off most of the methanol

(overhead temperature 79°C), then chilled in an ice-bath to initiate crystallization. The mixture was stored at 0°C overnight. The resulting crystalline solid was isolated by filtration. The red-orange crystals were
5 dried in vacuo (yield 13.0 g, mp 84.5-85.5°C). The postulated structure of V was confirmed by IR and ¹H NMR analyses.

EXAMPLE 3

10

Separation of 2-tert-butyl-4-methoxyphenol from commercial BHA

Commercial BHA (butylated hydroxyanisole) is a mixture of
15 2-t-butyl-4-methoxyphenol (about 80%) and 3-t-butyl-4-methoxyphenol (about 20%). The isomers can be separated by exploiting the increased acidity of the phenolic OH non-adjacent to the t-butyl group in 3-t-butyl-4-methoxyphenol.

20

Commercial BHA (615 g) was dissolved in toluene (2000 mL), washed sequentially with 10% aqueous potassium hydroxide solution (3 x 1500 mL), water (1000 mL, made acidic with hydrochloric acid), water (1000 mL, final pH about 7),
25 then dried over anhydrous sodium sulfate. The toluene solution was stripped to a solid (478 g) on a rotary evaporator. The solid was dried in vacuo to yield 2-t-butyl-4-methoxyphenol 93.2% pure (mp 59-69°C).

30

35

EXAMPLE 4

Synthesis of

5 2-(3'-t-butyl-2'-hydroxy-5'-methoxyphenyl)-5-
(3"-hydroxypropoxy)benzotriazole (VII)

A 50 mL Erlenmeyer flask fitted with magnetic stirring was charged with V (2.3 g, 0.011 mol) and hydrochloric acid (3.5 mL, 0.035 mol). The mixture was stirred 5 minutes to effect solution, water (1.5 mL) was added, and the solution was cooled to 0°C in an ice-salt bath. A solution of sodium nitrite (0.8 g, 0.012 mol) in water (2 mL) was added over 30 minutes, and the resulting mixture was stirred at 0°C for 40 minutes. Sulfamic acid (0.2 g) was added to destroy excess nitrous acid (negative starch/iodide test). The solution was filtered and maintained at 0°C.

20 Meanwhile, a 250 mL, 3-neck flask fitted with mechanical stirring and a thermocouple was charged with 2-t-butyl-4-methoxyphenol (2.0 g, 0.011 mol), water (30 mL), and potassium hydroxide (2.6 g of 88% pure base, 0.04 mol). The mixture was heated to effect solution and then cooled to 0°C in an ice-salt bath. The clear diazonium ion solution from above was added dropwise over 10 minutes. The mixture was then stirred at 0°C for an additional 10 minutes (pH=13). Hydrochloric acid (1N, 15 mL) was added (pH=0) to precipitate the intermediate azo compound, 2-t-butyl-6-[4'-(3"-hydroxypropoxy)-2'-nitrophenylazo]-4-methoxyphenol (VI).

The aqueous solution was removed from VI by suction. Reagent grade ethanol (50mL) was added and the mixture was stirred to effect solution. Then a solution of sodium

hydroxide (2.6 g, 0.07 mol), glucose (4.0 g, 0.02 mol), and water (30 mL) was added over 20 minutes. The solution was stirred at ambient temperature over a weekend. Zinc dust (10.0 g, activated with hydrochloric acid) was added
5 and the mixture was stirred at ambient temperature for 2 hours and then heated to 65°C for 3 hours. The zinc was removed by filtration, the filtrate was acidified with hydrochloric acid (50 mL 1N) (pH = 1), and then extracted with methylene chloride (2 x 30 mL). The methylene
10 chloride extract was washed with water (3 x 40 mL, final wash pH = 7), dried over anhydrous sodium sulfate, and stripped to a semi-solid (4.3 g) on a rotary evaporator. The semi-solid was passed through an alumina column (3 x 15 cm) with methylene chloride. The solution was stripped
15 to oil (3.4 g) on a rotary evaporator. The oil was dissolved in hot heptane (125 mL). The resulting clear, yellow solution was allowed to cool slowly to ambient temperature and then stored at 0°C. The crystalline precipitate was isolated by filtration and dried in vacuo
20 to yield 1.4 g of VII (mp 115-119°C). The postulated structure of VII was confirmed by IR and ¹H NMR analyses.

EXAMPLE 5

25 Synthesis of
2-(3'-t-butyl-2'-hydroxy-5'-methoxyphenyl)-5-(3''-methacryloyloxypropoxy)benzotriazole (VIII)

A 50 mL, round bottom flask fitted with magnetic stirring
30 was charged with VII (0.8 g, 2 mmol), cyclohexane (25 mL), hydroquinone (0.01 g), p-toluenesulfonic acid (0.1 g, 0.53 mmol), and methacrylic acid (0.4 ml, 4.7 mmol). A distillation head fitted with an inert gas inlet-topped reflux condenser was attached to the flask. The apparatus
35 was arranged so that condensate passed through a column of

sand (20 g) and anhydrous sodium sulfate (10 g) before returning to the reaction flask. The mixture was heated to the reflux temperature and maintained at that temperature for 18 hours. The mixture was cooled, and then methylene chloride (15 mL) and saturated aqueous sodium bicarbonate (15 mL) were added and stirred. The methylene chloride layer was separated, washed with water (1 x 40 mL, wash pH=7), cyclohexane (150 mL) added, and the solution was heated to distill off methylene chloride (overhead temperature 78.6°C, final volume 15 mL). The solution was cooled to ambient temperature, and then chilled (about 10°C) with stirring for 2 hours. The precipitate was isolated by filtration and dried in vacuo to yield 0.7 g of VIII (mp 103-105°C). The postulated structure of VIII was confirmed by IR and ¹H NMR analyses.

The following example illustrates the preparation of an ultraviolet absorbing polymer from the monomer of Example 5:

EXAMPLE 6

Preparation of Polymer

A test tube was charged with 0.30 g of VIII, 1.00 g of ethyl acrylate, 8.70 g of methyl methacrylate, 0.060 g of stearic acid, 0.0125 g of lauroyl peroxide, and 56 microliters of 1-dodecanethiol. After all solid ingredients were dissolved, argon gas was bubbled into the mixture for about 20 seconds to remove oxygen. The solution was then filtered through a 0.2 micron polytetrafluoroethylene (PTFE) membrane and was placed in a Pyrex polymerization tube under an argon stream. The tube was closed with a PTFE-coated cap and was placed in a

60°C water bath for 18 hours. The resulting rod was post-polymerized at 110°C for 6 hours and was pressed into a 1-mm-thick film at about 200°C. The film showed transmittance of 0.931 at 700 nm, 0.155 at 430 nm and
5 0.0008 at 400 nm. The GC and HPLC analyses of the post polymerized rod showed residual monomers: 0.19% of ethyl acrylate; 0.21% of methyl methacrylate, and 0.09% of H7 monomer.

10 The transmittance curves of the polymer of Example 6, above, (a 1.16 mm thick film), identified as "C", a 1.02 mm thick film of a polymer of copending application serial No. 937,171, identified as "B", and the human crystalline
15 are shown in Figure 1.

For optical uses, particularly contact lenses and intraocular lenses for aphakic patients, strong absorption of light up to about 420 nm is desired. In the case of
20 the compound of Example 5, from about 0.01 to 20 percent concentration, and particularly from about 0.1 to 10 percent concentration, is desirable for such optical applications.

25 The benzotriazoles of the invention may be copolymerized with any of a number of unsaturated monomers to provide polymeric compositions having desirable UV stabilizing and absorbing characteristics. Alternatively, homopolymers or copolymers of the benzotriazoles of the invention may be
30 utilized as additives to a wide variety of organic polymers to provide UV absorption properties. Representative of the polymers and copolymers useful in conjunction with the benzotriazole monomers and polymers of the invention are:

35

a. Polymers which are derived from mono- or diolefins, e.g., polyethylene which can optionally be crosslinked, polypropylene, polyisobutylene, polymethylbutene-1,
5 polymethylpentene-1, polyisoprene, and polybutadiene;

b. Mixtures of the homopolymers cited under (a), for example mixtures of polypropylene and polyethylene, polypropylene and polybutene-1, and polypropylene and
10 polyisobutylene;

c. Copolymers of the monomers based on the homopolymers cited under (a), for example ethylene/propylene copolymers, propylene/butene-1 copolymers,
15 propylene/isobutylene copolymers, ethylene/butene-1 copolymers, as well as terpolymers of ethylene and propylene with a diene, for example hexadiene, dicyclopentadiene or ethylidene norbornene, and copolymers of alpha-olefins, e.g., ethylene with acrylic or
20 methacrylic acid;

d. Polystyrene;

e. Copolymers of styrene or of alpha-methylstyrene, for example styrene/butadiene copolymers,
25 styrene/acrylonitrile copolymers, styrene/acrylonitrile/methacrylate copolymers, styrene/acrylonitrile copolymers modified with acrylic ester polymers to provide impact strength as well as block
30 copolymers, e.g., styrene/butadiene/styrene block copolymers;

f. Graft copolymers of styrene, for example the graft polymer of styrene to polybutadiene, the graft polymer of
35 styrene with acrylonitrile to polybutadiene as well as

mixtures thereof with the copolymers cited under (e), commonly referred to as acrylonitrile/butadiene/styrene or ABS plastics;

- 5 g. Silicone polymers such as the soft hydrophilic polysiloxanes disclosed in U.S. Patent 4,259,467 and the hard polyorganosiloxanes disclosed in U.S. Patent 4,355,147;
- 10 h. Halogen-containing vinyl polymers, for example polyvinyl chloride, polyvinylidene chloride, polyvinyl fluoride, polychloroprene, chlorinated rubbers, vinyl chloride/vinylidene chloride copolymers, vinyl chloride/vinyl acetate copolymers, vinylidene
15 chloride/vinyl acetate copolymers;
- i. Polymers which are derived from alpha,beta-unsaturated acids and derivatives thereof, polyacrylates and polymethacrylates, poly(hydroxyethyl methacrylate),
20 polyacrylic amides and polyacrylonitrile. The instant compounds are advantageously used in heat-curable acrylic resin lacquers which are composed of a copolymer of acrylic acid and one or more of its derivatives, and a melamine-formaldehyde resin;
- 25 j. Polymers which are derived from unsaturated alcohols and amines and from the acyl derivatives thereof or acetals, for example polyvinyl alcohol, polyvinyl acetate, polyvinyl stearate, polyvinyl benzoate, polyvinyl maleate,
30 polyvinyl butyral, polyallyl phthalate, polyallyl melamine, and copolymers thereof with other vinyl compounds, for example ethylene/vinyl acetate copolymers;

k. Homopolymers and copolymers which are derived from epoxides, for example polyethylene oxide or the polymers which are derived from bis-glycidyl ethers;

5

l. Polyacetals, for example polyoxymethylene, as well as polyoxymethylenes which contain ethylene oxide as comonomer;

10

m. Polyalkylene oxides, for example polyoxyethylene, polypropylene oxide or polybutylene oxide;

n. Polyphenylene oxides;

15

o. Polyurethanes and polyureas, such as in urethane coatings;

p. Polycarbonates;

20

q. Polysulfones;

r. Polyamides and copolyamides which are derived from diamines and dicarboxylic acids and/or from aminocarboxylic acids or the corresponding lactams, for example polyamide 6, polyamide 6/6, polyamide 6/10, polyamide 11, polyamide 12, n-vinyl lactams and poly-m-phenylene-isophthalamide;

25

s. Polyesters which are derived from dicarboxylic acids and dialcohols and/or from hydroxycarboxylic acids or the corresponding lactones, for example polyethylene glycol terephthalate, poly-1,4-dimethylolcyclohexane terephthalate;

30

35

t. Crosslinked polymers which are derived from aldehydes on the one hand and from phenols, ureas and melamine on the other, for example phenol/formaldehyde,
5 urea/formaldehyde and melamine/formaldehyde resins;

u. Alkyd resins, for example glycerol/phthalic acid resins and mixtures thereof with melamine/formaldehyde resins;
10

v. Unsaturated polyester resins which are derived from copolyesters of saturated and unsaturated dicarboxylic acids with polyhydric alcohols, as well as from vinyl compounds such as styrene as crosslinking agents, and also
15 the halogen-containing, flame-resistant modifications thereof; and

w. Natural polymers, for example cellulose, rubber, as well as the chemically modified homologous derivatives
20 thereof, for example cellulose acetates, cellulose propionates, and cellulose butyrates, and the cellulose ethers, for example methyl cellulose.

Particularly useful compositions are copolymers comprising
25 from 0.01 to 20% by weight of benzotriazoles of the invention with other ethylenically unsaturated materials such as styrene, methylstyrene, vinylsiloxanes, acrylates, methacrylates, acrylamide, acrylonitrile,
30 methacrylonitrile, vinyl acetate, vinylidene chloride, vinyl chloride, vinyl fluoride, vinyl lactams, ethylene, propylene, and mixtures thereof.

The homopolymers and copolymers of the benzotriazoles of the invention find wide application in formulating UV
35

absorbing plastics and other organic materials wherever
such materials are exposed to UV radiation from either
natural or artificial sources. In addition to the medical
use in intraocular and contact lenses described above, the
5 materials of the present invention are useful in many
industrial applications such as in solar energy
collectors, polymeric coatings, transparent plastic films,
fluorescent light diffusers, packaging materials, vinyl
window coverings, automobile paints and interior
10 coverings, epoxies, fiberglass constructions, and the
like. Many other applications will be readily apparent to
those familiar with this art as a result of reading the
preceeding specification.

15

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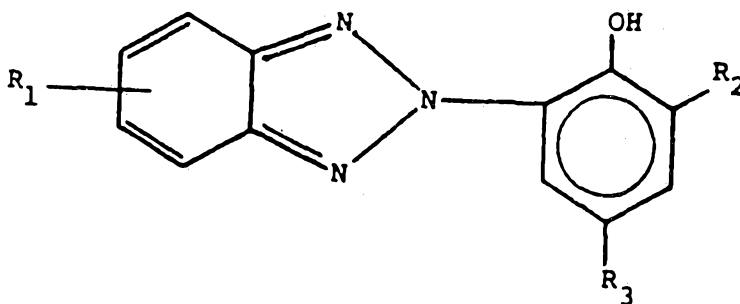
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THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A benzotriazole compound of the formula:

5

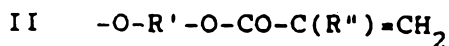
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- 15 wherein R₂ represents hydrogen or alkyl of from 1 to 6 carbon atoms, R₃ represents hydrogen, halogen, alkyl of 1 to 5 carbon atoms, or alkoxy of 1 to 8 carbon atoms, and R₁ represents a group of the formula:

20



wherein R' is C₂ to C₁₀ alkylene, which may be straight chain or branched, and R'' represents hydrogen, methyl, or halomethyl.

25

2. The compound of Claim 1 wherein R₂ is t-butyl.
3. The compound of Claim 1 wherein R₃ is methoxy.
- 30 4. The compound of Claim 1 wherein said compound is 2-(3'-t-butyl-2'-hydroxy-5'-methoxyphenyl)-5-(3''-methacryloyloxypropoxy)benzotriazole.
5. An ultraviolet absorbing compound comprising a
35 polymer of the compound of Claim 4.



6. An ultraviolet absorbing composition comprising a copolymer of an ethylenically unsaturated monomer and an effective amount of a benzotriazole compound of claim 1.

5

7. The composition of claim 6 wherein said ethylenically unsaturated monomer is selected from the group consisting of styrene, methylstyrene, vinylsiloxanes, acrylates, methacrylates, acrylamide, acrylonitrile,

10 methacrylonitrile, vinyl acetate, vinylidene chloride, vinyl chloride, vinyl lactams, ethylene, propylene, and mixtures thereof.

8. The composition of claim 6 wherein said ethylenically
15 unsaturated monomer comprises hydroxyethyl methacrylate.

9. The composition of claim 6 wherein said benzotriazole compound comprises from 0.01 to 20% by weight of said composition.

20

10. The composition of claim 9 wherein said ultraviolet absorbing composition comprises a copolymer of methyl methacrylate and from 0.01 to 20% by weight of said benzotriazole compound.

25

11. The composition of claim 6 wherein said benzotriazole compound is 2-(3'-t-butyl-2'-hydroxy-5'-methoxyphenyl)-5-(3"-methacryloyloxypropoxy)benzotriazole and comprises from 0.01 to 20% by weight of said composition.

30

12. The composition of claim 11 wherein said ultraviolet absorbing composition comprises a copolymer of methyl methacrylate and from 0.05 to 10.0% by weight of said benzotriazole compound.

35

13. An ultraviolet absorbing composition comprising an optically clear polymeric material and from 0.01 to 20% by weight of a benzotriazole compound of claim 1.
5
14. The composition of claim 13 wherein said polymeric material is selected from the group consisting of polyvinyl halides, polyacrylates, polystyrene, polyvinylidene halides, polycarbonates, and
10 acrylonitrile-butadiene-styrene terpolymers.
15. The composition of claim 13 wherein said benzotriazole compound is a homopolymer of 2-(3'-t-butyl-2'-hydroxy-5'-methoxyphenyl)-5-(3"-methacryloyloxypropoxy)-
15 benzotriazole.
16. An optical lens comprising an optically clear polymer composition of claim 6.
- 20 17. An optical lens comprising an optically clear polymer composition of claim 8.
18. An optical lens of claim 17 comprising a hydrogel of said optically clear polymer composition.
25
19. A lens of claim 16 which is a contact lens, intraocular lens, or spectacle lens.
20. A lens of claim 19 which is a contact lens or
30 intraocular lens.
21. A plastic film comprising the composition of claim 6.
22. A plastic film comprising the composition of claim 13.
35

23. A coating material comprising the composition of claim 6.

5 24. A coating material comprising the composition of claim 13.

10

Dated this 29th day of February 1988

15 IOLAB CORPORATION
By their Patent Attorney
GRIFFITH HASSEL & FRAZER

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FIG-1

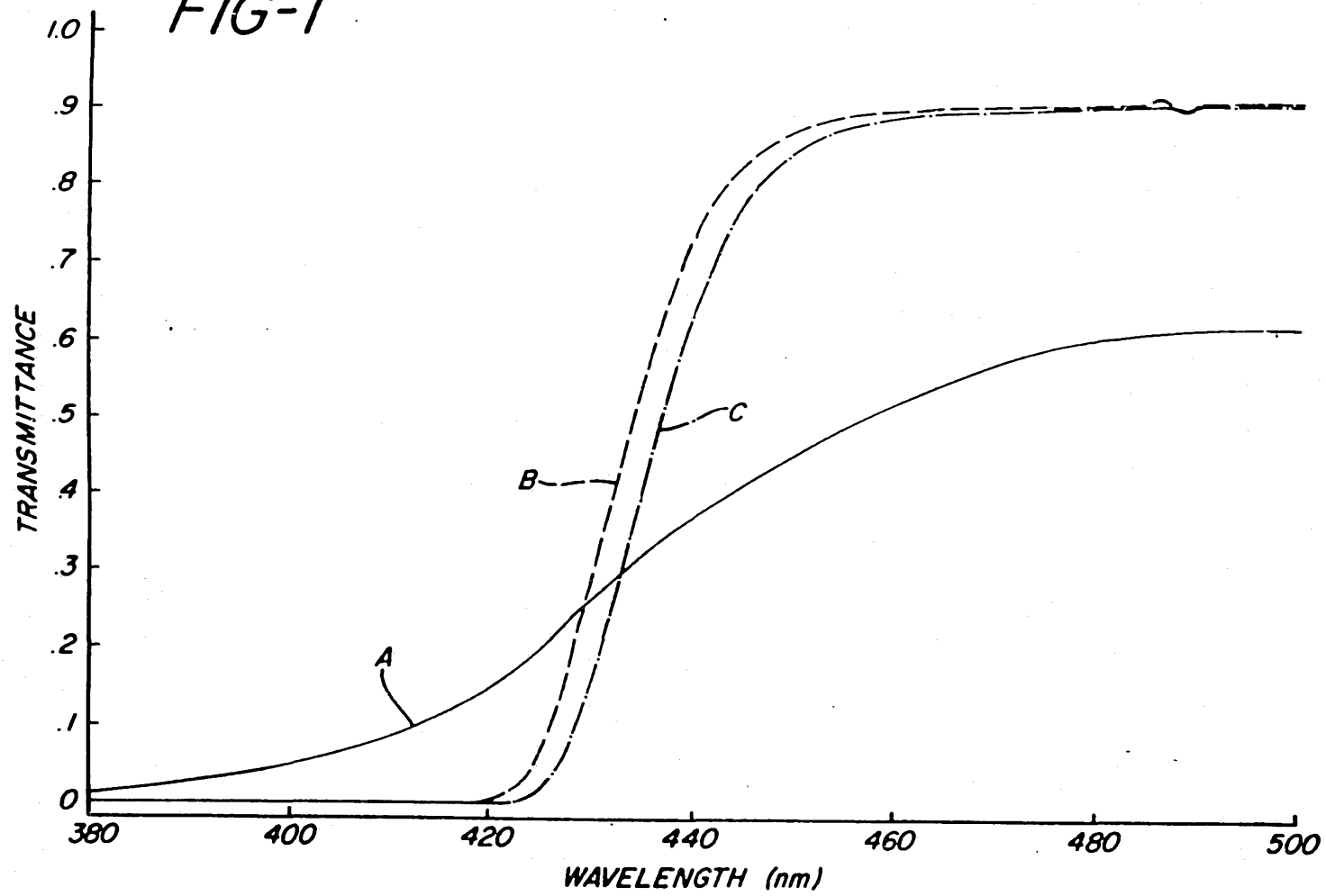


FIG-2a

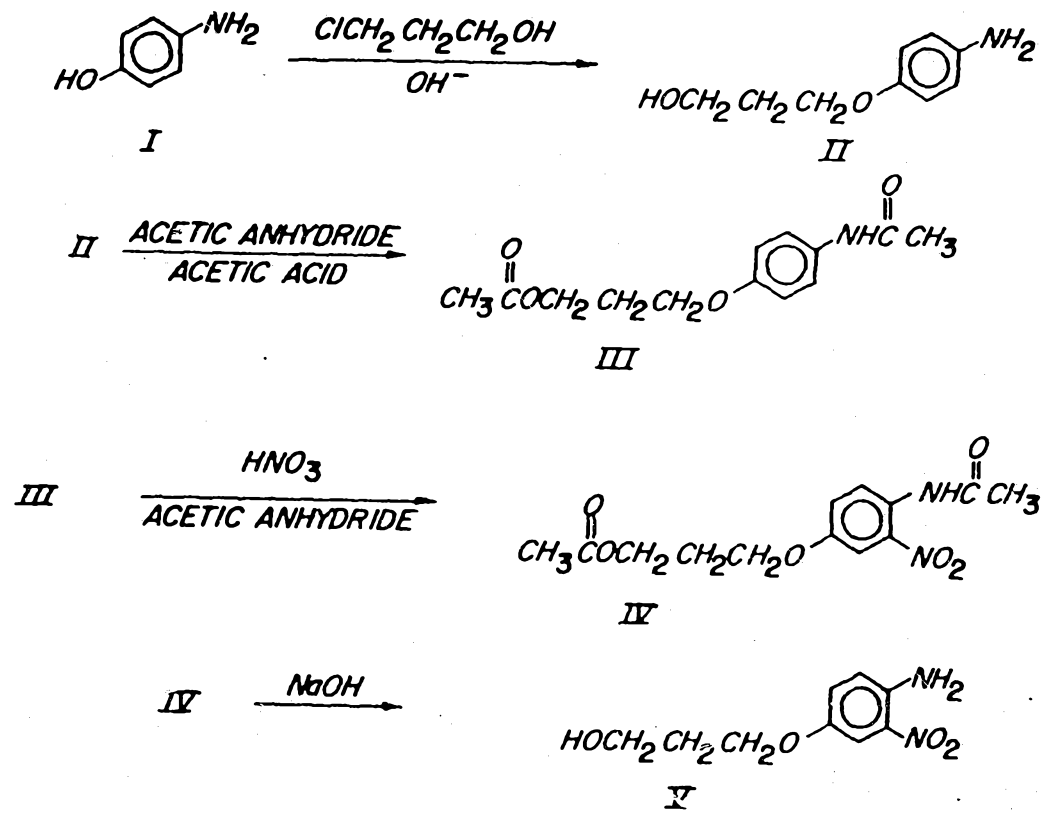


FIG-2b

