

[54] **METHOD OF PROTECTING THE SKIN FROM ULTRAVIOLET RADIATION WITH TITANIC ACID AND ESTERS OF TITANIC ACID**

[72] Inventor: **Edward J. Madigan**, Denver, Colo.
[73] Assignee: **Cosmetics & Pharmaceuticals, Inc.**, Denver, Colo.
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[58] Field of Search424/59; 260/429.3, 429.5

[56] **References Cited**

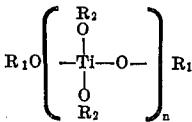
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Primary Examiner—Albert T. Meyers
Assistant Examiner—Dale R. Ore
Attorney—John E. Reilly

[57] **ABSTRACT**

An effective ultra-violet absorber composition and process for controlling sunburn by applying to the skin a composition which comprises a hydrated, substantially transparent gel represented by the formula:



wherein:

- a. R_1 and R_2 are independently selected from the group consisting of hydrogen, short chain alkyl, and ligands capable of chelate formation, and
- b. n is any integer

in a dermatologically acceptable carrier, the gel being employed in an amount effective to protect the skin and other surfaces from the harmful effects of the burning rays of the sun.

3 Claims, No Drawings

METHOD OF PROTECTING THE SKIN FROM ULTRAVIOLET RADIATION WITH TITANIC ACID AND ESTERS OF TITANIC ACID

This invention relates to new and useful ultraviolet absorber compounds, to compositions containing such compounds, to a method of preparing a sun-screen composition, and to methods for protecting the human skin and other surfaces against the burning effects of sunlight. More particularly the invention relates to substantially transparent gelatinous compounds adapted for incorporation into cosmetic formulations, said compounds being capable of absorbing the burning wavelengths of actinic radiation.

Extensive studies have been made of ultraviolet radiation and its effects on the human skin. It has been established that the radiation from about 290 to 315 N (1 Nanometer being equivalent to 10 Angstrom Units) contains a major portion of detrimental burning wavelengths, while the radiation from about 315 to 400 N promote the more desirable aesthetic feature known as tanning. The effect of the lower wavelengths on human skin is to produce, in most instances, severe burning, blistering and deterioration of the skin. As a result, various sun-screen compositions have been developed to screen out or block these burning wavelengths. While tanning may have some beneficial effects in that it protects the skin from further burning where there is continued exposure to the sun, nevertheless tanning in and of itself is associated with a general deterioration of the skin; and although the majority of people are not severely affected by tanning, many are extremely sensitive even to the tanning rays of the sun to the extent that exposure to these wave lengths creates serious health hazards. Included within the latter group are those persons who suffer from various dermatological problems, blood dyscrasias, skin cancer, and sensitive skin problems. Consequently, for those who must have protection against the burning rays as well as a portion of the shorting tanning rays of the sun, there has been a need for a broad spectrum, non-toxic, non-carcinogenic, sun-screen composition that will afford adequate protection to the skin, is sufficiently stable to remain effective for several hours, and can be readily applied to the skin.

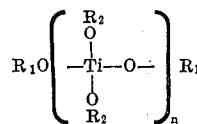
It is therefore a primary object of the present invention to provide relatively transparent gelatinous compounds which possess excellent absorption abilities for filtering out the burning wave lengths in the ultraviolet spectrum.

Is is another object of the present invention to provide compositions containing the novel compounds hereof which may be applied to the human skin to protect it against sunburn.

It is still another object of the present invention to provide a method of preparing an ultra-violet absorber compound for subsequent incorporation into various dermatologically acceptable carriers.

In accordance with the present invention, it has now been discovered that transparent and/or translucent compounds which contain direct oxygen linkages to titanium possess outstanding sun-screening abilities to absorb the burning rays of sunlight, and particularly those wave lengths in the ultra-violet region of from about 200 N to about 400 N. Those compounds which contain direct oxygen linkages to titanium and are em-

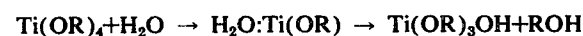
ployed in the compositions and processes of this invention are substantially transparent gels having the following general formula:



wherein R_1 and R_2 are preferably hydrogen, alkyl, and ligands capable of chelate formation, and n represents any integer. Thus, when the formula represents: (1) a condensation product of orthotitanic acid, then n may be any integer greater than 1; and (2) the chelated form, then n is 1. The alkyl is preferably of the short chain variety having between three and eight carbon atoms such as propyl, isopropyl, butyl, isobutyl, branched eight carbon atom chains, as well as polymers and mixtures thereof. The ligands capable of chelate formation include the amino alcohol, keto alcohols, and glycols which upon esterification form relatively stable five or six membered ring structures with titanium. Preferred members of this latter group are triethanolamine, octylene glycol and acetyl acetone. The compounds are prepared as transparent gels as hereinafter described, and thereafter usually dispersed in a dermatologically acceptable carrier.

It is generally accepted that titanium chemistry is a complex subject and for this reason, the invention should not be limited to the theory herein presented. However, it is known that orthotitanic acid, i.e., $\text{Ti}(\text{OH})_4$, hydrolyzes readily upon exposure to water to produce higher molecular weight condensation products and/or polymeric titanates thereof.

For example, one method forming the titanate occurs when alkyl ortho titanate esters are hydrolyzed. Hydrolysis proceeds rapidly with the intermediate formation of unstable coordination complexes between the ester and water thereby splitting out a molecule of alcohol according to the following reaction:



However, since the monohydroxy ester is unstable it immediately undergoes further reaction and condensation to form a dimeric condensed titanium ester, i.e., hexalkoxy titanate. Upon further hydrolysis and under controlled temperature conditions, it is possible to obtain a hydrous polymeric ortho titanate gel of the type represented by the following formula:



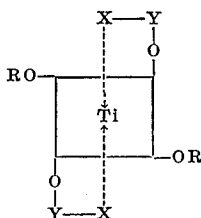
wherein x represents any integer.

Of course the rate of hydrolysis is dependent also upon the size and complexity of the alkyl group; the hydrolysis rate decreasing with increasing alkyl group size. Accordingly, because of the instability of the lower alkyl titanates they well undergo hydrolysis. Thus, the foregoing illustrates one method of forming an ultraviolet absorber of this invention.

Another and more preferred method of preparing the orthotitanic acid absorber of this invention involves hydrolyzing titanium tetrachloride at 0°C by reacting the titanium tetrachloride with ice to form gelatinous

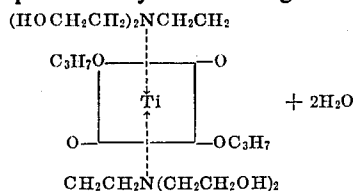
orthotitanic acid having a pH of less than about 5.0. The gel is then filtered and neutralized with an alkaline solution such as dilute ammonium hydroxide thereby forming a colloidal white transparent suspension. The suspension is thereafter reacidified with an organic acid, such as, citric acid to form a crystalline hydrated titanium dioxide precipitate which is further acidified to form a solution containing $Ti(OH)_4$ having a pH in the range of 5.0 to 9.0. The sun-screen agent prepared according to this procedure showed substantially complete absorption of all ultraviolet wave lengths shorter than about 375 nanometers as well as a gradual decreasing gradient of absorption of the higher ultraviolet wave lengths into the lower visible spectrum.

The titanium chelates which form a part of this invention may be satisfactorily utilized as effective sun-screen agents. Since titanium has a balance of four and a coordination number of six, it is possible to form chelated esters by coordinate bonding between titanium and electron-donating atoms, such as, nitrogen and oxygen. Accordingly, upon formation of alkyl esters of titanic acid from ligands such as amino alcohols, keto alcohols, or glycols, the hydroxyl groups of two of the ligand moles replace two alkoxy groups of the ester thereby forming a relatively stable five- or six-membered ring via electron donation from the polar group to titanium. These titanium chelates can be seen as having the following generalized formula:



wherein x is the polar group, i.e. oxygen or nitrogen, and y may be a two or three membered carbon chain thereby resulting in an unstrained five- or six-membered ring. R may be hydrogen, alkyl, or another ligand group. Some of the commercially available chelates are triethanolamine titanate, titanium acetyl acetate, tetra-octylene glycol titanate and titanium lactate. The titanium chelates are relatively stable and generally slow to hydrolyze, although they are soluble in various alcohols and alcohol-water solution, or miscible with water.

The general procedure for preparing the titanium chelate sun-screen agents of this invention involves firstly, formation of the chelate as illustrated by the preferred embodiment and secondly, incorporation of the chelate into a suitable carrier. Specifically, the preferred chelate embodiment of the present invention involves cosmetic compositions having triethanolamine titanate as the ultra-violet absorbing agent. The chelated form of triethanolamine titanate may be prepared by reacting 1 mole of tetraisopropyl titanate with two moles of triethanolamine at about 75°C to give a water soluble, substantially transparent gel wherein the chelate may be presented by the following formula:



When the compounds of this invention are to be applied to the human skin, they may be incorporated in various carriers such as hydroalcoholic lotions, solvent oily solutions, water, water-in-oil and oil-in-water emulsions, creams and other cosmetic preparations. Dual purpose formulations are also contemplated, for example, a combination sun tan and insect repellent lotion. It should also be understood that the invention is not to be limited to these particular formulations but may be incorporated in a variety of topical preparations. In general, the cosmetic formulations desirably contain between 1 and 50 percent of the sun-screen compound, although it should be understood that the concentrations are not critical but depend entirely upon the sun-screen protection desired. Furthermore, since each compound possesses differing ultra-violet wave length absorption abilities, each formulation should be chosen according to the desired effect.

Various embodiments of the invention will be further illustrated by the representative examples as set forth below wherein parts are given by weight unless otherwise indicated.

EXAMPLE 1

This example illustrates one method of forming the basic orthotitanic acid gel.

A 500 ml. beaker was placed in an ice bath and cooled at 0°C. 200 g. of purified titanium tetrachloride, $TiCl_4$, were placed in the beaker and cooled to 0°C. Thereafter, 120 g. of ice were added and mixed with the titanium tetrachloride until a light yellow gel having a pH of about 3.5 was formed. The gel was identified as orthotitanic acid. The gel was then treated with a sufficient amount of ammonium hydroxide to a pH of about 7.0. The neutralized gel was then washed with distilled water and filtered.

EXAMPLE 2

The gelatinous compound of Example 1 was dissolved in distilled water at a ratio of 50 parts orthotitanic acid to 50 parts distilled water. The product was then tested for ultra-violet absorption ability. From the following tabulated results, it is evident that substantially all of the burning wavelengths, as well as a major portion of the shorter tanning rays were absorbed:

TABLE I

Ultra-Violet Wave Lengths Absorbed (Nanometers)	% Absorption
375	100.0
380	97.5
385	81.5
390	58.0
400	18.0
410	12.0
420	4.5
430	0.0

EXAMPLE 3

This example illustrates a further procedure by which a buffered orthotitanic acid sun-screen was obtained.

Thirty-five g. of the gel product from Example 1 were dissolved in 20 g. of distilled water. The pH of the solution was brought to about 6.0 through the addition of 11 g. of a 50 percent ammonium hydroxide solution and 100 ml. of distilled water to obtain a pH of about eight whereupon a colloidal white suspension formed. The hydro-gel was decanted, washed with distilled water and filtered. The gel was then reacidified by mixing one part gel with twenty parts alcohol and a sufficient amount of a 20 percent citric acid solution to form a crystalline precipitate of hydrous orthotitanic acid having a pH of 6-7. The precipitate was filtered from the solution and incorporated into a cosmetic vanishing cream base. The sun-screen formulation had the following composition:

TABLE 2

Formulation	Parts
Hydrous Orthotitanic Acid Gel	150.0
Glyceryl Monosterol	30.0
Stearic Acid	10.0
Mineral Oil	10.0
Sorbitol	15.0
Water	95.0
Spermacetti	14.0
Potassium Hydroxide	0.6
Lanolin	5.0
Perfume, ml.	2.0

The above composition was then tested for ultra-violet absorption abilities by applying it to the skin of a human subject and exposing the subject to sunlight 1 hour between 2:00 and 3:00 P.M. The physical exposure was conducted next to a lake while using a white background. The results 24 hours after exposure indicated that the sun-screen was 100 percent in preventing sunburn.

EXAMPLE 4

This example illustrates the preparation of the preferred chelated form and the sun-screening abilities thereof.

One hundred ml. of tetraispropyl titanate were mixed with 50 ml. of triethanolamine at 75°C to form a chelated triethanolamine titanate product. To this product was added, slowly, 100 ml. of distilled water at 75°C. The mixture was stirred until a thin, relatively transparent gel formed. The product was then tested for ultra-violet absorption ability by dissolving the mixture in distilled water at a ratio of 50 parts of the gel to 50 parts water. From the following tabulated results, it is apparent that substantially all of the burning wavelengths, as well as a portion of the tanning rays were absorbed:

TABLE 3

Ultra-Violet Wave lengths Absorbed (Nanometers)	% Absorption
370	100.0
375	80.0
380	48.5
385	36.0
390	27.5
395	22.0
400	17.5
420	10.0

The PH of the solution was 7.0.

EXAMPLE 5

The gelatinous triethanolamine titanate product of Example 4 was incorporated in the following cream composition and tested for its ultra-violet absorption ability by applying it to the skin of a human subject under the exposure conditions set forth in Example 2.

TABLE 4

Formulation	Parts
Triethanolamine Titanate	250.0
Glyceryl Monosterol	18.0
Stearic Acid	6.0
Mineral Oil	6.0
Sorbitol	4.0
Spermacetti	7.0
Potassium Hydroxide	0.2
Water	
Perfume, ml.	2.0

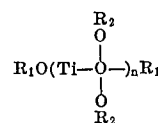
The pH of the formulation was 8.2. The results 24 hours after exposure showed the compound to be 100 percent effective in preventing sunburn.

It will be appreciated that various modifications and changes may be made to the various compounds, compositions, and processes of the invention by those skilled in the art, in addition to those set forth above, without departing from the spirit thereof. For instance, zirconium may be substituted for titanium in the examples given to provide an effective ultra-violet absorber. Therefore, the invention is to be limited only by the scope of the appended claims.

What is claimed is:

1. A method for protecting human skin against actinic radiation in the ultraviolet region of 200N to 400N which comprises applying to the skin a composition comprising:

I. a transparent gelatinous compound of the formula:



a. R_1 and R_2 are independently selected from the group consisting of hydrogen, alkyl groups having from three to eight carbon atoms, triethanolamine, octylene glycol and acetyl acetone,

b. n is the number one, and

II. a dermatologically acceptable carrier; said compound being present in the carrier in an effective sun-screening amount to protect the human skin from the burning wave lengths of actinic radiation.

2. The method of claim 1 wherein both R_1 and R_2 are hydrogen.

3. The method of claim 1 wherein R_1 is isopropyl, and R_2 is triethanolamine.

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