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(54) Title: SUNSCREEN COMPOSITIONS HAVING SYNERGISTIC COMBINATION OF UV FILTERS

(57) Abstract: The disclosure relates to sunscreen compositions having a synergistic combination of ultraviolet light (UV) filtering agents that provide a high sun protection factor (SPF). Compositions according to the disclosure have high SPF values without requiring high total amounts of UV filtering agents. Furthermore, the disclosure relates to methods of using the described compositions for protecting keratinous substances such as skin and hair from UV radiation.

TITLE

SUNSCREEN COMPOSITIONS HAVING SYNERGISTIC COMBINATION OF UV FILTERS

FIELD OF THE DISCLOSURE

The present disclosure relates to sunscreen compositions comprising a synergistic combination of ultra violet ("UV") filters, and to methods of using the combination of UV filters to protect keratinous substrates such as skin and hair from UV radiation.

BACKGROUND

The negative effects of exposure to ultraviolet ("UV") light are well-known. Prolonged exposure to sunlight causes damage such as sunburn to the skin and dries out hair making it brittle. When skin is exposed to UV light having a wavelength of from about 290 nm to about 400 nm, long term damage can lead to serious conditions such as skin cancer.

UV light also contributes to aging by causing free radicals to form in the skin. Free radicals include, for example, singlet oxygen, hydroxyl radical, the superoxide anion, nitric oxide and hydrogen radicals. Free radicals attack DNA, membrane lipids and proteins, generating carbon radicals. These in turn react with oxygen to produce a peroxyl radical that can attack adjacent fatty acids to generate new carbon radicals. This cascade leads to a chain reaction producing lipid peroxidation products. Damage to the cell membrane results in loss of cell permeability, increased intercellular ionic concentration, and decreased ability to excrete or detoxify waste products. The end result is a loss of skin elasticity and the appearance of wrinkles. This process is commonly referred to as photo-aging.

Sunscreens can be used to protect against UV damage and delay the signs of aging. The degree of UV protection afforded by a sunscreen composition is directly related to the amount and type of UV filters contained therein. The higher the amount of UV filters, the greater the degree of UV protection. Nevertheless, it is desirable to achieve the best photo protection efficacy with the lowest amount of UV filters. The inventors of the instant disclosure discovered ways to attain SPFs that were not previously attainable with such low amounts of overall UV filters.

SUMMARY OF THE INVENTION

The present disclosure relates to sunscreen compositions that have low amounts of UV filters yet excellent Sun Protection Factors (SPF). Typically, the more UV filters included in a sunscreen composition the higher the SPF. The inventors discovered that when certain UV filters are combined in particular ratios, they interact synergistically to exhibit a surprisingly effective SPF. This allows for use of less total amounts of UV filters while achieving sufficient SPF.

The present disclosure relates to a sunscreen composition comprising a combination of the UV filters set forth in the table below, wherein drometrizole trisiloxane and terephthalylidene dicamphor sulfonic acid are optionally present:

INCI AND/OR IUPAC NAME	TECHNICAL NAME
Butyl Methoxydibenzoylmethane (INCI)	Avobenzone
Ethylhexyl Triazone (INCI)	Uvinul T150
Drometrizole Trisiloxane	Mexoryl XL
Homosalate (INCI) 3,3,5-Trimethylcyclohexyl 2-hydroxybenzoate (IUPAC)	Homosalate
Ethylhexyl Salicylate (INCI)	Octisalate
Octocrylene (INCI)	Octocrylene
terephthalylidene dicamphor sulfonic acid (INCI)	Mexoryl SX*

*Mexoryl SX is 33% terephthalylidene dicamphor sulfonic acid.

The ratio of each filter relative to butyl methoxydibenzoylmethane in the sunscreen compositions is typically as follows:

the ratio of ethylhexyl triazone to butyl methoxydibenzoylmethane is 0.5:1.0 to 0.8:1.0;

the ratio of drometrizole trisiloxane to butyl methoxydibenzoylmethane is 0:1.0 to 0.5:1.0;

The ratio of homosalate to butyl methoxydibenzoylmethane is 0.4:1.0 to 0.7:1.0;

the ratio of ethylhexyl salicylate to butyl methoxydibenzoylmethane is 0.5:1.0 to 0.8:1.0;

the ratio of octocrylene to butyl methoxydibenzoylmethane is 1.0:1.0 to 1.5:1.0; and

the ratio of terephthalylidene dicamphor sulfonic acid to butyl methoxydibenzoylmethane is about 0:1.0 to 0.1:1.0.

In particular, the ratio of each filter relative to butyl methoxydibenzoylmethane may be about 1.0 : 0.7 : 0.4 : 0.4 : 0.7 : 1.2 : 0.1 (butyl methoxydibenzoylmethane: ethylhexyl triazone : drometrizole trisiloxane : homosalate : ethylhexyl salicylate : octocrylene : terephthalylidene dicamphor sulfonic acid). Likewise, the ratio fo each filter relative to butyl methoxydibenzoylmethane may be about 1.0 : 0.5 : 0.3 : 0.6 : 0.6 : 1.1 : 0.1 (butyl methoxydibenzoylmethane: ethylhexyl triazone : drometrizole trisiloxane : homosalate : ethylhexyl salicylate : octocrylene : terephthalylidene dicamphor sulfonic acid).

In one embodiment the UV filters can be separately, or in addition to the ratios set forth above, present in the following percentages by weight relative to the entire weight of the sunscreen composition:

2.7 to 6.7 wt.% butyl methoxydibenzoylmethane;

1.8 to 4.6 wt.% ethylhexyl triazone;

0 to 2.8 wt.% drometrizole trisiloxane;

1.0 to 3.0 wt.% homosalate;

1.8 to 4.4 wt.% ethylhexyl salicylate;

3.4 to 8.3 wt.% octocrylene; and

0 to about 0.6 wt.% terephthalylidene dicamphor sulfonic acid.

In some instances, the UV filters are present in the following percentages by weight relative to the entire weight of the sunscreen composition: about 3.4 wt.% butyl methoxydibenzoylmethane, about 2.3 wt.% ethylhexyl triazone, about 1.4 wt.% drometrizole trisiloxane, about 1.5 wt.% homosalate, about 2.2 wt.% ethylhexyl salicylate, about 4.2 wt.% octocrylene, and about 0.3 wt.% terephthalylidene dicamphor sulfonic acid. Likewise, the UV filters may be present in the following percentages by weight relative to the entire weight of the sunscreen composition: about 4.1 wt.% butyl methoxydibenzoylmethane, about 2.0 wt.% ethylhexyl triazone, about 1.4 wt.% drometrizole trisiloxane, about 2.6 wt.% homosalate, about 2.4 wt.% ethylhexyl salicylate, about 4.3 wt.% octocrylene, and about 0.3 wt.% terephthalylidene dicamphor sulfonic acid.

In some cases, the ratio of each filter relative to butyl methoxydibenzoylmethane in the sunscreen compositions is typically as follows:

the ratio of ethylhexyl triazone to butyl methoxydibenzoylmethane is 0.67:1.0 to 1.14:1.0;

the ratio of drometrizole trisiloxane to butyl methoxydibenzoylmethane is 0:1.0 to 0.57:1.0;

The ratio of homosalate to butyl methoxydibenzoylmethane is 0.11:1.0 to 0.57:1.0;

the ratio of ethylhexyl salicylate to butyl methoxydibenzoylmethane is 0.76:1.0 to 1.29:1.0;

the ratio of octocrylene to butyl methoxydibenzoylmethane is 0.89:1.0 to 1.71:1.0; and

the ratio of terephthalylidene dicamphor sulfonic acid to butyl methoxydibenzoylmethane is about 0:1.0 to about 0.1:1.0.

In particular, the ratio of each filter relative to butyl methoxydibenzoylmethane may be about 1.0 : 1.0 : 0.3 : 0.2 : 0.9 : 1.2 : 0.1 (butyl methoxydibenzoylmethane : ethylhexyl triazone : drometrizole trisiloxane : homosalate : ethylhexyl salicylate : octocrylene : terephthalylidene dicamphor sulfonic acid). Likewise, the ratio fo each filter relative to butyl methoxydibenzoylmethane may be about 1.0 : 0.9 : 0.3 : 0.5 : 0.9 : 1.3 : 0.1 (butyl methoxydibenzoylmethane : ethylhexyl triazone : drometrizole trisiloxane : homosalate : ethylhexyl salicylate : octocrylene : terephthalylidene dicamphor sulfonic acid).

In one embodiment the UV filters can be separately, or in addition to the ratios set forth above, present in the following percentages by weight relative to the entire weight of the sunscreen composition:

3.5 to 4.5 wt.% butyl methoxydibenzoylmethane;

3.0 to 4.0 wt.% ethylhexyl triazone;

0 to 2.0 wt.% drometrizole trisiloxane;

0.5 to 2.0 wt.% homosalate;

3.4 to 4.5 wt.% ethylhexyl salicylate;

4.0 to 6.0 wt.% octocrylene; and

0 to 0.6 wt.% terephthalylidene dicamphor sulfonic acid.

In some instances, the UV filters are present in the following percentages by weight relative to the entire weight of the sunscreen composition: about 4.2 wt.% butyl methoxydibenzoylmethane, about 4.0 wt.% ethylhexyl triazone, about 1.4 wt.% drometrizole trisiloxane, about 1.0 wt.% homosalate, about 3.8 wt.% ethylhexyl salicylate, about 5.0 wt.% octocrylene, and about 0.3 wt.% terephthalylidene dicamphor sulfonic acid. Likewise, the UV filters may be present in the following percentages by weight relative to the entire weight of the sunscreen composition: about 3.8 wt.% butyl methoxydibenzoylmethane, about 3.4 wt.% ethylhexyl triazone, about 1.0 wt.% drometrizole trisiloxane, about 1.75 wt.% homosalate, about 3.4 wt.% ethylhexyl salicylate, about 5.0 wt.% octocrylene, and about 0.3 wt.% terephthalylidene dicamphor sulfonic acid.

Further, in some cases, the ratio of each filter relative to butyl methoxydibenzoylmethane in the sunscreen compositions is typically as follows:

the ratio of ethylhexyl triazone to butyl methoxydibenzoylmethane is 0.67:1.0 to 1.14:1.0;

the ratio of drometrizole trisiloxane to butyl methoxydibenzoylmethane is 0:1.0 to 0.57:1.0;

The ratio of homosalate to butyl methoxydibenzoylmethane is 0.33:1.0 to 0.71:1.0;

the ratio of ethylhexyl salicylate to butyl methoxydibenzoylmethane is 0.33:1.0 to 0.71:1.0;

the ratio of octocrylene to butyl methoxydibenzoylmethane is 0.89:1.0 to 1.43:1.0; and

the ratio of terephthalylidene dicamphor sulfonic acid to butyl methoxydibenzoylmethane is 0:1.0 to 0.086:1.0.

In particular, the ratio of each filter relative to butyl methoxydibenzoylmethane may be about 1.0 : 0.9 : 0.4 : 0.7 : 0.5 : 1.1 : 0.1 (butyl methoxydibenzoylmethane : ethylhexyl triazone : drometrizole trisiloxane : homosalate : ethylhexyl salicylate : octocrylene : terephthalylidene dicamphor sulfonic acid).

In one embodiment the UV filters can be separately, or in addition to the ratios set forth above, present in the following percentages by weight relative to the entire weight of the sunscreen composition:

3.5 to 4.5 wt.% butyl methoxydibenzoylmethane;

3.0 to 4.0 wt.% ethylhexyl triazone;

0 to 2.0 wt.% drometrizole trisiloxane;

1.5 to 2.5 wt.% homosalate;

1.5 to 2.5 wt.% ethylhexyl salicylate;

4.0 to 5.0 wt.% octocrylene; and

0 to 0.6 wt.% terephthalylidene dicamphor sulfonic acid.

In some instances, the UV filters are present in the following percentages by weight relative to the entire weight of the sunscreen composition: about 3.8 wt.% butyl methoxydibenzoylmethane, about 3.4 wt.% ethylhexyl triazone, about 1.4 wt.% drometrizole trisiloxane, about 2.5 wt.% homosalate, about 1.8 wt.% ethylhexyl salicylate, about 4.2 wt.% octocrylene, and about 0.3 wt.% terephthalylidene dicamphor sulfonic acid.

The present disclosure is also directed to methods of protecting a keratinous substrate from ultraviolet radiation, methods of absorbing ultraviolet light, and method for preventing sun damage and/or sun burn to a keratinous substrate such as skin or hair. Such methods encompass applying a sunscreen composition to a keratinous substrate (such as the skin or hair) and subjecting the keratinous substrate to ultraviolet radiation.

DETAILED DESCRIPTION

Where the following terms are used in this specification, they are used as defined below.

The terms “comprising,” “having,” and “including” are used in their open, non-limiting sense.

The terms “a” and “the” are understood to encompass the plural as well as the singular.

As used herein, the expression “at least one” means one or more and thus includes individual components as well as mixtures/combinations.

"Cosmetically acceptable" means that the item in question is compatible with any keratinous substrate. For example, "cosmetically acceptable carrier" means a carrier that is compatible with any keratinous substrate.

A "physiologically acceptable medium" means a medium which is not toxic and can be applied to the skin, lips, hair, scalp, lashes, brows, nails or any other cutaneous region of the body. The composition of the instant disclosure may especially constitute a cosmetic or dermatological composition.

A "sunscreen composition" as used herein, is meant to include a composition for topical application to sun-exposed areas of the skin and/or hair of mammals, especially humans. Such a composition may be generally classified as leave-on or rinse off, and includes any product applied to a human body for also improving appearance, cleansing, odor control or general aesthetics. The composition of the present invention can be in the form of a liquid, lotion, cream, foam, scrub, gel, soap bar or toner, or applied with an implement or via a face mask, pad or patch. Non-limiting examples of such sunscreen compositions include leave-on skin lotions, creams, antiperspirants, deodorants, lipsticks, foundations, mascara, sunless tanners and sunscreen lotions and wash-off shampoos, conditioners, shower gels, toilet bars. In some cases, the sunscreen composition is clear. Also, the sunscreen composition may be a spray-on sunscreen composition.

The phrase "essentially free" refers to less than or equal to 0.5, 0.1, 0.05 or 0.01 wt.%.

The phrase "stable emulsion" refers to a composition that does not undergo phase separation up to a temperature of 45°C for at least two weeks.

A "clear" composition refers to a composition that is visually clear to the naked eye. For example, the compositions may have a turbidity measurement of less than 30 NTU. Distilled water has a turbidity of 1 NTU and whole milk diluted 1 part in 350 parts of distilled water has a turbidity of 200 NTU.

In one embodiment, the present disclosure relates to a sunscreen composition having a combination of the following UV filters: butyl methoxydibenzoylmethane, ethylhexyl triazone, drometrizole trisiloxane, homosalate, ethylhexyl salicylate, octocrylene, and terephthalylidene dicamphor sulfonic acid, wherein the ratio of each UV filter relative to butyl methoxydibenzoylmethane is as follows:

The ratio of each filter relative to butyl methoxydibenzoylmethane in the sunscreen compositions is typically as follows:

the ratio of ethylhexyl triazone to butyl methoxydibenzoylmethane is 0.5:1.0 to 0.8:1.0;

the ratio of drometrizole trisiloxane to butyl methoxydibenzoylmethane is 0:1.0 to 0.5:1.0;

The ratio of homosalate to butyl methoxydibenzoylmethane is 0.4:1.0 to 0.7:1.0;

the ratio of ethylhexyl salicylate to butyl methoxydibenzoylmethane is 0.5:1.0 to 0.8:1.0;

the ratio of octocrylene to butyl methoxydibenzoylmethane is 1.0:1.0 to 1.5:1.0; and

the ratio of terephthalylidene dicamphor sulfonic acid to butyl methoxydibenzoylmethane is about 0:1.0 to 0.1:1.0.

As shown above the bottom range for the ratio of drometrizole trisiloxane and terephthalylidene dicamphor sulfonic acid to butyl methoxydibenzoylmethane is zero (indicating that the UV filter is not present). In some cases one or both of these UV filters may be present, and the bottom end for the ratios is 0.05:1.0 (drometrizole trisiloxane or terephthalylidene dicamphor sulfonic acid : butyl methoxydibenzoylmethane).

Furthermore, the ratio of each filter relative to butyl methoxydibenzoylmethane in the sunscreen compositions may be as follows:

the ratio of ethylhexyl triazone to butyl methoxydibenzoylmethane is 0.5:1.0 to 0.8:1.0;

the ratio of drometrizole trisiloxane to butyl methoxydibenzoylmethane is 0.3:1.0 to 0.5:1.0;

The ratio of homosalate to butyl methoxydibenzoylmethane is 0.4:1.0 to 0.7:1.0;

the ratio of ethylhexyl salicylate to butyl methoxydibenzoylmethane is 0.5:1.0 to 0.8:1.0;

the ratio of octocrylene to butyl methoxydibenzoylmethane is 1.0:1.0 to 1.5:1.0; and

the ratio of terephthalylidene dicamphor sulfonic acid to butyl methoxydibenzoylmethane is about 0.1:1.0

In particular, the ratio of each filter relative to butyl methoxydibenzoylmethane may be about 1.0 : 0.7 : 0.4 : 0.4 : 0.7 : 1.2 : 0.1 (butyl methoxydibenzoylmethane : ethylhexyl triazone : drometrizole trisiloxane : homosalate : ethylhexyl salicylate : octocrylene : terephthalylidene dicamphor sulfonic acid). Likewise, the ratio fo each filter relative to butyl methoxydibenzoylmethane may be about 1.0 : 0.5 : 0.3 : 0.6 : 0.6 : 1.1 : 0.1 (butyl methoxydibenzoylmethane : ethylhexyl triazone : drometrizole trisiloxane : homosalate : ethylhexyl salicylate : octocrylene : terephthalylidene dicamphor sulfonic acid).

In some instances, the total amount of the combination of UV filters is at least 1 wt.% but not more than 40 wt.%, 35 wt.%,30 wt.%, 25 wt.%, or 20 wt.% based on the total weight of the sunscreen composition. Additionally, in some cases, none of the individual UV filters of the combination are present in an amount greater than 10 wt.%, 9 wt.%, 8 wt.%, 7 wt.%, 6 wt.%, or 5 wt.%. For example, the sunscreen composition may comprise:

not more than 7 wt.% butyl methoxydibenzoylmethane;

not more than 5 wt.% ethylhexyl triazone;

not more than 3 wt.% drometrizole trisiloxane;

not more than 4 wt.% homosalate;

not more than 4 wt.% ethylhexyl salicylate;

not more than 9 wt.% octocrylene; and

not more than 0.7 wt.% terephthalylidene dicamphor sulfonic acid.

In some instances, the UV filters can be separately, or in addition to the ratios set forth above, present in the following percentages by weight relative to the entire weight of the sunscreen composition:

2.7 to 6.7 wt.% butyl methoxydibenzoylmethane;

1.8 to 4.6 wt.% ethylhexyl triazone;

0 to 2.8 wt.% drometrizole trisiloxane;

1.0 to 3.0 wt.% homosalate;

1.8 to 4.4 wt.% ethylhexyl salicylate;

3.4 to 8.3 wt.% octocrylene; and

0 to 0.6 wt.% terephthalylidene dicamphor sulfonic acid.

As shown above, the drometrizole trisiloxane and the terephthalylidene dicamphor sulfonic acid may not be present in the sunscreen compositions. Alternatively, drometrizole trisiloxane may be present in a positive amount, or from 0.1 wt.% to 2.8 wt.%. Likewise, the terephthalylidene dicamphor sulfonic acid may be present in a positive amount, or from 0.1 wt.% to 0.6 wt.%. In some cases, the amount of terephthalylidene dicamphor sulfonic acid is present in an amount of about 0.3 wt.%.

More specifically, the sunscreen composition may have the following amounts of UV filters:

about 3.1 wt.% to about 3.7 wt. % of butyl methoxydibenzoylmethane;
about 2.1 wt.% to about 2.5 wt.% ethylhexyl triazone;
about 1.3 wt.% to about 1.5 wt.% drometrizole trisiloxane;
about 1.4 wt.% to about 1.7 wt.% homosalate;
about 2.0 wt.% to about 2.4 wt.% ethylhexyl salicylate;
about 3.8 wt.% to about 4.6 wt.% octocrylene; and
about 0.1 wt.% to about 0.5 wt.% terephthalylidene dicamphor sulfonic acid.

In some cases, the terephthalylidene dicamphor sulfonic acid is in an amount of about 0.3 wt.%.

The total amount of the combination of UV filters can vary depending on the desired SPF and overall UV filtering strength of a final sunscreen composition. In one aspect, the total amount of the combination of UV filters in a sunscreen combination is about 50, 40, 30, 25, 20, 19, 18, 17, 16, 15, 14, 13, 12, 11, 10, 9, 8, 7, 6, 5, 4, 3, 2, or 1 wt.% or less, so long as a positive amount of the combination of UV filters is present. In another aspect, the sunscreen formulation has an SPF value that is at least about 5, 10, 15, 16, 17, 18, 19, 20, 21, 22, or 23 times the total weight percent of the combination of UV filters of the sunscreen compositions. For example, as shown in the examples, it is possible for a composition comprising about 15.3 wt.% of a total combination of UV filters to exhibit an in vitro SPF of 329 (Example 1) (the SPF is about 21.5 times higher than the total amount of the combination of UV filters used in the composition). In Example 2, the SPF is about

23.7 times higher than the total amount of the combination of UV filters used in the composition.

The present disclosure makes it possible to achieve the described SPFs in sunscreen compositions without the use of boosters, or essentially free of boosters, *e.g.*, sorbeth-2-hexaoleate. Although boosters may be included in the sunscreen compositions of the instant disclosure, they are not required. In some cases, a booster is included in the sunscreen compositions to further raise the SPF beyond the amount achieved by the synergistic combination of UV filters alone.

Sunscreen compositions according to the present embodiment can be formulated to achieve a variety of different SPFs. For example, the sunscreen formulations can have an in vitro or in vivo SPF of at least 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95, 100, 105, 110, 115, 120, 125, 135, 150, 175, 200, 225, 250, 300. 325, 350, 375, 400 or higher (or in a range between any of these values).

In a second embodiment, the present disclosure relates to a sunscreen composition having a combination of the following UV filters: butyl methoxydibenzoylmethane, ethylhexyl triazone, drometrizole trisiloxane, homosalate, ethylhexyl salicylate, octocrylene, and terephthalylidene dicamphor sulfonic acid, wherein the ratio of each UV filter relative to butyl methoxydibenzoylmethane is as follows:

the ratio of ethylhexyl triazone to butyl methoxydibenzoylmethane is 0.67:1.0 to 1.14:1.0;

the ratio of drometrizole trisiloxane to butyl methoxydibenzoylmethane is 0:1.0 to 0.57:1.0;

The ratio of homosalate to butyl methoxydibenzoylmethane is 0.11:1.0 to 0.57:1.0;

the ratio of ethylhexyl salicylate to butyl methoxydibenzoylmethane is 0.76:1.0 to 1.29:1.0;

the ratio of octocrylene to butyl methoxydibenzoylmethane is 0.89:1.0 to 1.71:1.0; and

the ratio of terephthalylidene dicamphor sulfonic acid to butyl methoxydibenzoylmethane is about about 0:1.0 to about 0.1:1.0.

As shown above the bottom range for the ratio of drometrizole trisiloxane and terephthalylidene dicamphor sulfonic acid to butyl methoxydibenzoylmethane is zero (indicating that the UV filter is not present). In some cases one or both of these UV filters may be present, and the bottom end for the ratios is 0.05:1.0 (drometrizole trisiloxane or terephthalylidene dicamphor sulfonic acid : butyl methoxydibenzoylmethane).

Furthermore, the ratio of each filter relative to butyl methoxydibenzoylmethane in the sunscreen compositions may be as follows:

the ratio of ethylhexyl triazone to butyl methoxydibenzoylmethane is 0.67:1.0 to 1.14:1.0;

the ratio of drometrizole trisiloxane to butyl methoxydibenzoylmethane is 0.22:1.0 to 0.57:1.0;

The ratio of homosalate to butyl methoxydibenzoylmethane is 0.11:1.0 to 0.57:1.0;

the ratio of ethylhexyl salicylate to butyl methoxydibenzoylmethane is 0.76:1.0 to 1.29:1.0;

the ratio of octocrylene to butyl methoxydibenzoylmethane is 0.89:1.0 to 1.71:1.0; and

the ratio of terephthalylidene dicamphor sulfonic acid to butyl methoxydibenzoylmethane is about 0.067:1.0 to about 0.086:1.0.

Moreover, the ratio of each filter relative to butyl methoxydibenzoylmethane in the sunscreen compositions may be as follows:

the ratio of ethylhexyl triazone to butyl methoxydibenzoylmethane is 0.9:1.0 to 1.0:1.0;

the ratio of drometrizole trisiloxane to butyl methoxydibenzoylmethane is 0.32:1.0 to 0.35:1.0;

The ratio of homosalate to butyl methoxydibenzoylmethane is 0.23:1.0 to 0.25:1.0;

the ratio of ethylhexyl salicylate to butyl methoxydibenzoylmethane is 0.86:1.0 to 0.95:1.0;

the ratio of octocrylene to butyl methoxydibenzoylmethane is 1.13:1.0 to 1.25:1.0; and

the ratio of terephthalylidene dicamphor sulfonic acid to butyl methoxydibenzoylmethane is 0.068:1.0 to 0.075:1.0.

In particular, the ratio of each filter relative to butyl methoxydibenzoylmethane may be about 1.0 : 1.0 : 0.3 : 0.2 : 0.9 : 1.2 : 0.1 (butyl methoxydibenzoylmethane : ethylhexyl triazone : drometrizole trisiloxane : homosalate : ethylhexyl salicylate : octocrylene : terephthalylidene dicamphor sulfonic acid). Likewise, the ratio fo each filter relative to butyl methoxydibenzoylmethane may be about 1.0 : 0.9 : 0.3 : 0.5 : 0.9 : 1.3 : 0.1 (butyl methoxydibenzoylmethane : ethylhexyl triazone : drometrizole trisiloxane : homosalate : ethylhexyl salicylate : octocrylene : terephthalylidene dicamphor sulfonic acid).

In some instances, the total amount of the combination of UV filters is at least 1 wt.% but not more than 40 wt.%, 35 wt.%,30 wt.%, 25 wt.%, or 20 wt.% based on the total weight of the sunscreen composition. Additionally, in some cases, none of the individual UV filters of the combination are present in an amount greater than 10 wt.%, 9 wt.%, 8 wt.%, 7 wt.%, 6 wt.%, or 5 wt.%. For example, the sunscreen composition may comprise:

not more than 5 wt.% butyl methoxydibenzoylmethane;

not more than 4 wt.% ethylhexyl triazone;

not more than 2 wt.% drometrizole trisiloxane;

not more than 3 wt.% homosalate;

not more than 4 wt.% ethylhexyl salicylate;

not more than 5 wt.% octocrylene; and

not more than 2 wt.% terephthalylidene dicamphor sulfonic acid.

In some instances, the UV filters can be separately, or in addition to the ratios set forth above, present in the following percentages by weight relative to the entire weight of the sunscreen composition:

3.5 to 4.5 wt.% butyl methoxydibenzoylmethane;

3.0 to 4.0 wt.% ethylhexyl triazone;

0 to 2.0 wt.% drometrizole trisiloxane;

0.5 to 2.0 wt.% homosalate;

3.4 to 4.5 wt.% ethylhexyl salicylate;

4.0 to 6.0 wt.% octocrylene; and

0 to 0.6 wt.% terephthalylidene dicamphor sulfonic acid.

As shown above, the drometrizole trisiloxane and the terephthalylidene dicamphor sulfonic acid may not be present in the sunscreen compositions. Alternatively, drometrizole trisiloxane may be present in a positive amount, or from 1.0 wt.% to 2.0 wt.%. Likewise, the terephthalylidene dicamphor sulfonic acid may be present in a positive amount, or from 0.1 wt.% to 0.6 wt.%. In some cases, the amount of terephthalylidene dicamphor sulfonic acid is present in an amount of about 0.3 wt.%.

More specifically, the sunscreen composition may have the following amounts of UV filters:

about 3.5 wt.% to about 4.5 wt. % of butyl methoxydibenzoylmethane;
about 3.0 wt.% to about 4.0 wt.% ethylhexyl triazone;
about 1.0 wt.% to about 2.0 wt.% drometrizole trisiloxane;
about 0.5 wt.% to about 2.0 wt.% homosalate;
about 3.4 wt.% to about 4.5 wt.% ethylhexyl salicylate;
about 4.0 wt.% to about 6.0 wt.% octocrylene; and
about 0.1 wt.% to about 0.5 wt.% terephthalylidene dicamphor sulfonic acid.

In some cases, the terephthalylidene dicamphor sulfonic acid is in an amount of about 0.3 wt.%.

The total amount of the combination of UV filters can vary depending on the desired SPF and overall UV filtering strength of a final sunscreen composition. In one aspect, the total amount of the combination of UV filters in a sunscreen combination is about 50, 40, 30, 25, 20, 19, 18, 17, 16, 15, 14, 13, 12, 11, 10, 9, 8, 7, 6, 5, 4, 3, 2, or 1 wt.% or less, so long as a positive amount of the combination of UV filters is present. In another aspect, the sunscreen formulation has an SPF value that is at least about 5, 10, 15, 20, 21, 22, 23, 24, 25, 26, 27, or 28 times the total weight percent of the combination of UV filters of the sunscreen compositions. For example, as shown in the examples, it is possible for a composition comprising about 19.7 wt.% of a total combination of UV filters to exhibit an in vitro SPF of 555 (Example 1) (the SPF is about 28.2 times higher than the total amount of the combination of UV filters used in the composition). In Example 2, the SPF is about

26.1 times higher than the total amount of the combination of UV filters used in the composition.

The present disclosure makes it possible to achieve the described SPFs in sunscreen compositions without the use of boosters, or essentially free of boosters, *e.g.*, sorbeth-2-hexaoleate. Although boosters may be included in the sunscreen compositions of the instant disclosure, they are not required. In some cases, a booster is included in the sunscreen compositions to further raise the SPF beyond the amount achieved by the synergistic combination of UV filters alone.

Sunscreen compositions according to the second embodimenrt can be formulated to achieve a variety of different in vitro or in vivo SPFs. For example, the sunscreen formulations can have an SPF of at least 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95, 100, 105, 110, 115, 120, 125, 135, 150, 175, 200, 225, 250, 300. 325, 350, 375, 400. 425, 450, 475, 500, 525, 550, or higher (or in a range between any of these values).

In a third embodiment, the present disclosure relates to a sunscreen composition having a combination of the following UV filters: butyl methoxydibenzoylmethane, ethylhexyl triazone, drometrizole trisiloxane, homosalate, ethylhexyl salicylate, octocrylene, and terephthalylidene dicamphor sulfonic acid, wherein the ratio of each UV filter relative to butyl methoxydibenzoylmethane is as follows:

The ratio of each filter relative to butyl methoxydibenzoylmethane in the sunscreen compositions is typically as follows:

the ratio of ethylhexyl triazone to butyl methoxydibenzoylmethane is 0.67:1.0 to 1.14:1.0;

the ratio of drometrizole trisiloxane to butyl methoxydibenzoylmethane is 0:1.0 to 0.57:1.0;

The ratio of homosalate to butyl methoxydibenzoylmethane is 0.33:1.0 to 0.71:1.0;

the ratio of ethylhexyl salicylate to butyl methoxydibenzoylmethane is 0.33:1.0 to 0.71:1.0;

the ratio of octocrylene to butyl methoxydibenzoylmethane is 0.89:1.0 to 1.43:1.0; and

the ratio of terephthalylidene dicamphor sulfonic acid to butyl methoxydibenzoylmethane is 0:1.0 to 0.086:1.0.

As shown above the bottom range for the ratio of drometrizole trisiloxane and terephthalylidene dicamphor sulfonic acid to butyl methoxydibenzoylmethane is zero (indicating that the UV filter is not present). In some cases one or both of these UV filters may be present, and the bottom end for the ratios is 0.05:1.0 (drometrizole trisiloxane or terephthalylidene dicamphor sulfonic acid : butyl methoxydibenzoylmethane).

Furthermore, the ratio of each filter relative to butyl methoxydibenzoylmethane in the sunscreen compositions may be as follows:

the ratio of ethylhexyl triazone to butyl methoxydibenzoylmethane is 0.67:1.0 to 1.14:1.0;

the ratio of drometrizole trisiloxane to butyl methoxydibenzoylmethane is 0.30:1.0 to 0.57:1.0;

The ratio of homosalate to butyl methoxydibenzoylmethane is 0.33:1.0 to 0.71:1.0;

the ratio of ethylhexyl salicylate to butyl methoxydibenzoylmethane is 0.33:1.0 to 0.71:1.0;

the ratio of octocrylene to butyl methoxydibenzoylmethane is 0.89:1.0 to 1.43:1.0; and

the ratio of terephthalylidene dicamphor sulfonic acid to butyl methoxydibenzoylmethane is 0.050:1.0 to 0.086:1.0.

Moverover, the ratio of each filter relative to butyl methoxydibenzoylmethane in the sunscreen compositions may be as follows:

the ratio of ethylhexyl triazone to butyl methoxydibenzoylmethane is 0.85:1.0 to 0.94:1.0;

the ratio of drometrizole trisiloxane to butyl methoxydibenzoylmethane is 0.35:1.0 to 0.39:1.0;

The ratio of homosalate to butyl methoxydibenzoylmethane is 0.63:1.0 to 0.69:1.0;

the ratio of ethylhexyl salicylate to butyl methoxydibenzoylmethane is 0.45:1.0 to 0.50:1.0;

the ratio of octocrylene to butyl methoxydibenzoylmethane is 1.05:1.0 to 1.16:1.0; and

the ratio of terephthalylidene dicamphor sulfonic acid to butyl methoxydibenzoylmethane is 0.075:1.0 to 0.083:1.0.

In particular, the ratio of each filter relative to butyl methoxydibenzoylmethane may be about 1.0 : 0.9 : 0.4 : 0.7 : 0.5 : 1.1 : 0.1 (butyl methoxydibenzoylmethane : ethylhexyl triazone : drometrizole trisiloxane : homosalate : ethylhexyl salicylate : octocrylene : terephthalylidene dicamphor sulfonic acid).

In some instances, the total amount of the combination of UV filters is at least 1 wt.% but not more than 40 wt.%, 35 wt.%,30 wt.%, 25 wt.%, or 20 wt.% based on the total weight of the sunscreen composition. Additionally, in some cases, none of the individual UV filters of the combination are present in an amount greater than 10 wt.%, 9 wt.%, 8 wt.%, 7 wt.%, 6 wt.%, or 5 wt.%. For example, the sunscreen composition may comprise:

not more than 5 wt.% butyl methoxydibenzoylmethane;

not more than 4 wt.% ethylhexyl triazone;

not more than 2 wt.% drometrizole trisiloxane;

not more than 3 wt.% homosalate;

not more than 3 wt.% ethylhexyl salicylate;

not more than 5 wt.% octocrylene; and

not more than 1 wt.% terephthalylidene dicamphor sulfonic acid.

In some instances, the UV filters can be separately, or in addition to the ratios set forth above, present in the following percentages by weight relative to the entire weight of the sunscreen composition:

3.5 to 4.5 wt.% butyl methoxydibenzoylmethane;

3.0 to 4.0 wt.% ethylhexyl triazone;

0 to 2.0 wt.% drometrizole trisiloxane;

1.5 to 2.5 wt.% homosalate;

1.5 to 2.5 wt.% ethylhexyl salicylate;

4.0 to 5.0 wt.% octocrylene; and

0 to 0.6 wt.% terephthalylidene dicamphor sulfonic acid.

As shown above, the drometrizole trisiloxane and the terephthalylidene dicamphor sulfonic acid may not be present in the sunscreen compositions. Alternatively, drometrizole trisiloxane may be present in a positive amount, or from 1.0 wt.% to 2.0 wt.%. Likewise, the terephthalylidene dicamphor sulfonic acid may be present in a positive amount, or from 0.1 wt.% to 0.6 wt.%. In some cases, the amount of terephthalylidene dicamphor sulfonic acid is present in an amount of about 0.3 wt.%.

More specifically, the sunscreen composition may have the following amounts of UV filters:

about 3.5 to about 4.5 wt.% butyl methoxydibenzoylmethane;

about 3.0 to about 4.0 wt.% ethylhexyl triazone;

about 1.0 to about 2.0 wt.% drometrizole trisiloxane;

about 1.5 to about 2.5 wt.% homosalate;

about 1.5 to about 2.5 wt.% ethylhexyl salicylate;

about 4.0 to about 5.0 wt.% octocrylene; and

about 0.1 to about 0.5 wt.% terephthalylidene dicamphor sulfonic acid.

In some cases, the terephthalylidene dicamphor sulfonic acid is in an amount of about 0.3 wt.%.

The total amount of the combination of UV filters can vary depending on the desired SPF and overall UV filtering strength of a final sunscreen composition. In one aspect, the total amount of the combination of UV filters in a sunscreen combination is about 50, 40, 30, 25, 20, 19, 18, 17, 16, 15, 14, 13, 12, 11, 10, 9, 8, 7, 6, 5, 4, 3, 2, or 1 wt.% or less, so long as a positive amount of the combination of UV filters is present. In another aspect, the sunscreen formulation has an SPF value that is at least about 5, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, or 20 times the total weight percent of the combination of UV filters of the sunscreen compositions. For example, as shown in the examples, it is possible for a composition comprising about 17.4 wt.% of a total combination of UV filters to exhibit an in vitro SPF of 358 (Example 1) (the SPF is about 20.6 times higher than the total amount of the combination of UV filters used in the composition).

The present disclosure makes it possible to achieve the described SPFs in sunscreen compositions without the use of boosters, or essentially free of boosters, *e.g.*, sorbeth-2-hexaoleate. Although boosters may be included in the sunscreen compositions of the instant disclosure, they are not required. In some cases, a booster is included in the sunscreen compositions to further raise the SPF beyond the amount achieved by the synergistic combination of UV filters alone.

Sunscreen compositions according to the third embodiment can be formulated to achieve a variety of different SPFs. For example, the sunscreen formulations can have an in vitro or in vivo SPF of at least 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95, 100, 105, 110, 115, 120, 125, 135, 150, 175, 200, 225, 250, 300. 325, 350, or higher (or in a range between any of these values).

The present disclosure is also directed to methods for protecting a keratinous substrate from ultraviolet radiation and to methods of absorbing ultraviolet light. Such methods encompass applying a sunscreen composition to a keratinous substrate and subjecting the keratinous substrate to ultraviolet radiation.

Oils/Emollients

Examples of oils/emollients that may be included in the sunscreen compositions include: hydrocarbon-based oils of plant origin, such as liquid triglycerides of fatty acids containing from 4 to 10 carbon atoms, for instance heptanoic or octanoic acid triglycerides, or alternatively, for example, sunflower oil, corn oil, soybean oil, marrow oil, grapeseed oil, sesameseed oil, hazelnut oil, apricot oil, macadamia oil, arara oil, coriander oil, castor oil, avocado oil, caprylic/capric acid triglycerides, for instance those sold by the company Stearineries Dubois or those sold under the names Miglyol 810, 812 and 818 by the company Dynamit Nobel, jojoba oil, shea butter oil and caprylyl glycol; synthetic esters and ethers, especially of fatty acids, for instance Purcellin oil, 2-octyldodecyl stearate, 2-octyldodecyl erucate, isostearyl isostearate; hydroxylated esters, for instance isostearyl lactate, octyl hydroxystearate, octyldodecyl hydroxystearate, diisostearyl malate or triisocetyl citrate; fatty alcohol heptanoates, octanoates or decanoates; polyol esters, for instance propylene glycol dioctanoate, neopentyl glycol diheptanoate and diethylene glycol diisononanoate; and pentaerythritol esters, for instance pentaerythrityl tetraisostearate, or isopropyl lauroyl sarcosinate, sold especially under the trade name Eldew SL 205 by the company Ajinomoto; linear or branched hydrocarbons, of

mineral or synthetic origin, such as volatile or non-volatile liquid paraffins, and derivatives thereof, petroleum jelly, polydecenes, isohexadecane, isododecane, hydrogenated polyisobutene such as Parleam oil, or the mixture of n-undecane (C_{11}) and of n-tridecane (C_{13}) sold under the reference Cetiol UT by the company Cognis; fluoro oils that are partially hydrocarbon-based and/or silicone-based, for instance those described in document JP-A-2 295 912; silicone oils, for instance volatile or non-volatile polymethylsiloxanes (PDMS) with a linear or cyclic silicone chain, which are liquid or pasty at room temperature, in particular volatile silicone oils, especially cyclopolydimethylsiloxanes (cyclomethicones) such as cyclohexadimethylsiloxane and cyclopentadimethylsiloxane; polydimethylsiloxanes comprising alkyl, alkoxy or phenyl groups, which are pendent or at the end of a silicone chain, these groups containing from 2 to 24 carbon atoms; phenyl silicones, for instance phenyl trimethicones, phenyl dimethicones, phenyltrimethylsiloxydiphenylsiloxanes, diphenyl dimethicones, diphenylmethyldiphenyltrisiloxanes or 2-phenylethyl trimethylsiloxy silicates, and polymethylphenylsiloxanes; mixtures thereof.

Additional examples include benzoic acid esters of C_9-C_{15} alcohols, isononyl iso-nonanoate, C_{12} - C_{15} alkyl benzoate, or any combinations thereof.

Specific examples of oils/emollients include cocoglyceride, cyclomethicone, dimethicone, dicapryl maleate, caprylic/capric triglyceride, isopropyl myristate, octyl stearate, isostearyl linoleate, lanolin oil, coconut oil, cocoa butter, olive oil, avocado oil, aloe extracts, jojoba oil, castor oil, fatty acid, oleic acid, stearic acid, fatty alcohol, cetyl alcohol, hexadecyl alcohol, diisopropyl adipate, hydroxybenzoate esters, benzoic acid esters of C_9 - C_{15} alcohols, isononyl iso-nonanoate, alkanes, mineral oil, silicone, dimethyl polysiloxane, ether, polyoxypropylene butyl ether, polyoxypropylene cetyl ether, C_{12}-C_{15} alkyl benzoate, aryl alkyl benzoate, Isopropyl Lauroyl sarcosinate , and any combinations thereof.

Examples of hydrophilic organic solvents that may be included in the sunscreen compositions include:

monohydric C_1-C_8 alcohols such as ethanol, propanol, butanol, isopropanol, isobutanol;

Polyethylene glycols from 6 to 80 ethylene oxides such as propylene glycol, isoprene glycol, butylene glycol, glycerol, sorbitol;

mono or di-alkyl isosorbides such as dimethyl isosorbide;

Examples of amphiphilic organic solvents include : polypropylene glycol (PPG) like propylene glycol alkyl ester or alkyl ether of PPG like PPG-23 oleyl ether and PPG-36 oleate.

The above lists are only examples and not limiting.

The total amount of oils/emollient present in the compositions is typically about 0.1, 0.5, 1.0, or 2.5 wt.% to about 5.0, 7.5, 10.0, 15.0, 20.0, or 30 wt.% of the total weight of the composition.

Film Formers

Film-formers are often incorporated into sunscreen compositions to ensure even coverage of the UV filters and can be used to render the composition water resistant. The film former is typically a hydrophobic material that imparts film forming and/or waterproofing characteristics. One such agent is polyethylene, which is available from New Phase Technologies as Performalene® 400, a polyethylene having a molecular weight of 400. Another suitable film former is polyethylene 2000 (molecular weight of 2000), which is available from New Phase Technologies as Performalene®. Yet, another suitable film former is synthetic wax, also available from New Phase Technologies as Performa® V-825. Other typical film-formers include acrylates/acrylamide copolymer, acrylates copolymer, acrylates/C_{12}- C_{22} alkylmethacrylate copolymer, polyethylene, waxes, VP/dimethiconylacrylate/polycarbamylpolyglycol ester, butylated PVP, PVP/hexadecene copolymer, octadecene/MA copolymer, PVP/eicosene copolymer, tricontanyl PVP, Brassica Campestris/Aleuritis Fordi Oil copolymer, decamethyl cyclopentasiloxane (and) trimethylsiloxysilicate, and mixtures thereof. In some cases, the film former is acrylates/C_{12}- C_{22} alkylmethacrylate copolymer sold under the tradename Allianz OPT® by ISP.

Many of the common film-forming polymers included in sunscreen compositions are not soluble in ethanol (such as PVP/Eicosene copolymer). A common film-former employed in ethanol based sunscreen products is Dermacryl LT or Dermacryl 79 marketed by Akzo Nobel (INCI Name: acrylates/octylacrylamide copolymner). Dermacryl LT (CAS Number: 80570-62-3) is a hydrophobic, high molecular weight carboxylated acrylic copolymer. It functions as a film-former in a

broad range of cosmetic formulations, imparting waterproofing, increased occlusivity and decreased rub-off of actives.

The above lists are only examples and not limiting.

The total amount of film-formers present in the compositions is typically in an amount of about 0.1, 0.5, 1.0, or 5 wt.% to about 5, 10, 20, or 25 wt.%, based on the total weight of the composition.

Emulsifiers

The sunscreen compositions typically include at least one emulsifier such as an amphoteric, anionic, cationic or nonionic emulsifier, used alone or as a mixture, and optionally a co-emulsifier. The emulsifiers are chosen in an appropriate manner according to the emulsion to be obtained (W/O or O/W). The emulsifier and the co-emulsifier are generally present in the composition in a proportion ranging from 0.3% to 30% by weight and preferably from 0.5% to 20% by weight relative to the total weight of the composition.

For W/O emulsions, examples of emulsifiers that may be mentioned include dimethicone copolyols, such as the mixture of cyclomethicone and dimethicone copolyol sold under the trade name DC 5225 C by the company Dow Corning, and alkyl dimethicone copolyols such as the lauryl dimethicone copolyol sold under the name Dow Corning 5200 Formulation Aid by the company Dow Corning, and the cetyl dimethicone copolyol sold under the name Abil EM 90™ by the company Goldschmidt. A crosslinked elastomeric solid organopolysiloxane comprising at least one oxyalkylene group, such as those obtained according to the procedure of Examples 3, 4 and 8 of U.S. Pat. No. 5,412,004 and of the examples of U.S. Pat. No. 5,811,487, especially the product of Example 3 (synthesis example) of U.S. Pat. No. 5,412,004, such as the product sold under the reference KSG 21 by the company Shin-Etsu, may also be used as surfactants for W/O emulsions.

For O/W emulsions, examples of emulsifiers that may be mentioned include nonionic emulsifiers such as oxyalkylenated (more particularly polyoxyethylenated) fatty acid esters of glycerol; oxyalkylenated fatty acid esters of sorbitan; oxyalkylenated (oxyethylenated and/or oxypropylenated) fatty acid esters; oxyalkylenated (oxyethylenated and/or oxypropylenated) fatty alcohol ethers; sugar esters such as sucrose stearate; and mixtures thereof.

The fatty acid esters of a sugar that can be used as nonionic amphiphilic lipids can be chosen in particular from the group comprising esters or mixtures of esters of a C_8-C_{22} fatty acid and of sucrose, of maltose, of glucose or of fructose, and esters or mixtures of esters of a C_{14}-C_{22} fatty acid and of methylglucose.

The C_8-C_{22} or C_{14}-C_{22} fatty acids forming the fatty unit of the esters that can be used in the emulsion comprise a saturated or unsaturated linear alkyl chain having, respectively, from 8 to 22 or from 14 to 22 carbon atoms. The fatty unit of the esters can be chosen in particular from stearates, behenates, arachidonates, palmitates, myristates, laurates, caprates and mixtures thereof.

By way of example of esters or of mixtures of esters of a fatty acid and of sucrose, of maltose, of glucose or of fructose, mention may be made of sucrose monostearte, sucrose distearate, sucrose tristearate and mixtures thereof, such as the products sold by the company Croda under the name Crodesta F50, F70, F110 and F160 having, respectively, an HLB (Hydrophilic Lipophilic Balance) of 5, 7, 11 and 16; and, by way of example of esters or of mixtures of esters of a fatty acid and of methylglucose, mention may be made of the disearate of methylglucose and of polyglycerol-3, sold by the company Goldschmidt under the name Tego-care 450. Mention may also be made of glucose monoesters or maltose monoesters, such as methyl O-hexadecanoyl-6-D-glucoside and O-hexadecanoyl-6-D-maltoside.

The fatty alcohol ethers of a sugar that can be used as nonionic amphiphilic lipids can be chosen in particular form the group comprising ethers or mixtures of ethers of a C_8-C_{22} fatty alcohol and of glucose, of maltose, of sucrose or of fructose, and ethers or mixtures of ethers of a C_{14}-C_{22} fatty alcohol and of methylglucose. They are in particular alkylpolyglucosides.

The C_8-C_{22} or C_{14}-C_{22} fatty alcohols forming the fatty unit of the ethers that can be used in the emulsion of the instant disclosure comprise a saturated or unsaturated linear alkyl chain having, respectively, from 8 to 22 or from 14 to 22 carbon atoms. The fatty unit of the ethers can be chosen in particular from decyl, cetyl, behenyl, arachidyl, stearyl, palmityl, myristyl, lauryl, capryl and hexadecanoyl units, and mixtures thereof such as cetearyl.

By way of example of fatty alcohol ethers of a sugar, mention may be made of alkylpolyglucosides, such as decylglucoside and laurylglucoside sold, for example, by the company Henkel under the respective names Plantaren 2000 and Plantaren

1200, cetostearylglucoside, optionally as a mixture with cetostearyl alcohol, sold, for example, under the name Montanov 68 by the company Seppic, under the name Tego-care CG90 by the company Goldschmidt and under the name Emulgade KE3302 by the company Henkel, and also arachidylglucoside, for example in the form of the mixture of arachidyl and behenyl alcohols and of arachidylglucoside sold under the name Montanov 202 by the company Seppic.

Use is more particularly made, as nonionic amphiphilic lipid of this type, of sucrose monostearate, sucrose distearate, sucrose tristearate and mixtures thereof, the distearate of methylglucose and of polyglycerol-3, and alkylpolyglucosides.

The glycerol fatty esters that can be used as nonionic amphiphilic lipids can be chosen in particular from the group comprising the esters formed from at least one acid comprising a saturated linear alkyl chain having from 16 to 22 carbon atoms, and from 1 to 10 glycerol units. Use may be made of one or more of these glycerol fatty esters in the emulsion of the instant disclosure.

These esters may be chosen in particular from stearates, behenates, arachidates, palmitates and mixtures thereof. Stearates and palmitates are preferably used.

By way of example of a surfactant that can be used in the emulsion of the instant disclosure, mention may be made of decaglycerol monostearate, distearate, tristearate and pentastearate (10 glycerol units) (CTFA names: polyglyceryl-10 stearate, polyglyceryl-10 distearate, polyglyceryl-10 tristearate, polyglyceryl-10 pentastearate), such as the products sold under the respective names Nikkol Decaglyn 1-S, 2-S, 3-S and 5-S by the company Nikko, and diglyceryl monostearate (CTFA name: polyglyceryl-2 stearate) such as the product sold by the company Nikko under the name Nikkol DGMS.

The sorbitan fatty esters that can be used as nonionic amphiphilic lipids chosen in particular from the group comprising esters of a C_{16}-C_{22} fatty acid and of sorbitan and oxyethylenated esters of a C_{16}-C_{22} fatty acid and of sorbitan. They are formed from at least one fatty acid comprising at least one saturated linear alkyl chain, having, respectively, from 16 to 22 carbon atoms, and from sorbitol or from ethoxylated sorbitol. The oxyethylenated esters generally comprise from 1 to 100 ethylene oxide units, and preferably from 2 to 40 ethylene oxide (EO) units.

These esters can be chosen in particular from stearates, behenates, arachidates, palmitates and mixtures thereof. Stearates and palmitates are preferably used.

By way of example of sorbitan fatty ester and of an oxyethylenated sorbitan fatty ester, mention may be made of sorbitan monostearate (CTFA name: sorbitan stearate) sold by the company ICI under the name Span 60, sorbitan monopalmitate (CTFA name: sorbitan palmitate) sold by the company ICI under the name Span 40, or sorbitan 20 EO tristearate (CTFA name: polysorbate 65) sold by the company ICI under the name Tween 65.

The ethoxylated fatty ethers are typically ethers made up of 1 to 100 ethylene oxide units and of at least one fatty alcohol chain having from 16 to 22 carbon atoms. The fatty chain of the ethers can be chosen in particular from behenyl, arachidyl, stearyl and cetyl units, and mixtures thereof, such as cetearyl. By way of example of ethoxylated fatty ethers, mention may be made of ethers of behenyl alcohol comprising 5, 10, 20 and 30 ethylene oxide units (CTFA names: beheneth-5, beheneth-10, beheneth-20 and beheneth-30), such as the products sold under the names Nikkol BB5, BB10, BB20 and BB30 by the company Nikko, and the ether of stearyl alcohol comprising 2 ethylene oxide units (CTFA name: steareth-2), such as the product sold under the name Brij 72 by the company ICI.

The ethoxylated fatty esters that can be used as nonionic amphiphilic lipids are esters made up of 1 to 100 ethylene oxide units and of at least one fatty acid chain comprising from 16 to 22 carbon atoms. The fatty chain of the esters can be chosen in particular from stearate, behenate, arachidate and palmitate units, and mixtures thereof. By way of example of ethoxylated fatty esters, mention may be made of the ester of stearic acid comprising 40 ethylene oxide units, such as the product sold under the name Myrj 52 (CTFA name: PEG-40 stearate) by the company ICI, and the ester of behenic acid comprising 8 ethylene oxide units (CTFA name: PEG-8 behenate), such as the product sold under the name Compritol HD5 ATO by the company Gattefosse.

The block copolymers of ethylene oxide and of propylene oxide that can be used as nonionic amphiphilic can be chosen in particular from poloxamers and in particular from Poloxamer 231, such as the product sold by the company ICI under the name Pluronic L81 of formula (V) with x=z=6, y=39 (HLB 2); Poloxamer 282,

such as the product sold by the company ICI under the name Pluronic L92 of formula (V) with x=z=10, y=47 (HLB 6); and Poloxamer 124, such as the product sold by the company ICI under the name Pluronic L44 of formula (V) with x=z=11, y=21 (HLB 16).

As nonionic amphiphilic lipids, mention may also be made of the mixtures of nonionic surfactants described in document EP-A-705593, incorporated herein for reference.

Suitable hydrophobically-modified emulsifiers include, for example, inulin lauryl carbamate, commercially available from Beneo Orafti under the tradename Inutec SP1.

The above lists are only examples and not limiting.

The total amount of emulsifier present in the compositions is typically in an amount of about 0.1, 0.2, or 0.5 wt.% to about 4.0, 5.0, 6.0, or 7.5 wt.%, based on the total weight of the composition.

Gelling Agent

Gelling agents may also be included in the sunscreen compositions. Examples of suitable hydrophilic gelling agents include carboxyvinyl polymers such as the Carbopol products (carbomers) and the Pemulen products (acrylate/C10-C30-alkylacrylate copolymer); polyacrylamides, for instance the crosslinked copolymers sold under the names Sepigel 305 (CTFA name: polyacrylamide/C13-14 isoparaffin/Laureth 7) or Simulgel 600 (CTFA name: acrylamide/sodium acryloyldimethyltaurate copolymer/isohexadecane/polysorbate 80) by the company SEPPIC; 2-acrylamido-2-methylpropanesulfonic acid polymers and copolymers, which are optionally crosslinked and/or neutralized, for instance the poly(2-acrylamido-2-methylpropanesulfonic acid) (CTFA name: ammonium polyacryldimethyltauramide); cellulose-based derivatives such as hydroxyethyl-cellulose; polysaccharides and especially gums such as xanthan gum; and mixtures thereof.

Lipophilic gelling agents (thickeners) that may be mentioned include modified clays such as hectorite and its derivatives, for instance the products sold under the name bentone.

In some instances, the gelling agent is ammonium acryloyldimethyltaurate/steareth-25 methacrylate crosspolymer, commercially available from Clariant under the tradename Aristoflex HMS.

The above lists are only examples and not limiting.

The gelling agent is typically used in an amount of about 0.05 to about 1.5% by weight, from about 0.08 to about 1.0% by weight, or about 0.1 to about 0.5% by weight, based on the total weight of the composition.

Additional Sunscreen Filters (Protective Agents)

The sunscreen compositions can include additional sunscreen filters such as, for example, mineral UV filters. Examples of mineral UV filters include pigments and nanopigments (mean size of the primary particles is generally is from 5 nm to 100 nm or from 10 nm to 50 nm) of treated or untreated metal oxides such as, for example, nanopigments of titanium oxide (amorphous or crystallized in rutile and/or anatase form), of iron oxide, of zinc oxide, of zirconium oxide or of cerium oxide. The treated nanopigments are pigments that have undergone one or more surface treatments of chemical, electronic, mechanochemical and/or mechanical nature with compounds as described, for example, in Cosmetics & Toiletries, February 1990, Vol. 105, pp. 53-64, such as amino acids, beeswax, fatty acids, fatty alcohols, anionic surfactants, lecithins, sodium, potassium, zinc, iron or aluminium salts of fatty acids, metal (titanium or aluminium) alkoxides, polyethylene, silicones, proteins (collagen or elastin), alkanolamines, silicon oxides, metal oxides, sodium hexametaphosphate, alumina or glycerol. The treated nanopigments may more particularly be titanium oxides treated with:

- silica and alumina, such as the products “Microtitanium Dioxide MT 500 SA” and “Microtitanium Dioxide MT 100 SA” from the company Tayca, and the products “Tioveil Fin”, “Tioveil OP”, “Tioveil MOTG” and “Tioveil IPM” from the company Tioxide;

- alumina and aluminium stearate, such as the product “Microtitanium Dioxide MT 100 T” from the company Tayca;

- alumina and aluminium laurate, such as the product “Microtitanium Dioxide MT 100 S” from the company Tayca;

- iron oxides and iron stearate, such as the product “Microtitanium Dioxide MT 100 F” from the company Tayca;

- silica, alumina and silicone, such as the products “Microtitanium Dioxide MT 100 SAS”, “Microtitanium Dioxide MT 600 SAS” and “Microtitanium Dioxide MT 500 SAS” from the company Tayca;

- sodium hexametaphosphate, such as the product “Microtitanium Dioxide MT 150 W” from the company Tayca;

- octyltrimethoxysilane, such as the product “T-805” from the company Degussa;

- alumina and stearic acid, such as the product “UVT-M160” from the company Kemira;

- alumina and glycerol, such as the product “UVT-M212” from the company Kemira;

- alumina and silicone, such as the product “UVT-M262” from the company Kemira.

Other titanium oxide nanopigments treated with a silicone are TiO_2 treated with octyltrimethylsilane and for which the mean size of the elementary particles is between 25 and 40 nm, such as the product sold under the trade name “T805” by the company Degussa Silices, TiO_2 treated with a polydimethylsiloxane and for which the mean size of the elementary particles is 21 nm, such as the product sold under the trade name “70250 Cardre UF TiO2SI3” by the company Cardre, anatase/rutile TiO_2 treated with a polydimethylhydrogenosiloxane and for which the mean size of the elementary particles is 25 nm, such as the product sold under the trade name “Microtitanium Dioxide USP Grade Hydrophobic” by the company Color Techniques.

Uncoated titanium oxide nanopigments are sold, for example, by the company Tayca under the trade names “Microtitanium Dioxide MT 500 B” or “Microtitanium Dioxide MT 600 B”, by the company Degussa under the name “P 25”, by the company Wackher under the name “Oxyde de titane transparent PW”, by the company Myoshi Kasei under the name “UFTR”, by the company Tomen under the name “ITS” and by the company Tioxide under the name “Tioveil AQ”.

The uncoated zinc oxide nanopigments are, for example:

- those sold under the name “Z-Cote” by the company Sunsmart;

- those sold under the name “Nanox” by the company Elementis; and

- those sold under the name “Nanogard WCD 2025” by the company Nanophase Technologies.

The coated zinc oxide nanopigments are, for example:

- those sold under the name “Zinc Oxide CS-5” by the company Toshibi (ZnO coated with polymethylhydrogenosiloxane);

- those sold under the name “Nanogard Zinc Oxide FN” by the company Nanophase Technologies (as a 40% dispersion in Finsolv TN, C_{12}-C_{15} alkyl benzoate);

- those sold under the name “Daitopersion ZN-30” and “Daitopersion ZN-50” by the company Daito (dispersions in cyclopolymethylsiloxane/oxyethylenated polydimethylsiloxane, containing 30% or 50% of nanozinc oxides coated with silica and polymethylhydrogenosiloxane);

- those sold under the name “NFD Ultrafine ZNO” by the company Daikin (ZnO coated with perfluoroalkyl phosphate and copolymer based on perfluoroalkylethyl as a dispersion in cyclopentasiloxane);

- those sold under the name “SPD-Z1” by the company Shin-Etsu (ZnO coated with silicone-grafted acrylic polymer, dispersed in cyclodimethylsiloxane);

- those sold under the name “Escalol Z100” by the company ISP (alumina-treated ZnO dispersed in an ethylhexyl methoxycinnamate/PVP-hexadecene/methicone copolymer mixture);

- those sold under the name “Fuji ZNO-SMS-10” by the company Fuji Pigment (ZnO coated with silica and polymethylsilsesquioxane); and

- those sold under the name “Nanox Gel TN” by the company Elementis (ZnO dispersed at a concentration of 55% in C_{12}-C_{15} alkyl benzoate with hydroxystearic acid polycondensate).

The uncoated cerium oxide nanopigments are sold under the name “Colloidal Cerium Oxide” by the company Rhone-Poulenc. The uncoated iron oxide nanopigments are sold, for example, by the company Arnaud under the names “Nanogard WCD 2002 (FE 45B)”, “Nanogard Iron FE 45 BL AQ”, “Nanogard FE 45R AQ” and “Nanogard WCD 2006 (FE 45R)” or by the company Mitsubishi under the name “TY-220”. The coated iron oxide nanopigments are sold, for example, by the company Arnaud under the names “Nanogard WCD 2008 (FE 45B FN)”, “Nanogard

WCD 2009 (FE 45B 556)", "Nanogard FE 45 BL 345" and "Nanogard FE 45 BL" or by the company BASF under the name "Transparent Iron Oxide".

Mixtures of metal oxides may also be used, especially of titanium dioxide and of cerium dioxide, including the silica-coated equal-weight mixture of titanium dioxide and of cerium dioxide, sold by the company Ikeda under the name "Sunveil A", and also the alumina, silica and silicone-coated mixture of titanium dioxide and of zinc dioxide, such as the product "M 261" sold by the company Kemira, or the alumina, silica and glycerol-coated mixture of titanium dioxide and of zinc dioxide, such as the product "M 211" sold by the company Kemira.

The above lists are only examples and not limiting.

The compositions according to the instant disclosure may be prepared according to techniques that are well known to those skilled in the art, in particular those intended for the preparation of emulsions of oil-in-water or water-in-oil type. They may be in particular in the form of a simple or complex emulsion (O/W, W/O, O/W/O or W/O/W emulsion) such as a cream or a milk, in the form of a gel or a cream-gel, or in the form of a lotion.

The instant disclosure will be better understood from the examples that follow, all of which are intended for illustrative purposes only and are not meant to limit the scope of the instant disclosure in any way.

EXAMPLES 1-7

Samples comprising different amounts of UV filters were prepared by dissolving the UV filters in ethanol and solvent as illustrated in the table below.

TABLE 1

Ingredient	Range
butyl methoxydibenzoylmethane (Avobenzone)	2.6 – 4.1 %
ethylhexyl triazone (Uvinul T150)	2.1 – 4.0 %
drometrizole trisiloxane (Mexoryl XL)	1.0 – 5.0 %
Homosalate	1.0 – 6.3 %
ethylhexyl salicylate (Octisalate)	1.4 – 2.6 %
Octocrylene	3.0 – 4.4 %
terephthalylidene dicamphor sulfonic acid	about 0.3 %
TEA (Triethanolamine)	0 - 1.05%
Polysorbate 20	5.50%
Propylene Glycol	5%
Eldew SL205 Solvent*	10%
Dermacryl 79**	12.5%
Ethanol	Qs 100%

* Eldew SL 205 (Ajinomoto) is Isopropyl Lauroyl Sarcosinate (emollient)

** Dermacryl 79 (Akzo Nobel) is an acrylate/octylacrylamide Copolymner (film-former)

Each sample was applied to a PMMA (polymethyl methacrylate) plate with a draw down bar to control the thickness and the homogeneity of the film. The in vitro SPF was measured using a Labsphere 2000. Each measurement was made 6 times (6 times on each plate) times on 3 plates for each composition. The amount of UV filters included in each sample and the resulting in vitro SPF is reported in the table below.

TABLE 2

No.	butyl methoxy dibenzoylmethane (Avobenzone)	ethylhexyl triazone (Uvinul T150)	drometrizole trisiloxane (Mexoryl XL)	Homosalate	ethylhexyl salicylate (Octisalate)	Octocrylene	terephthalylidene dicamphor sulfonic acid	**Total UV Filters**	**SPF in vitro**
1	3.4	2.3	1.4	1.5	2.2	4.2	0.3	15.3	329
2	4.1	2.0	1.4	2.6	2.4	4.3	0.3	17.1	406
Comparisons									
3	3.8	2.1	3.3	1.0	2.2	4.4	0.3	17.1	101
4	3.0	3.4	1.0	6.3	1.4	4.2	0.3	19.6	329
5	2.6	3.4	1.0	5.5	2.6	3	0.3	18.4	302
6	3.0	2.8	5.0	2.5	1.8	4.2	0.3	19.6	248
7	2.6	4.0	1.0	1.0	2.2	3.8	0.3	14.9	183

The following table corresponds to the table above (TABLE 2) but lists each UV filter as a ratio relative to butyl methoxydibenzoylmethane (avobenzone).

TABLE 3

No.	butyl methoxy dibenzoylmethane (Avobenzone)	ethylhexyl triazone (Uvinul T150)	drometrizole trisiloxane (Mexoryl XL)	Homosalate	ethylhexyl salicylate (Octisalate)	Octocrylene	terephthalylidene dicamphor sulfonic acid	**Total UV Filters**	**SPF in vitro**
1	1.00	0.68	0.41	0.44	0.65	1.24	0.09	15.3	329
2	1.00	0.49	0.34	0.63	0.59	1.05	0.07	17.1	406
Comparisons									
3	1.00	0.55	**0.87**	**0.26**	0.58	1.16	0.08	17.1	101
4	1.00	**1.13**	0.33	**2.1**	**0.47**	1.4	0.10	19.6	329
5	1.00	**1.31**	0.38	**2.12**	**1.00**	1.15	0.11	18.4	302
6	1.00	**0.93**	**1.67**	**0.83**	0.60	1.40	0.10	19.6	248
7	1.00	**1.54**	0.38	**0.38**	**0.85**	1.46	0.11	14.9	183

*__Note__: the bolded numbers fall outside the claimed range.

As illustrated in the tables above, Example 1 has a ratio of about 1.0 : 0.7 : 0.4 : 0.4 : 0.7 : 1.2 : 0.1 and Example 2 has a ratio of about 1.0 : 0.5 : 0.3 : 0.6 : 0.6 : 1.1 : 0.1 (butyl methoxydibenzoylmethane: ethylhexyl triazone : drometrizole trisiloxane : homosalate : ethylhexyl salicylate : octocrylene : terephthalylidene dicamphor sulfonic acid).

Example 8
(Oil-in-Water Emulsion)

The following oil-in-water emulsions were prepared and the in vivo SPF measured.

TABLE 4

FORMULA:		**Comparative Example**	**Inventive Example**
Phase	**Ingredients**	**% wt/wt**	**% wt/wt**
A-1	Water	Q.S.	Q.S.
	EDTA	0.100	0.100
	Glycerin	1.0 - 5.0	1.0 - 5.0
	Preservative	0.1 - 2.0	0.1 - 2.0
	Emulsifier	0.1 to 1.0	0.1 to 1.0
B	butyl methoxydibenzoylmethane (Avobenzone)	3.000	3.360
	ethylhexyl triazone (Uvinul T150)	1.500	2.300
	drometrizole trisiloxane (Mexoryl XL)	4.000	1.390
	Homosalate	10.000	1.500
	ethylhexyl salicylate (Octisalate)	5.000	2.160
	Octocrylene	5.000	4.210
	terephthalylidene dicamphor sulfonic acid (Mexoryl SX)	0.3300 (0.9)	0.3300 (0.9)
	Emulsifiers	0.5 to 4.0	0.5 to 4.0
	Emollients	1.0 to 8.0	1.0 to 8.0
	Antioxident	0.05 to 0.15	0.05 to 0.15
	SPF Booster	3.0 - 10.0	3.0 - 10.0
C	Polymeric Emulsifier	0.05 - 0.30	0.05 - 0.30
D	TEA	0.1 - 0.60	0.1 - 0.60
D	Silicones	1.0 - 10.0	1.0 - 10.0
E	Film former	0.5 to 3.0	0.5 to 3.0
F	Wetting agent	0.1 to 1.5	0.1 to 1.5
Total %UV filters		**28.83 (29.4)**	**15.25 (15.82)**
SPF (in-vivo)		**59.4**	**75.7**

The components of the Lotion Sunscreen were combined as outlined below.

1) Weigh Phase A and heat to 85°C.
2) Weigh Phase B ingredients in another beaker and heat to 85°C.

3) Add Phase B into Phase A and homogenized for 20 minutes. Maintain the temperature at 90°C.

4) Check emulsion quality. If emulsion quality is good then begin cooling to room temperature.

5) Add Phase C into Phase A/B and homogenize for 5 minutes.

6) Pass the emulsion through a high pressure homogenizer two times at 500 bar.

7) Add phase D at room temperature and mix for 5 minutes.

EXAMPLES 9-14

Samples comprising different amounts of UV filters were prepared by dissolving the UV filters in ethanol and solvent as illustrated in the table below.

TABLE 5

Ingredient	Range
butyl methoxydibenzoylmethane (Avobenzone)	2.2 – 4.2 %
ethylhexyl triazone (Uvinul T150)	1.6 – 4.0 %
drometrizole trisiloxane (Mexoryl XL)	1.0 – 4.2 %
Homosalate	1.0 – 10.0 %
ethylhexyl salicylate (Octisalate)	1.0 – 5.0 %
Octocrylene	3.0 – 5.0 %
terephthalylidene dicamphor sulfonic acid (Mexoryl SX)	about 0.3 % (about 0.9%)
TEA (Triethanolamine)	0 - 1.05%
Polysorbate 20	5.50%
Propylene Glycol	5%
Eldew SL205 Solvent*	10.0%
Dermacryl 79**	12.5%
Ethanol	Qs 100%

* Eldew SL 205 (Ajinomoto) is Isopropyl Lauroyl Sarcosinate (emollient)

** Dermacryl 79 (Akzo Nobel) is an acrylate/octylacrylamide Copolymner (film-former)

Each sample was applied to a PMMA (polymethyl methacrylate) plate with a draw down bar to control the thickness and the homogeneity of the film. The in vitro SPF was measured using a Labsphere 2000. Each measurement was made 6 times (6 times on each plate) times on 3 plates for each composition. The amount of UV filters included in each sample and the resulting in vitro SPF is reported in the table below.

TABLE 6

No.	butyl methoxy dibenzoylmethane (Avobenzone)	ethylhexyl triazone (Uvinul T150)	drometrizole trisiloxane (Mexoryl XL)	Homosalate	ethylhexyl salicylate (Octisalate)	Octocrylene	terephthalylidene dicamphor sulfonic acid (Mexoryl SX)	**Total UV Filters**	**SPF in vitro**
9	4.2	4.0	1.4	1.0	3.8	5.0	0.3	19.7	555
10	3.8	3.4	1.0	1.75	3.4	5.0	0.3	18.7	488
Comparisons									
11	2.6	1.6	1.8	4	5.0	4.6	0.3	19.9	72
12	2.2	2.5	4.2	2.5	5.0	3.0	0.3	19.7	62
13	2.2	1.6	1.4	10	1.0	3.4	0.3	19.9	136
14	2.6	1.9	3.8	1.75	5.0	4.6	0.3	20.0	59

The following table corresponds to the table above (TABLE 6) but lists each UV filter as a ratio relative to avobenzone.

TABLE 7

No.	butyl methoxy dibenzoylmethane Avobenzone	ethylhexyl triazone (Uvinul T150)	drometrizole trisiloxane (Mexoryl XL)	Homosalate	ethylhexyl salicylate (Octisalate)	Octocrylene	terephthalylidene dicamphor sulfonic acid (Mexoryl SX)	**Total UV Filters**	**SPF in vitro**
9	1.00	0.95	0.33	0.24	0.90	1.19	0.07	19.7	555
10	1.00	0.89	0.26	0.46	0.89	1.32	0.08	18.7	488
Comparisons									
11	1.00	0.62	**0.69**	**1.54**	**1.92**	**1.77**	0.12	19.9	72
12	1.00	1.14	**1.91**	**1.14**	**2.27**	1.36	0.14	19.7	62
13	1.00	0.73	**0.64**	**4.55**	**0.45**	1.55	0.14	19.9	136
14	1.00	0.73	**1.46**	**0.67**	**1.92**	**1.77**	0.12	20.0	59

***Note**: the bolded numbers fall outside the claimed range.

As illustrated in the tables above, Example 1 has a ratio of about 1.0 : 1.0 : 0.3 : 0.2 : 0.9 : 1.2 : 0.1 (butyl methoxydibenzoylmethane : ethylhexyl triazone : drometrizole trisiloxane : homosalate : ethylhexyl salicylate : octocrylene : terephthalylidene dicamphor sulfonic acid) and Example 2 has a ratio of about 1.0 : 0.9 : 0.3 : 0.5 : 0.9 : 1.3 : 0.1 (butyl methoxydibenzoylmethane : ethylhexyl triazone : drometrizole trisiloxane : homosalate : ethylhexyl salicylate : octocrylene : terephthalylidene dicamphor sulfonic acid).

Example 15

(Oil-in-Water Emulsion)

The following oil-in-water emulsions were prepared and the in vivo SPF measured.

TABLE 8

FORMULA:		**Comparative Example**	**Inventive Example**
Phase	**Ingredients**	**% wt/wt**	**% wt/wt**
A-1	Water	Q.S.	Q.S.
	EDTA	0.100	0.100
	Glycerin	1.0 - 5.0	1.0 - 5.0
	Preservative	0.1 - 2.0	0.1 - 2.0
	Emulsifier	0.1 to 1.0	0.1 to 1.0
B	butyl methoxydibenzoylmethane (Avobenzone)	3.000	4.2
	ethylhexyl triazone (Uvinul T150)	1.500	4.0
	drometrizole trisiloxane (Mexoryl XL)	4.000	1.4
	Homosalate	10.000	1.0
	ethylhexyl salicylate (Octisalate)	5.000	3.8
	Octocrylene	5.000	1.19
	terephthalylidene dicamphor sulfonic acid (Mexoryl SX)	0.3300 (0.9)	0.3 (0.9)
	Emulsifiers	0.5 to 4.0	0.5 to 4.0
	Emollients	1.0 to 8.0	1.0 to 8.0
	Antioxident	0.05 to 0.15	0.05 to 0.15
	SPF Booster	3.0 - 10.0	3.0 - 10.0
C	Polymeric Emulsifier	0.05 - 0.30	0.05 - 0.30
D	TEA	0.1 - 0.60	0.1 - 0.60
D	Silicones	1.0 - 10.0	1.0 - 10.0
E	Film former	0.5 to 3.0	0.5 to 3.0
F	Wetting agent	0.1 to 1.5	0.1 to 1.5
Total %UV filters		**28.83 (29.4)**	**19.7 (20.3)**
SPF (in-vivo)		**59.4**	**62.7**

The components of the Lotion Sunscreen were combined in the same manner as Example 8.

EXAMPLES 16-20

Samples comprising different amounts of UV filters were prepared by dissolving the UV filters in ethanol and solvent as illustrated in the table below.

TABLE 9

Ingredient	Range
butyl methoxydibenzoylmethane (Avobenzone)	1.4 – 3.8 %
ethylhexyl triazone (Uvinul T150)	1.3 – 3.7 %
drometrizole trisiloxane (Mexoryl XL)	1.4 – 5.0 %
Homosalate	2.5 – 7.8 %
ethylhexyl salicylate (Octisalate)	1.8 – 3.4 %
Octocrylene	1.8 – 5.0 %
terephthalylidene dicamphor sulfonic acid (Mexoryl SX)	about 0.3 (about 0.9 %)
TEA(Triethanolamine)	0 - 1.05%
Polysorbate 20	5.50%
Propylene Glycol	5%
Eldew SL205 Solvent*	10.0%
Dermacryl 79**	12.5%
Ethanol	Qs 100%

* Eldew SL 205 (Ajinomoto) is Isopropyl Lauroyl Sarcosinate (emollient)

** Dermacryl 79 (Akzo Nobel) is an acrylate/octylacrylamide Copolymner (film-former)

Each sample was applied to a PMMA (polymethyl methacrylate) plate with a draw down bar to control the thickness and the homogeneity of the film. The in vitro SPF was measured using a Labsphere 2000. Each measurement was made 6 times (6 times on each plate) times on 3 plates for each composition. The amount of UV filters included in each sample and the resulting in vitro SPF is reported in the table below.

TABLE 10

No.	butyl methoxy dibenzoylmethane (Avobenzone)	ethylhexyl triazone (Uvinul T150)	drometrizole trisiloxane (Mexoryl XL)	Homosalate	ethylhexyl salicylate (Octisalate)	Octocrylene	terephthalylidene dicamphor sulfonic acid	**Total UV Filters**	**SPF in vitro**
16	3.8	3.4	1.4	2.5	1.8	4.2	0.3	17.4	358
Comparisons									
17	1.4	3.1	3.4	7.8	2.2	1.8	0.3	20.0	81
18	3.4	3.7	1.4	2.5	2.2	3.8	0.3	17.3	237
19	3.0	1.3	1.4	5.5	3.4	5.0	0.3	19.9	244
20	3.0	2.8	5.0	2.5	1.8	4.2	0.3	19.6	248

The following table corresponds to the table above (TABLE 10) but lists each UV filter as a ratio relative to butyl methoxydibenzoylmethane.

TABLE 11

No.	butyl methoxy dibenzoylmethane (Avobenzone)	ethylhexyl triazone (Uvinul T150)	drometrizole trisiloxane (Mexoryl)XL	Homosalate	ethylhexyl salicylate (Octisalat)e	Octocrylene	terephthalylidene dicamphor sulfonic acid	**Total UV Filters**	**SPF in vitro**
16	1.00	0.90	0.37	0.66	0.47	1.11	0.08	17.4	358
Comparisons									
17	1.00	**2.21**	**2.43**	**5.54**	**1.57**	1.29	0.21	20.0	81
18	1.00	1.09	0.41	0.74	0.65	1.12	0.09	17.3	237
19	1.00	0.43	0.47	**1.83**	1.13	**1.67**	0.10	19.9	244
20	1.00	0.93	1.67	0.83	0.60	1.40	0.10	19.6	248

*__Note__: the bolded numbers fall outside the claimed range.

As illustrated in the tables above, Example 1 has a ratio of about 1.0 : 0.9 : 0.4 : 0.7 : 0.5 : 1.1 : 0.1 (butyl methoxydibenzoylmethane : ethylhexyl triazone : drometrizole trisiloxane : homosalate : ethylhexyl salicylate : octocrylene : terephthalylidene dicamphor sulfonic acid).

Example 21
(Comparative Formulation)

The following oil-in-water emulsion was prepared and the in vivo SPF measured.

FORMULA:		**Comparative Example**
Phase	**Ingredients**	**% wt/wt**
A-1	Water	Q.S.
	EDTA	0.100
	Glycerin	1.0 - 5.0
	Preservative	0.1 - 2.0
	Emulsifier	0.1 to 1.0
B	butyl methoxydibenzoylmethane (Avobenzone)	3.000
	ethylhexyl triazone (Uvinul T150)	1.500
	drometrizole trisiloxane (Mexoryl XL)	4.000
	Homosalate	10.000
	ethylhexyl salicylate (Octisalate)	5.000
	Octocrylene	5.000
	terephthalylidene dicamphor sulfonic acid (Mexoryl SX)	0.3300 (0.9)
	Emulsifiers	0.5 to 4.0
	Emollients	1.0 to 8.0
	Antioxident	0.05 to 0.15
	SPF Booster	3.0 - 10.0
C	Polymeric Emulsifier	0.05 - 0.30
D	TEA	0.1 - 0.60
D	Silicones	1.0 - 10.0
E	Film former	0.5 to 3.0
F	Wetting agent	0.1 to 1.5
Total %UV filters		**28.83 (29.4)**
SPF (in-vivo)		**59.4**

The components of the Lotion Sunscreen were combined in the same manner as Example 8.

CLAIMS

It is claimed:

1. A sunscreen composition comprising:

(a) a combination of the following UV filters: butyl methoxydibenzoylmethane, ethylhexyl triazone, drometrizole trisiloxane, homosalate, ethylhexyl salicylate, octocrylene, and terephthalylidene dicamphor sulfonic acid, wherein the ratio of each UV filter relative to butyl methoxydibenzoylmethane is as follows:

the ratio of ethylhexyl triazone to butyl methoxydibenzoylmethane is 0.5:1.0 to 0.8:1.0;

the ratio of drometrizole trisiloxane to butyl methoxydibenzoylmethane is 0:1.0 to 0.5:1.0;

The ratio of homosalate to butyl methoxydibenzoylmethane is 0.4:1.0 to 0.7:1.0;

the ratio of ethylhexyl salicylate to butyl methoxydibenzoylmethane is 0.5:1.0 to 0.8:1.0;

the ratio of octocrylene to butyl methoxydibenzoylmethane is 1.0:1.0 to 1.5:1.0; and

the ratio of terephthalylidene dicamphor sulfonic acid to butyl methoxydibenzoylmethane is 0:1.0 to 0.1:1.0; or

(b) a combination of the following UV filters: butyl methoxydibenzoylmethane, ethylhexyl triazone, drometrizole trisiloxane, homosalate, ethylhexyl salicylate, octocrylene, and terephthalylidene dicamphor sulfonic acid, wherein the ratio of each UV filter relative to butyl methoxydibenzoylmethane is as follows:

the ratio of ethylhexyl triazone to butyl methoxydibenzoylmethane is 0.67:1.0 to 1.14:1.0;

the ratio of drometrizole trisiloxane to butyl methoxydibenzoylmethane is 0:1.0 to 0.57:1.0;

The ratio of homosalate to butyl methoxydibenzoylmethane is 0.11:1.0 to 0.57:1.0;

the ratio of ethylhexyl salicylate to butyl methoxydibenzoylmethane is 0.76:1.0 to 1.29:1.0;

the ratio of octocrylene to butyl methoxydibenzoylmethane is 0.89:1.0 to 1.71:1.0; and

the ratio of terephthalylidene dicamphor sulfonic acid to butyl methoxydibenzoylmethane is about about 0:1.0 to about 0.1:1.0; or

(c) a combination of the following UV filters: butyl methoxydibenzoylmethane, ethylhexyl triazone drometrizole trisiloxane, homosalate, ethylhexyl salicylate, octocrylene, and terephthalylidene dicamphor sulfonic acid, wherein the ratio of each UV filter relative to butyl methoxydibenzoylmethane is as follows:

the ratio of ethylhexyl triazone to butyl methoxydibenzoylmethane is 0.67:1.0 to 1.14:1.0;

the ratio of drometrizole trisiloxane to butyl methoxydibenzoylmethane is 0:1.0 to 0.57:1.0;

The ratio of homosalate to butyl methoxydibenzoylmethane is 0.33:1.0 to 0.71:1.0;

the ratio of ethylhexyl salicylate to butyl methoxydibenzoylmethane is 0.33:1.0 to 0.71:1.0;

the ratio of octocrylene to butyl methoxydibenzoylmethane is 0.89:1.0 to 1.43:1.0; and

the ratio of terephthalylidene dicamphor sulfonic acid to butyl methoxydibenzoylmethane is 0:1.0 to 0.086:1.0.

2. The sunscreen composition of claim 1 comprising:

(a) a combination of the following UV filters: butyl methoxydibenzoylmethane, ethylhexyl triazone, drometrizole trisiloxane, homosalate, ethylhexyl salicylate, octocrylene, and terephthalylidene dicamphor sulfonic acid, wherein the ratio of each UV filter relative to butyl methoxydibenzoylmethane is as follows:

the ratio of ethylhexyl triazone to butyl methoxydibenzoylmethane is 0.5:1.0 to 0.8:1.0;

the ratio of drometrizole trisiloxane to butyl methoxydibenzoylmethane is 0:1.0 to 0.5:1.0;

The ratio of homosalate to butyl methoxydibenzoylmethane is 0.4:1.0 to 0.7:1.0;

the ratio of ethylhexyl salicylate to butyl methoxydibenzoylmethane is 0.5:1.0 to 0.8:1.0;

the ratio of octocrylene to butyl methoxydibenzoylmethane is 1.0:1.0 to 1.5:1.0; and

the ratio of terephthalylidene dicamphor sulfonic acid to butyl methoxydibenzoylmethane is 0:1.0 to 0.1:1.0

3. The sunscreen composition according to claim 2, wherein the total amount of the combination of UV filters is at least 1 wt.% but not more than 35 wt.%, based on the total weight of the sunscreen composition.

4. The sunscreen composition according to claim 3, wherein none of the individual UV filters of the combination are present in an amount greater than 9 wt.%.

5. The sunscreen composition according to claim 2 comprising:

not more than 7 wt.% butyl methoxydibenzoylmethane;

not more than 5 wt.% ethylhexyl triazone;

not more than 3 wt.% drometrizole trisiloxane;

not more than 4 wt.% homosalate;

not more than 4 wt.% ethylhexyl salicylate;

not more than 9 wt.% octocrylene; and

not more than 0.7 wt.% terephthalylidene dicamphor sulfonic acid.

6. The sunscreen composition according to claim 2, wherein the ratio of each filter relative to butyl methoxydibenzoylmethane is about 1.0 : 0.7 : 0.4 : 0.4 : 0.7 : 1.2 : 0.1 (butyl methoxydibenzoylmethane : ethylhexyl triazone : drometrizole trisiloxane : homosalate : ethylhexyl salicylate : octocrylene : terephthalylidene dicamphor sulfonic acid).

7. The sunscreen composition according to claim 2, wherein the ratio of each filter relative to butyl methoxydibenzoylmethane is about 1.0 : 0.5 : 0.3 : 0.6 : 0.6 : 1.1 : 0.1 (butyl methoxydibenzoylmethane : ethylhexyl triazone : drometrizole trisiloxane : homosalate : ethylhexyl salicylate : octocrylene : terephthalylidene dicamphor sulfonic acid).

8. A sunscreen composition comprising:

about 2.7 to about 6.7 wt.% butyl methoxydibenzoylmethane;

about 1.8 to about 4.6 wt.% ethylhexyl triazone;

0 to about 2.8 wt.% drometrizole trisiloxane;

about 1.0 to about 3.0 wt.% homosalate;

about 1.8 to about 4.4 wt.% ethylhexyl salicylate;

about 3.4 to about 8.3 wt.% octocrylene; and

0 to about 0.6 wt.% terephthalylidene dicamphor sulfonic acid,

wherein the weight percent in each case is based on the total weight of the sunscreen composition.

9. A sunscreen composition according to claim 8 comprising:

about 3.4 wt.% butyl methoxydibenzoylmethane;

about 2.3 wt.% ethylhexyl triazone;

about 1.4 wt.% drometrizole trisiloxane;

about 1.5 wt.% homosalate;

about 2.2 wt.% ethylhexyl salicylate;

about 4.2 wt.% octocrylene; and

about 0.3 wt.% terephthalylidene dicamphor sulfonic acid.

10. A sunscreen composition according to claim 8 comprising:

about 4.1 wt.% butyl methoxydibenzoylmethane;

about 2.0 wt.% ethylhexyl triazone;

about 1.4 wt.% drometrizole trisiloxane;

about 2.6 wt.% homosalate;

about 2.4 wt.% ethylhexyl salicylate;

about 4.3 wt.% octocrylene; and

about 0.3 wt.% terephthalylidene dicamphor sulfonic acid.

11. The sunscreen composition of claim 1 comprising

(b) a combination of the following UV filters: butyl methoxydibenzoylmethane, ethylhexyl triazone, drometrizole trisiloxane, homosalate, ethylhexyl salicylate, octocrylene, and terephthalylidene dicamphor sulfonic acid, wherein the ratio of each UV filter relative to butyl methoxydibenzoylmethane is as follows:

the ratio of ethylhexyl triazone to butyl methoxydibenzoylmethane is 0.67:1.0 to 1.14:1.0;

the ratio of drometrizole trisiloxane to butyl methoxydibenzoylmethane is 0:1.0 to 0.57:1.0;

The ratio of homosalate to butyl methoxydibenzoylmethane is 0.11:1.0 to 0.57:1.0;

the ratio of ethylhexyl salicylate to butyl methoxydibenzoylmethane is 0.76:1.0 to 1.29:1.0;

the ratio of octocrylene to butyl methoxydibenzoylmethane is 0.89:1.0 to 1.71:1.0; and

the ratio of terephthalylidene dicamphor sulfonic acid to butyl methoxydibenzoylmethane is about about 0:1.0 to about 0.1:1.0.

12. The sunscreen composition according to claim 11, wherein the total amount of the combination of UV filters is at least 1 wt.% but not more than 35 wt.%, based on the total weight of the sunscreen composition.

13. The sunscreen composition according to claim 12, wherein none of the individual UV filters of the combination are present in an amount greater than 6 wt.%.

14. The sunscreen composition according to claim 11 comprising:

not more than 5 wt.% butyl methoxydibenzoylmethane;

not more than 4 wt.% ethylhexyl triazone;

not more than 2 wt.% drometrizole trisiloxane;

not more than 3 wt.% homosalate;

not more than 5 wt.% ethylhexyl salicylate;

not more than 6 wt.% octocrylene; and

not more than 2 wt.% terephthalylidene dicamphor sulfonic acid.

15. The sunscreen composition according to claim 11, wherein the ratio of each filter relative to butyl methoxydibenzoylmethane is about 1.0 : 1.0 : 0.3 : 0.2 : 0.9 : 1.2 : 0.1 (butyl methoxydibenzoylmethane : ethylhexyl triazone : drometrizole trisiloxane : homosalate : ethylhexyl salicylate : octocrylene : terephthalylidene dicamphor sulfonic acid).

16. The sunscreen composition according to claim 11, wherein the ratio of each filter relative to butyl methoxydibenzoylmethane is about 1.0 : 0.9 : 0.3 : 0.5 : 0.9 : 1.3 : 0.1 (butyl methoxydibenzoylmethane : ethylhexyl triazone : drometrizole trisiloxane : homosalate : ethylhexyl salicylate : octocrylene : terephthalylidene dicamphor sulfonic acid).

17. A sunscreen composition comprising:

about 3.5 to about 4.5 wt.% butyl methoxydibenzoylmethane;

about 3.0 to about 4.0 wt.% ethylhexyl triazone;

0 to about 2.0 wt.% drometrizole trisiloxane;

about 0.5 to about 2.0 wt.% homosalate;

about 3.4 to about 4.5 wt.% ethylhexyl salicylate;

about 4.0 to about 6.0 wt.% octocrylene; and

0 to 0.6 wt.% terephthalylidene dicamphor sulfonic acid,

wherein the weight percent in each case is based on the total weight of the sunscreen composition.

18. A sunscreen composition according to claim 17 comprising:

about 4.2 wt.% butyl methoxydibenzoylmethane;

about 4.0 wt.% ethylhexyl triazone;

about 1.4 wt.% drometrizole trisiloxane;

about 1.0 wt.% homosalate;

about 3.8 wt.% ethylhexyl salicylate;

about 5.0 wt.% octocrylene; and

about 0.3 wt.% terephthalylidene dicamphor sulfonic acid.

19. A sunscreen composition according to claim 17 comprising:

about 3.8 wt.% butyl methoxydibenzoylmethane,

about 3.4 wt.% ethylhexyl triazone,

about 1.0 wt.% drometrizole trisiloxane,

about 1.75 wt.% homosalate,

about 3.4 wt.% ethylhexyl salicylate,

about 5.0 wt.% octocrylene, and

about 0.3 wt.% terephthalylidene dicamphor sulfonic acid.

20. A sunscreen composition according to claim 1 comprising

(c) a combination of the following UV filters: butyl methoxydibenzoylmethane, ethylhexyl triazone drometrizole trisiloxane, homosalate, ethylhexyl salicylate, octocrylene, and terephthalylidene dicamphor sulfonic acid, wherein the ratio of each UV filter relative to butyl methoxydibenzoylmethane is as follows:

the ratio of ethylhexyl triazone to butyl methoxydibenzoylmethane is 0.67:1.0 to 1.14:1.0;

the ratio of drometrizole trisiloxane to butyl methoxydibenzoylmethane is 0:1.0 to 0.57:1.0;

The ratio of homosalate to butyl methoxydibenzoylmethane is 0.33:1.0 to 0.71:1.0;

the ratio of ethylhexyl salicylate to butyl methoxydibenzoylmethane is 0.33:1.0 to 0.71:1.0;

the ratio of octocrylene to butyl methoxydibenzoylmethane is 0.89:1.0 to 1.43:1.0; and

the ratio of terephthalylidene dicamphor sulfonic acid to butyl methoxydibenzoylmethane is 0:1.0 to 0.086:1.0.

21. The sunscreen composition according to claim 20, wherein the total amount of the combination of UV filters is at least 1 wt.% but not more than 35 wt.%, based on the total weight of the sunscreen composition.

22. The sunscreen composition according to claim 21, wherein none of the individual UV filters of the combination are present in an amount greater than 5 wt.%.

23. The sunscreen composition according to claim 20 comprising:

not more than 5 wt.% butyl methoxydibenzoylmethane;

not more than 4 wt.% ethylhexyl triazone;

not more than 2 wt.% drometrizole trisiloxane;

not more than 3 wt.% homosalate;

not more than 3 wt.% ethylhexyl salicylate;

not more than 5 wt.% octocrylene; and

not more than 1 wt.% terephthalylidene dicamphor sulfonic acid.

24. The sunscreen composition according to claim 20, wherein the ratio of each filter relative to butyl methoxydibenzoylmethane is about 1.0 : 0.9 : 0.4 : 0.7 : 0.5 : 1.1 : 0.1 (butyl methoxydibenzoylmethane : ethylhexyl triazone : drometrizole trisiloxane : homosalate : ethylhexyl salicylate : octocrylene : terephthalylidene dicamphor sulfonic acid).

25. A sunscreen composition comprising:

3.5 to 4.5 wt.% butyl methoxydibenzoylmethane;

3.0 to 4.0 wt.% ethylhexyl triazone;

0 to 2.0 wt.% drometrizole trisiloxane;

1.5 to 2.5 wt.% homosalate;

1.5 to 2.5 wt.% ethylhexyl salicylate;

4.0 to 5.0 wt.% octocrylene; and

0 to 0.6 wt.% terephthalylidene dicamphor sulfonic acid,

wherein the weight percent in each case is based on the total weight of the sunscreen composition.

26. A sunscreen composition according to claim 25 comprising:

about 3.8 wt.% butyl methoxydibenzoylmethane;

about 3.4 wt.% ethylhexyl triazone;

about 1.4 wt.% drometrizole trisiloxane;

about 2.5 wt.% homosalate;

about 1.8 wt.% ethylhexyl salicylate;

about 4.2 wt.% octocrylene; and

about 0.3 wt.% terephthalylidene dicamphor sulfonic acid.

27. The sunscreen composition according to any one of the above claims, further comprising a booster.

28. A clear sunscreen composition according to any one of the above claims.

29. A spray-on sunscreen composition according to any one of the above claims.

30. The sunscreen composition according to any one of the above claims, further comprising a booster.

31. A method of protecting a keratinous substrate from ultraviolet radiation comprising applying a sunscreen composition according to any one of the above claims to the keratinous substrate.

32. A method of protecting a keratinous substrate from ultraviolet radiation comprising applying a sunscreen composition according to any one of the above claims to the keratinous substrate.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 16/37761

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - A61K 8/02 (2016.01)
CPC - A61Q 19/00; A61Q 17/04; A61Q 19/08
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC(8) - A61K 8/02 (2016.01)
CPC - A61Q 19/00; A61Q 17/04; A61Q 19/08

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Patents and non-patent literature (classification, keyword; search terms below)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
PatBase, Google Scholar (NPL), Google Patents; search terms: sunscreen composition, UV filters, butyl methoxydibenzoylmethane, ethylhexyl triazone, drometrizole trisiloxane, homosalate, ethylhexyl salicylate, octocrylene, terephthalylidene dicamphor sulfonic acid, ratio

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2005/0013781 A1 (Dueva-Koganov et al.) 20 January 2005 (20.01.2005) para [0021], [0039], [0043], [0045], [0123]	1-27
X	US 2014/0170192 A1 (Halpern et al.) 19 June 2014 (19.06.2014) abstract, [0062]-[0063], [0066], [0070]-[0114]	1-27
A	US 2008/0112904 A1 (Traynor et al.) 15 May 2008 (15.05.2008) entire document	1-27
A	US 2010/0239677 A1 (Josso) 23 September 2010 (23.09.2010) entire document	1-27
A, P	US 9,308,155 B2 (Candau) 12 April 2016 (12.04.2016) entire document	1-27

☐ Further documents are listed in the continuation of Box C. ☐

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
11 August 2016 (11.08.2016)	19 SEP 2016
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-8300	Authorized officer: Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 16/37761

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☒ Claims Nos.: 28-32
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.