



(51) International Patent Classification:

A61K 8/34 (2006.01) A61Q 17/00 (2006.01)  
A61K 8/67 (2006.01) A61Q 19/00 (2006.01)

(21) International Application Number:

PCT/US2014/023985

(22) International Filing Date:

12 March 2014 (12.03.2014)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

13/803,692 14 March 2013 (14.03.2013) US

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(81) Designated States (unless otherwise indicated, for every  
kind of national protection available): AE, AG, AL, AM,  
AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY,  
BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM,  
DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT,  
HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR,  
KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME,  
MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ,  
OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA,  
SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM,  
TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM,  
ZW.

(84) Designated States (unless otherwise indicated, for every  
kind of regional protection available): ARIPO (BW, GH,  
GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ,  
UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ,  
TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK,  
EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV,  
MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM,  
TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW,  
KM, ML, MR, NE, SN, TD, TG).

Published:

- with international search report (Art. 21(3))
- before the expiration of the time limit for amending the  
claims and to be republished in the event of receipt of  
amendments (Rule 48.2(h))

(54) Title: COSMETIC COMPOSITIONS AND METHODS PROVIDING ENHANCED PENETRATION OF SKIN CARE ACT-  
IVES

(57) Abstract: A cosmetic composition suitable for topical application is provided. In some examples, the cosmetic composition can  
include glycerin, hexyldecanol, a vitamin B compound, and one or more materials selected from the group consisting of 1,2-pentane-  
diol, 1,4-pentanediol, 2,4-pentanediol, 1,5-pentanediol, 1,2-butanediol, 1,3-butanediol, 1,4-butanediol, 2,3-butanediol, 1,2-hexane-  
diol, 1,5-hexanediol, 1,6-hexanediol, 2,5-hexanediol, hexylene glycol, and combinations thereof.



## COSMETIC COMPOSITIONS AND METHODS PROVIDING ENHANCED PENETRATION OF SKIN CARE ACTIVES

### TECHNICAL FIELD

5           Cosmetic compositions providing enhanced penetration of skin care actives are provided along with methods of use related thereto.

### BACKGROUND

10           Vitamin B compounds, such as niacinamide, are well known cosmetic skin care agents that are believed to provide a variety of skin care benefits (see, e.g., Bissett et al. "Niacinamide: A B Vitamin that Improves Aging Facial Skin Appearance" and Draelos "Clinical Situations Conducive to Proactive Skin Health and Anti-Aging Improvement"). Some of the reported benefits include improvement in the appearance of facial skin texture, red blotchiness, hyperpigmentation, and the enhancement of skin barrier function. Given these benefits, there is  
15           a continuing desire to increase the amount of vitamin B compounds delivered into human skin from topically applied cosmetic compositions to further enhance the skin benefits provided by these compounds.

          It is known that a rate limiting step in the percutaneous absorption of ingredients is their initial penetration into and across the stratum corneum, see, e.g., Suhonen et al., "Chemical  
20           Enhancement of Percutaneous Absorption In Relation To Stratum Corneum Structural Alterations", Suhonen et al., Journal of Controlled Release, 59 (1999), pgs 149-161. Suhonen et al. also observed that there are at least two potential pathways thru the stratum corneum: 1) transcellular (i.e., across the corneocytes and the lipid matrix), and 2) intercellular (i.e., via the lipid domains between the corneocytes), with the intercellular route believed to be providing the  
25           principal route for the permeation of ingredients.

          Skin penetration enhancers are well known. As far back as 1997, a literature review by Osborne et al. purported to find more than 275 chemical compounds cited as enhancing skin permeation (see, e.g., Osborne, David, "Skin Penetration Enhancers Cited in the Technical Literature, Pharmaceutical Technology", 1997, pp 58-66). Compounds identified by Osborne  
30           include various species of fatty alcohols, fatty acid esters, fatty acids, fatty alcohol ethers, enzymes, amines and amides, surfactants, n-methyl pyrrolidones, ionic compounds and various

others. More recently, Williams et al. noted that “[n]umerous compounds have been evaluated for penetration enhancing activity, including sulfoxides (such as dimethylsulphoxide, DMSO), azones (e.g., laurocapram), pyrrolidones, (for example 2-pyrrolidone, 2P), alcohols and alkanols (ethanol, or decanol), glycols (for example propylene glycol, PG, a common excipient in topically applied dosage forms), surfactants (also common in dosage forms) and terpenes”. Williams et al., “Penetration Enhancers”, Advanced Drug Delivery Reviews 56, pgs 603-618 (2004), see also, Pathan et al., “Chemical Penetration Enhancers for Transdermal Drug Delivery Systems”, Tropical Journal of Pharmaceutical Research, Vol. 8(2), pgs 173-179 (2009).

While various skin penetration enhancers are known, their mechanisms of action, particularly in the stratum corneum, are still being investigated. For example, Suhonen et al. postulated that “many penetration enhancers are capable of inserting between the hydrophobic tails of the bilayer, thus disturbing their packing, increasing their fluidity and, subsequently, leading to easier diffusion of lipid-like penetrants”. Suhonen et al. also concluded however that “[a]lthough during the last 10 years an enormous amount of knowledge became available on the structure of the stratum corneum and the effect of solvent and penetration enhancers on this structure, still our knowledge on this tissue and its lipid organization is very limited”. Similarly, Williams et al. noted in 2004 that the inclusion of penetration enhancers “into topical or transdermal formulations is limited since the underlying mechanisms of action of these agents are seldom clearly defined”. Even more recently, Williams and Barry, “Penetration enhancers”, Advanced Drug Delivery Reviews, Vol. 64, pgs 128-137 (2012), stated that “[i]t is difficult to select rationally a penetration enhancer for a given permeant.” While the effects of certain individual ingredients on skin penetration has been studied to some degree, the role that combinations of ingredients might play in enhancing penetration of cosmetic agents into and thru the stratum corneum appears to be even less well studied, including how varying concentrations, ratios and/or combinations of ingredients might affect penetration of cosmetic skin ingredients.

## SUMMARY

A cosmetic composition suitable for topical application is provided. In some embodiments, the cosmetic composition comprises glycerin, hexyldecanol, a vitamin B compound, and one or more materials selected from the group consisting of pentylene glycol, hexylene glycol, propylene glycol, triethylene glycol, butylene glycol, and hexanediol. In some

embodiments, the ratio of the combination of glycerin, hexyldecanol, and one or more materials to the vitamin B compound is at least 2:1.

In some embodiments, the cosmetic composition comprises glycerin, hexyldecanol, and a vitamin B compound, wherein the concentration of hexyldecanol is greater than 3% by weight of cosmetic composition, and the concentration of the vitamin B compound is greater than 1% by weight of the cosmetic composition.

In some embodiments, the cosmetic composition comprises glycerin; a vitamin B compound; one or more materials selected from the group consisting of pentylene glycol, hexylene glycol, propylene glycol, triethylene glycol, butylene glycol, and hexanediol; and one or more penetration enhancers selected from the group consisting of hexyldecanol, butyldecanol, 4-methyl-5-decanol, 2-heptyldecanol, octyldecanol, decyltetradecanol, 2-butyl-1-octanol, 2-octyl-1-decanol, 2-dodecyl-1-hexadecanol, and 2-tetradecylotadecanol. In some embodiments, the ratio of the combination of glycerin, hexyldecanol, and one or more materials to the vitamin B compound is at least 2:1.

A method of using a cosmetic composition of using the composition is also provided. At least one method may comprise applying a cosmetic composition to a facial skin surface in need of treatment, wherein the cosmetic composition comprises: glycerin; one or more materials selected from the group consisting of 1,2-pentanediol, 1,4-pentanediol, 2,4-pentanediol, 1,5-pentanediol, 1,2-butanediol, 1,3-butanediol, 1,4-butanediol, 2,3-butanediol, 1,2-hexanediol, 1,5-hexanediol, 1,6-hexanediol, 2,5-hexanediol, hexylene glycol, and combinations thereof; hexyldecanol; a vitamin B compound; and wherein the ratio of the combination of i) and ii) and iii) to iv) in the skin care composition is at least 2:1.

#### BRIEF DESCRIPTION OF THE DRAWINGS

While the specification concludes with claims, it is believed that the same will be better understood from the following description taken in conjunction with the accompanying drawings in which:

FIG. 1 is a graph of total niacinamide penetration versus glycerin/niacinamide concentration ratio for four cosmetic compositions;

FIG. 2 is a schematic representation of the epidermal and dermal layers of human skin;

FIG. 3 is a schematic representation of lipid bilayers and water channels of the stratum corneum;

FIG. 4 is a graphic depiction from an *in silico* model of a lipid bilayer and water channels of the stratum corneum, wherein molecules of niacinamide are shown;

5 FIG. 5 is an enlargement of a portion of the lipid bilayer shown in FIG. 5, wherein niacinamide molecules are shown embedded in the head groups of the lipid bilayer;

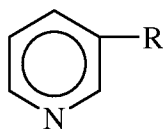
FIG. 6 graphic depiction from an *in silico* model of a lipid bilayer and water channels of the stratum corneum, wherein molecules of niacinamide are shown within the water channels following introduction of glycerin into the water channels; and

10 FIG. 7 is an enlargement of a portion of the lipid bilayer shown in FIG. 7.

#### DETAILED DESCRIPTION

Described hereafter are various embodiments of cosmetic compositions providing enhanced penetration of vitamin B compounds into the stratum corneum. It has been  
15 surprisingly discovered that it is possible to enhance penetration by combining certain ingredients and/or ratios/concentrations of ingredients in a skin care composition.

As used herein, vitamin B compounds include B1 compounds, B2 compounds, B3 compound, B5 compounds, such as panthenol or “pro-B5”, pantothenic acid, pantothenyl; B6  
20 compounds, such as pyroxidine, pyridoxal, pyridoxamine, carnitine, thiamine, and riboflavin. In some embodiments, the vitamin B compound is a B3 compound having the formula:



wherein R is - CONH<sub>2</sub> (*i.e.*, niacinamide), - COOH (*i.e.*, nicotinic acid) or - CH<sub>2</sub>OH (*i.e.*, nicotinyl alcohol); derivatives thereof; and salts of any of the foregoing.

As used herein, the term diol refers to a compound comprising two hydroxyl groups  
25 bonded to different carbon atoms and having the general formula R-OH. A diol may be linear or branched, the hydroxyl groups may be on adjacent or non-adjacent carbon atoms, and the carbon bonds may include single and/or double bonds. In some embodiments, the diol may be linear and has a carbon chain length from between 4 and 6 atoms (C<sub>4</sub> to C<sub>6</sub>), optionally with one or more branched methyl groups (CH<sub>3</sub>).

## I. *IN VITRO* OBSERVATIONS RELATING TO A VITAMIN B COMPOUND AND GLYCERIN

Topical application of niacinamide, which is soluble in both water and glycerin, can be associated with a variety of cosmetic skin care benefits. These may include: i) normalization of age associated depletions of nicotinamide coenzymes in skin, ii) up-regulation of epidermal ceramide synthesis with concurrent epidermal barrier benefits, iii) protection against damage produced by UV irradiation, iv) inhibition of the transfer of melanosomes from melanocytes to keratinocytes (thereby providing a potential skin tone benefit), and reduction in sebaceous lipogenesis. These activities may improve the appearance of aging/photo-damaged skin.

Glycerin is a small, polar molecule that is liquid at room temperature and miscible with water. Endogenous glycerin is believed to be an important component of skin hydration and topical application of cosmetic products containing glycerin can be associated with improvements in barrier function, induction of biomarkers associated with keratinocyte proliferation and wound healing, reduction in melanin intensity, increases in epidermal thickness, and improvements in general skin appearance.

Given the cosmetic benefits likely provided by glycerin and vitamin B compounds, it is often desirable to combine both in cosmetic compositions. However, it has been observed that the presence of glycerin in such a cosmetic composition can retard the penetration of niacinamide into the skin. Referring to Example 1, it has been observed that increasing glycerin concentrations can decrease niacinamide skin penetration from a variety of cosmetic compositions. In Example 1, a series of *in vitro* skin penetration studies were conducted over a 6 hr time period to assess the impact of glycerin upon the penetration of radiolabeled niacinamide from several cosmetic compositions, including an oil-water emulsion, a water-in-silicone emulsion, and a water gel. The cosmetic compositions were topically applied to split-thickness human cadaver skin. A Franz diffusion cell system was used to measure the amount of penetration of the radiolabeled niacinamide thru the cadaver skin. The kinetics of *in vitro* radiolabeled niacinamide skin penetration were observed at fixed glycerin concentrations, and the impact of glycerin and niacinamide concentrations upon the penetration of radiolabeled niacinamide and glycerin over 6 hours were measured. In addition, niacinamide penetration was measured as a function of glycerin concentration.

Referring to FIG. 1, total niacinamide penetration as a function of the glycerin/niacinamide ratio for the four cosmetic compositions tested in Example 1 are plotted. The data suggests that the addition of glycerin decreases niacinamide penetration from a variety of cosmetic compositions. Further, the data suggests that increasing glycerin concentration  
5 incrementally decreases niacinamide skin penetration from a variety of cosmetic compositions.

## II. *IN SILICO* OBSERVATIONS RELATING TO A VITAMIN B COMPOUND AND GLYCERIN

Referring to FIG. 2, a schematic representation of the epidermal and dermal skin layers is  
10 shown. The outer most layer of the epidermis 10 is the stratum corneum 12. Below the stratum corneum lies the stratum lucidum, the stratum granulosum, the stratum spinosum, and the stratum basale layers (collectively, reference numeral 18). Referring to FIG. 3, the stratum corneum comprises lipid bilayers 16 and water channels 18. The lipid bilayers 16 predominantly  
15 comprise ceramides, cholesterol, and free fatty acid (FFA) mixtures arranged in a highly matrixed head/tail configuration, represented by the head groups 20 and tail groups 22, shown schematically in FIG. 3.

Referring to FIGS. 4 and 5, atomistic, in-silico modeling of a lipid bilayer region suggests a possible explanation for the *in vitro* glycerin effect previously discussed, namely the effect of decreasing niacinamide penetration into the skin when glycerin is present in a cosmetic  
20 composition. FIGS. 4 and 5 illustrate an *in silico* model of the lipid bilayer region of the stratum corneum, where heads groups and tails groups of the lipids are shown in a packed arrangement. In between the opposing head groups are the water channels. The *in silico* model suggests that niacinamide molecules, when only interacting with water molecules of the water channels, will distribute themselves between sitting on the head group surface of the lipid bilayer and  
25 dissolving in the water of the water channels. In comparison, FIGS. 6 and 7 illustrate the effect of glycerin on niacinamide in the water channels. It appears that glycerin favorably binds to the hydrophilic head groups of the lipid bilayers and to itself via effective H-bonding and networking, thereby essentially “gelling” the water channel and entrapping the niacinamide molecules within the water channels to retard penetration of niacinamide through the water  
30 channels.

While it has been observed, both *in vitro* and *in silico*, that glycerin may sometimes be an impediment to the penetration of niacinamide thru the skin, it has been surprisingly discovered that certain ingredient(s), such as hexyldecanol (e.g. 2-hexyl-1-decanol) and/or certain diols, may counteract this effect and in fact may, in some instances, enable glycerin to synergistically enhance rather than retard penetration of niacinamide into and thru the stratum corneum. Still further, empirical evidence suggests that particular ratios/concentrations of ingredients may be more effective at enhancing the penetration of vitamin B compounds into and thru the stratum corneum.

### III. VITAMIN B COMPOUNDS, GLYCERIN, AND HEXYLDECANOL

It has been surprisingly observed *in vitro* that the addition of glycerin to a cosmetic composition comprising hexyldecanol can increase, rather than decrease, the penetration of radiolabeled niacinamide thru split thickness human cadaver skin. Tables 1-7 below summarize the total percentage dose of niacinamide recovered from the combination of the epidermis, dermis, and the Franz Cell Receptor (which represents total niacinamide penetration thru the skin during the test period) after application of the cosmetic compositions set forth in Tables 9-11.

Referring to Example 2, penetration of radiolabeled niacinamide into cadaver skin was assessed over a 24 hour time period using a Franz diffusion cell system, which is a well known device in the art for measuring penetration of compounds into skin samples. Table 1 below summarizes the total percentage dose of niacinamide recovered from the combination of the epidermis, dermis, and the Franz Cell Receptor (which represents total niacinamide penetration thru the skin during the test period) after application of the cosmetic compositions set forth in Examples 2A, 2B, 2C, and 2D. Six replicates were tested for each cosmetic composition. In addition, Table 1 sets forth the ratio of the concentrations of glycerin/hexyldecanol to niacinamide and total concentration of glycerin/hexyldecanol in the cosmetic composition. The cosmetic composition of Example 2A included 5% niacinamide. The cosmetic composition of Example 2B included 5% niacinamide (shown in Table as "N") and 7% glycerin (shown in Table as "G"). The cosmetic composition of Example 2C included 5% niacinamide and 5% hexyldecanol (shown in Table as "HD"), and the cosmetic composition of Example 2D included 5% niacinamide, 7% glycerin, and 5% hexyldecanol.



TABLE 1

|                        | Example 2A<br>5%N | Example 2B<br>5%N/7%G | Example 2C<br>5%N/ 5%HD | Example 2D<br>5%N/7%G/<br>5%HD |
|------------------------|-------------------|-----------------------|-------------------------|--------------------------------|
| Ratio                  | NA                | 1.4                   | 1                       | 2.4                            |
| Total<br>Concentration | NA                | 7%                    | 5%                      | 12%                            |
| Sample #1              | 15.94             | 32.43                 | 64.16                   | 64.29                          |
| Sample #2              | 22.01             | 38.04                 | 53.58                   | 91.75                          |
| Sample #3              | 36.81             | 20.91                 | 74.96                   | 72.08                          |
| Sample #4              | 29.61             | 29.43                 | 64.39                   | 93.78                          |
| Sample #5              | 44.98             | 32.60                 | 50.40                   | 68.24                          |
| Sample #6              | 52.56             | 30.64                 | 30.85                   | 46.33                          |
| Avg                    | 33.65             | 30.68                 | 56.39                   | 72.74                          |
| Stdv                   | 13.87             | 5.62                  | 15.27                   | 17.85                          |
| P value                |                   | 0.64                  | 0.02                    | 0.002                          |

Comparing Examples 2A and 2B, it appears that the addition of 7% glycerin resulted in no increase to a slight decrease in average niacinamide penetration, consistent with the observations previously discussed for Example 1 over a shorter 6 hour time period. While the p-value and standard deviation values are somewhat high, it is believed this data still tends to support the general directionality of the observation. Comparing Examples 2A and 2C, the addition of 5% hexyldecanol resulted in an increase in average niacinamide penetration from 33.65% to 56.39%. However, comparing Examples 2A and 2D, the addition of both 7% glycerin and 5% hexyldecanol resulted in an increase in average niacinamide penetration to 72.74%. Surprisingly, it appears that the negative effect that glycerin can have on niacinamide penetration can be reduced or mitigated by adding hexyldecanol to a cosmetic composition. Further, it appears that, in at least some instances, glycerin in the presence of hexyldecanol can increase rather than decrease average niacinamide penetration. Further, to achieve at least a doubling of

average niacinamide penetration, it appears that a ratio of around 2:1 (or greater) of the concentrations of glycerin/hexyldecanol to niacinamide may be beneficial.

Referring to Table 2 below, the effect of increasing hexyldecanol concentration on niacinamide penetration, in the absence of glycerin, on human cadaver skin is illustrated. Example 2E included 5% niacinamide and 10% hexyldecanol, while Example 2F included 5% niacinamide and 15% hexyldecanol.

TABLE 2

| Sample  | Example 2A<br>5%N | Example 2C<br>5%N/ 5%HD | Example 2E<br>5%N/10%HD | Example 2F<br>5%N/15%HD |
|---------|-------------------|-------------------------|-------------------------|-------------------------|
| #1      | 15.94             | 64.16                   | 55.21                   | 87.11                   |
| #2      | 22.01             | 53.58                   | 42.04                   | 85.95                   |
| #3      | 36.81             | 74.96                   | 61.74                   | 60.81                   |
| #4      | 29.61             | 64.39                   | 87                      | 93.17                   |
| #5      | 44.98             | 50.40                   | 88.22                   | 70.59                   |
| #6      | 52.56             | 30.85                   | 88.32                   | 80.12                   |
| Avg     | 33.65             | 56.39                   | 70.42                   | 79.63                   |
| Stdv    | 13.87             | 15.27                   | 20.12                   | 11.96                   |
| P value |                   | 0.02                    | 0.004                   | 0.0001                  |

Comparing Examples 2A and 2C, the addition of 5% hexyldecanol increased average niacinamide penetration from 33.65% to 56.39%. Comparing Examples 2A and 2E, the addition of 10% hexyldecanol increased average niacinamide penetration to 70.42% from 33.65%. Finally, comparing Examples 2A and 2F, the addition of 15% hexyldecanol increased average niacinamide penetration from 33.65% to 79.63%. This data appears to suggest a slowing of the rate of increase of the niacinamide penetration benefit from increasing hexyldecanol concentration.

Referring to Table 3 below, the effect of increasing hexyldecanol concentration on niacinamide penetration, in the presence of glycerin, on human cadaver skin is illustrated. Table 4 summarizes the total percentage dose of niacinamide recovered from the combination of the

epidermis, dermis, and the Franz Cell Receptor after application of the cosmetic compositions set forth in Examples 2B, 2D, 2G, and 2H. The cosmetic composition of Example 2G included 5% niacinamide, 7% glycerin, and 10% hexyldecanol; and the cosmetic composition of Example 2H included 5% niacinamide, 7% glycerin, and 15% hexyldecanol.

5

TABLE 3

| Sample  | Example 2B<br>5%N/7%G | Example 2D<br>5%N/7%G/<br>5%HD | Example 2G<br>5%N/7%G/<br>10%HD | Example 2H<br>5%N/7%G/<br>15%HD |
|---------|-----------------------|--------------------------------|---------------------------------|---------------------------------|
| #1      | 32.43                 | 64.29                          | 70.67                           | 83.86                           |
| #2      | 38.04                 | 91.75                          | 80.15                           | 83.77                           |
| #3      | 20.91                 | 72.08                          | 68.88                           | 77.68                           |
| #4      | 29.43                 | 93.78                          | 75.56                           | 68.58                           |
| #5      | 32.60                 | 68.24                          | 80.65                           | 74.74                           |
| #6      | 30.64                 | 46.33                          | 83.31                           | 88.03                           |
| Avg     | 30.68                 | 72.74                          | 76.54                           | 79.44                           |
| Stdv    | 5.62                  | 17.85                          | 5.83                            | 7.14                            |
| P value | 0.64                  | 0.002                          | <0.0001                         | <0.0001                         |

Comparing Examples 2B and 2D, the addition of 5% hexyldecanol increased average niacinamide penetration from 30.68% to 72.74%. Comparing Examples 2B and 2G, the addition of 10% hexyldecanol increased average niacinamide penetration from 30.68% to 76.54%. Comparing Examples 2B and 2H, the addition of 15% hexyldecanol increased average niacinamide penetration to 79.44%, which appears to suggest (although less strongly than shown by the data in Table 2) a slowing of the rate of increase of the penetration benefit from increasing hexyldecanol concentration in the presence of glycerin. It also appears that as hexyldecanol concentration increases (for fixed glycerin concentrations), the positive effect on niacinamide penetration by glycerin decreases. For example, comparing again Examples 2C and 2D, niacinamide penetration increased from 56.39% to 72.74% with the addition of 7% glycerin in

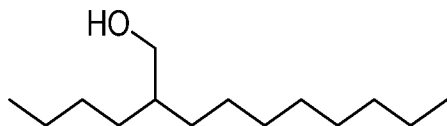
the presence of 5% hexyldecanol. Comparing Examples 2E (Table 3) and 2G (Table 4), the addition of 7% glycerin in the presence of 10% hexyldecanol resulted in a modest average increase in niacinamide penetration from 70.42% to 76.54%. Comparing Examples 2F (Table 3) and 2H (Table 4), the addition of 7% glycerin in the presence of 15% hexyldecanol resulted in no appreciable average increase in niacinamide penetration (79.63% v. 79.44%).

This data appears to support the proposition previously discussed that the negative impact that glycerin can have on niacinamide penetration can be reduced or mitigated by the addition of hexyldecanol. Further, this data would appear to suggest that the increase in niacinamide penetration observed when comparing Examples 2C and 2D appears to erode as the concentration of hexyldecanol increases at a fixed glycerin concentration. Without intending to be bound by any theory, it appears that relatively higher concentrations of hexyldecanol (and/or ratios of hexyldecanol to glycerin) may provide a diminishing incremental improvement in niacinamide penetration in the presence of glycerin. It also seems possible that relatively lower concentrations of hexyldecanol may not overcome the observed effect of glycerin retarding niacinamide penetration if the concentration of glycerin is too great.

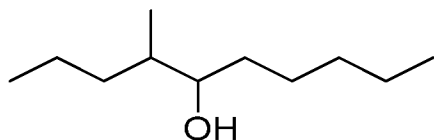
Thus, in some embodiments, the cosmetic compositions described herein may have a concentration of hexyldecanol greater than 0.5%, 1%, 2%, 3%, 4%, 5%, 6%, 8%, 10% or 12% and/or less than 20%, 18%, 16%, 15% or 14% by weight of the cosmetic composition. In some embodiments, the cosmetic compositions described herein may have a concentration of hexyldecanol greater than about 0.5%, 1%, 2%, 3%, 4%, 5%, 6%, 8%, 10% or 12% and/or less than about 20%, 18%, 16%, 15% or 14% by weight of the cosmetic composition. Further, in some embodiments, the cosmetic compositions have a ratio of hexyldecanol to glycerin of greater than 0.75:1; 1:1; or 1.25:1 and/or less than 2.5:1, 2:1, 1.75:1 or 1.5:1. Further, in some embodiments, the cosmetic compositions have a ratio of hexyldecanol to glycerin of greater than about 0.75:1, 1:1, or 1.25:1 and/or less than about 2.5:1, 2:1, 1.75:1, or 1.5:1. Still further, in some embodiments, the cosmetic compositions can have a concentration of glycerin, by weight of the cosmetic composition, of greater than 4%, 5%, 6%, 7%, 8%, 10%, 12%, 15%, 20% and/or less than 30%, 25%, or 20% in combination with hexyldecanol. Still further, the cosmetic compositions can also have a concentration of glycerin, by weight of the cosmetic composition, of greater than about 4%, 5%, 6%, 7%, 8%, 10%, 12%, 15%, 20% and/or less than about 30%, 25%, or 20% in combination with hexyldecanol. In some embodiments, the cosmetic

compositions have a concentration of a vitamin B compound, by weight of the cosmetic composition, of greater than 1%, 2%, 3%, 4%, or 5% and/or less than 10%, 8%, or 6%. In some embodiments, the cosmetic compositions have a concentration of a vitamin B compound, by weight of the cosmetic composition, of greater than about 1%, 2%, 3%, 4%, or 5% and/or less than about 10%, 8%, or 6%. It is believed that higher, rather than lower, concentrations of the vitamin B compound are preferred in order to improve the likelihood of a detectable *in vivo* skin benefit from the niacinamide. In some embodiments, the cosmetic composition has an average vitamin B total recovery, as a percentage of total dose using a Franz cell test method, greater than 50%, 60%, or 70% and/or less than 85%, 80% or 70%.

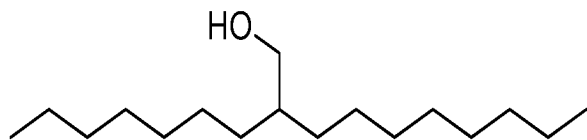
Alternatively, hexyldecanol may be replaced or combined with butyldecanol. For example, the butyldecanol may have the following formula:



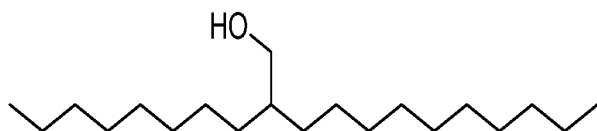
Alternatively, hexyldecanol may be replaced or combined with 4-methyl-5-decanol. For example, 4-methyl-5-decanol may have the following formula:



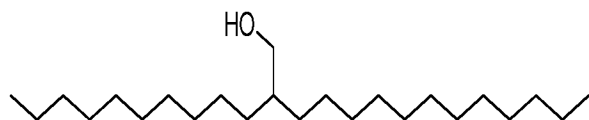
Alternatively, hexyldecanol may be replaced or combined with 2-heptyldecanol. For example, 2-heptyldecanol may have the following formula:



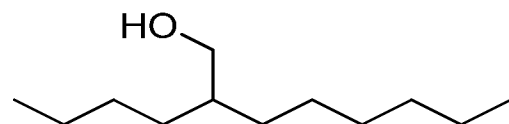
Alternatively, hexyldecanol may be replaced or combined with octyldecanol. For example, octyldecanol may have the following formula:



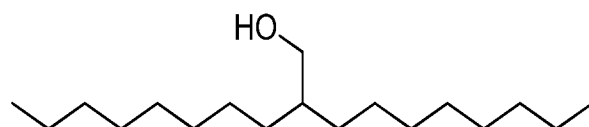
Alternatively, hexyldecanol may be replaced or combined with decyltetradecanol. For example, decyltetradecanol may have the following formula:



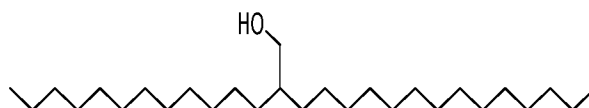
Alternatively, hexyldecanol may be replaced or combined with 2-butyl-1-octanol. For example, 2-butyl-1-octanol may have the following formula:



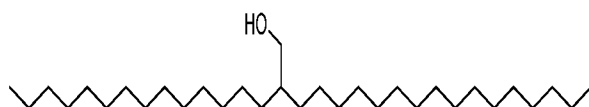
Alternatively, hexyldecanol may be replaced or combined with 2-octyl-1-decanol. For example, 2-octyl-1-decanol may have the following formula:



Alternatively, hexyldecanol may be replaced or combined with 2-dodecyl-1-hexadecanol. For example, 2-dodecyl-1-hexadecanol may have the following formula:



Alternatively, hexyldecanol may be replaced or combined with 2-tetradecyloctadecanol. For example, the 2-tetradecyloctadecanol may have the following formula:



Alternatively, hexyldecanol may be replaced or combined with a mixture including two or more of butyldecanol, 4-methyl-5-decanol, 2-heptyldecanol, octyldecanol, decyltetradecanol, 2-butyl-1-octanol, 2-octyl-1-decanol, 2-dodecyl-1-hexadecanol, and 2-tetradecyloctadecanol.

IV. VITAMIN B COMPOUNDS, HEXYLDECANOL, GLYCERIN AND VARIOUS DIOLS

It has also been discovered that some liquid diols can further increase niacinamide penetration when combined with hexyldecanol and glycerin and that, in some embodiments, certain ratios and concentrations of ingredients may be desirable. These discoveries can allow a cosmetic composition formulator to customize a cosmetic composition to achieve varying degrees of penetration of a vitamin B compound in the presence of glycerin while providing significant formulation flexibility. For example, by combining certain ingredients, it may be possible to achieve superior penetration of a vitamin B compound while lowering the individual (and total combined) concentrations of the operative ingredients, thereby allowing "more space" in the formulation for the inclusion of other materials. Alternatively, by including certain ingredients versus others, a formulator may be able to better tailor the formulation to achieve desired aesthetics. Some of the diols include, but are not limited to, various forms of pentylene glycol, butylene glycol, hexylene glycol, hexanediol, propylene glycol, triethylene glycol, and combinations thereof. In some embodiments, the diols may include 1,2-pentanediol; 1,4-pentanediol; 2,4-pentanediol; 1,5-pentanediol; 1,2-butanediol; 1,3-butanediol; 1,4-butanediol; 2,3-butanediol; 1,2-hexanediol; 1,5-hexanediol; 1,6-hexanediol; 2,5-hexanediol; hexylene glycol; and combinations thereof. Diols that are liquid at room temperature are believed to be better at solubilizing the vitamin B compound and enhancing the transport of the niacinamide and/or hexyldecanol from the cosmetic composition and into the stratum corneum.

Referring to Example 3, penetration of radiolabeled niacinamide into cadaver skin was assessed using the same Franz Diffusion Cell system as previously discussed for Example 2. Table 4 below summarizes the total percentage dose of niacinamide recovered from the combination of the epidermis, dermis, and the Franz Cell Receptor after application of the cosmetic compositions set forth in Examples 2H, 3A, 3B, 3C, and 3D. In addition, Table 4 sets forth the ratio of the concentrations of diols/glycerin/hexyldecanol to niacinamide, and total concentration of diols/glycerin/hexyldecanol in the cosmetic composition. The cosmetic composition of Example 3A included 5% niacinamide, 7% glycerin, 6% pentylene glycol and 5% hexyldecanol. The cosmetic composition of Example 3B included 5% niacinamide, 7% glycerin, 1% hexanediol, and 5% hexyldecanol. The cosmetic composition of Example 3C included 5% niacinamide, 7% glycerin, 6% pentylene glycol, 1% hexanediol, and 5% hexyldecanol.

TABLE 4

| Sample                 | Example 2H<br>5%N/7%G/<br>15%HD | Example 3A<br>5%N/7%G/6%PG/<br>5%HD | Example 3B<br>5%N/7%G/1%H/<br>5%HD | Example 3C<br>5%N/7%G/6%PG<br>/1%H/5%HD |
|------------------------|---------------------------------|-------------------------------------|------------------------------------|-----------------------------------------|
| Ratio                  | 4.4                             | 3.6                                 | 2.6                                | 3.8                                     |
| Total<br>Concentration | 22%                             | 18%                                 | 13%                                | 19%                                     |
| #1                     | 83.86                           | 75.06                               | 78.52                              | 94.66                                   |
| #2                     | 83.77                           | 74.95                               | 80.29                              | 91.39                                   |
| #3                     | 77.68                           | 85.94                               | 69.25                              | 85.5                                    |
| #4                     | 68.58                           | 88.89                               | 79.63                              | 84.54                                   |
| #5                     | 74.74                           | 85.21                               | 89.70                              | 96.23                                   |
| #6                     | 88.03                           | 84.21                               | 95.63                              | 89.84                                   |
| Avg                    | 79.44                           | 82.38                               | 82.17                              | 90.36                                   |
| Stdv                   | 7.14                            | 5.92                                | 9.25                               | 4.73                                    |
| P value                | < 0.0001                        | < 0.0001                            | < 0.0001                           | < 0.0001                                |

Comparing Examples 3A and 2H, the cosmetic composition of Example 3A provided similar (or slightly superior) average niacinamide penetration results with 5% hexyldecanol and 18% total concentration of diols/glycerin/hexyldecanol as Example 2H, which included 15% hexyldecanol and 22% total concentration of diols/glycerin/hexyldecanol. Example 3B provided similar average niacinamide penetration results to Examples 3A and 2H, with the lowest total concentration of diols/glycerin/hexyldecanol (13% v. 18% and 22%). Example 3C provided superior average niacinamide penetration results to Example 2H with a lower total concentration of diols/glycerin/hexyldecanol (19% v. 22%). Surprisingly, this data suggests that it is possible to achieve superior (and/or more efficient) niacinamide penetration in the presence of glycerin by combining hexyldecanol with diols such as pentylene glycol and/or hexanediol versus merely increasing the concentration of hexyldecanol to achieve a penetration increase.



Table 5 below summarizes the total percentage dose of niacinamide recovered from the combination of the epidermis, dermis, and the Franz Cell Receptor after application of the cosmetic compositions set forth in Examples 2A, 2B, 2D, 3D, and 3E. The cosmetic composition of Example 3D included 5% niacinamide, 7% glycerin, and 6% pentylene glycol, and the cosmetic composition of Example 3E included 5% niacinamide and 6% pentylene glycol.

TABLE 5

| Sample  | Example 2A<br>5%N | Example 2B<br>5%N/7%G | Example 2D<br>5%N/7%G/<br>5%HD | Example 3D<br>5%N/7%G/<br>6%PG | Example 3E<br>5%N/6%PG |
|---------|-------------------|-----------------------|--------------------------------|--------------------------------|------------------------|
| #1      | 15.94             | 32.43                 | 64.29                          | 19.94                          | 38.46                  |
| #2      | 22.01             | 38.04                 | 91.75                          | 49.83                          | 72.31                  |
| #3      | 36.81             | 20.91                 | 72.08                          | 34.60                          | 32.52                  |
| #4      | 29.61             | 29.43                 | 93.78                          | 22.50                          | 70.60                  |
| #5      | 44.98             | 32.60                 | 68.24                          | 40.59                          | 33.74                  |
| #6      | 52.56             | 30.64                 | 46.33                          | 49.06                          | 84.43                  |
| Avg     | 33.65             | 30.68                 | 72.74                          | 36.09                          | 55.34                  |
| Stdv    | 13.87             | 5.62                  | 17.85                          | 12.85                          | 22.97                  |
| P value | -                 | 0.64                  | 0.002                          | 0.76                           | 0.08                   |

Comparing Examples 2B and 3D, the addition of pentylene glycol resulted in an increase in the average niacinamide penetration (36.09% v. 30.68%) in the presence of glycerin. However, comparing Examples 3E and 2A, this increase was not nearly as great as provided by the addition of pentylene glycol in the absence of glycerin. This data would tend to support the prior observation that the presence of glycerin in a cosmetic composition can retard penetration of niacinamide thru the skin. This data would also suggest that adding pentylene glycol to a cosmetic composition containing glycerin can result in a modest increase in average niacinamide penetration but not nearly as significant as observed by the addition of a similar concentration of hexyldecanol. For example, comparing Examples 2D and 3D, the addition of hexyldecanol

provided a superior average niacinamide penetration result compared to that achieved by the addition of pentylene glycol (72.74% v. 36.09%), despite the fact that the added concentration of hexyldecanol was slightly lower than the pentylene glycol concentration (5% v. 6%).

Table 6 below summarizes the total percentage dose of niacinamide recovered from the combination of the epidermis, dermis, and the Franz Cell Receptor after application of the cosmetic compositions set forth in Examples 2A, 3E, 3F, and 3G. The cosmetic composition of Example 3F included 5% niacinamide and 1% hexanediol. The cosmetic composition of Example 3G included 5% niacinamide and 3% hexylene glycol.

TABLE 6

| Sample  | Example 2A<br>5%N | Example 3E<br>5%N/6%PG | Example 3F<br>5%N/<br>1%Hexanediol | Example 3G<br>5%N/ 3%Hexylene<br>Glycol |
|---------|-------------------|------------------------|------------------------------------|-----------------------------------------|
| #1      | 15.94             | 38.46                  | 33.94                              | 46.94                                   |
| #2      | 22.01             | 72.31                  | 34.95                              | 43.44                                   |
| #3      | 36.81             | 32.52                  | 52.73                              | 50.21                                   |
| #4      | 29.61             | 70.6                   | 31.77                              | 38.96                                   |
| #5      | 44.98             | 33.74                  | 80.83                              | 39.77                                   |
| #6      | 52.56             | 84.43                  | 80.56                              | 38.1                                    |
| Avg     | 33.65             | 55.34                  | 52.46                              | 42.9                                    |
| Stdv    | 13.87             | 22.97                  | 23.12                              | 4.87                                    |
| P value |                   | 0.08                   | 0.12                               | 0.15                                    |

Notably, the average penetration of niacinamide increased in all the Examples compared to Example 2A. Thus, it seems possible that these materials could at least marginally improve the penetration of niacinamide in the presence of glycerin and hexyldecanol. Comparing Examples 3E and 3F, hexanediol appears to be much more efficient than pentylene glycol at increasing the average penetration of niacinamide at a given concentration, as hexanediol achieved a penetration result close to that of pentylene glycol with only a 1% concentration

versus a 6% concentration of pentylene glycol. Comparing Examples 3E and 2C (Table 2), while both hexyldecanol and pentylene glycol increased average niacinamide penetration similarly in the absence of glycerin, the combination of hexyldecanol and glycerin (Example 2D, Table 3) provided a superior penetration benefit to the combination of pentylene glycol and glycerin (Example 3D, Table 5) at similar concentrations. Comparing Examples 3E and 3D (Table 5), the addition of 7% glycerin in Example 3D resulted in a decrease in average niacinamide penetration from 55.32% to 36.09%, which tends to support the previously discussed observations of a niacinamide penetration decrease from resulting from the addition of glycerin.

Table 7 below summarizes the total percentage dose of niacinamide recovered from the combination of the epidermis, dermis, and the Franz Cell Receptor after application of the cosmetic compositions set forth in Examples 4A-4G. The cosmetic composition of Example 4A included 5% niacinamide, 2% butylene glycol, and 3% pentylene glycol. The cosmetic composition of Example 4B included 5% niacinamide, 7% glycerin, 5% hexyldecanol, 3% butylene glycol, 6% pentylene glycol, 3% hexylene glycol, and 1% hexanediol (shown as “XD” in Table 7). The cosmetic composition of Example 4C included 5% niacinamide, 7% glycerin, 5% hexyldecanol, 3% propylene glycol, and 1.5% hexylene glycol. The cosmetic composition of Example 4D included 5% niacinamide, 7% glycerin, 5% hexyldecanol, 3% pentylene glycol, and 1.5% hexylene glycol. The cosmetic composition of Example 4E included 5% niacinamide, 7% glycerin, 5% hexyldecanol, 3% triethylene glycol (shown as “TG” in Table 7), and 1.5% hexylene glycol.

TABLE 7

| Sample  | 4A                    | 4B                                                       | 4C                                        | 4D                                       | 4E                                       |
|---------|-----------------------|----------------------------------------------------------|-------------------------------------------|------------------------------------------|------------------------------------------|
|         | 5%N/<br>2%BG/<br>3%PG | 5%N/<br>7%G/<br>5%HD/<br>3%BG/<br>6%PG/<br>3%HG/<br>1%XD | 5%N/<br>7%G/<br>5%HD/<br>3%PrG/<br>1.5%HG | 5%N/<br>7%G/<br>5%HD/<br>3%PG/<br>1.5%HG | 5%N/<br>7%G/<br>5%HD/<br>3%TG/<br>1.5%HG |
| #1      | 40.99                 | 91.05                                                    | 81.68                                     | 59.00                                    | 71.19                                    |
| #2      | 60.84                 | 92.30                                                    | 60.99                                     | 74.91                                    | 78.19                                    |
| #3      | 31.32                 | 81.66                                                    | 85.69                                     | 72.21                                    | 63.80                                    |
| #4      | 39.35                 | 91.61                                                    | 64.03                                     | 89.69                                    | 80.72                                    |
| Avg     | 43.12                 | 89.15                                                    | 73.10                                     | 73.95                                    | 73.47                                    |
| Stdv    | 10.86                 | 4.35                                                     | 10.74                                     | 10.90                                    | 6.59                                     |
| P value |                       | 0.00049                                                  | 0.015                                     | 0.013                                    | 0.006                                    |

Comparing Examples 4A and 4C, the cosmetic composition of Example 4C provided significantly superior average niacinamide penetration results with a combination of glycerin, hexyldecanol, and the diols propylene glycol and hexylene glycol as compared to Example 4A, which did not include hexyldecanol or glycerin but did include the diols butylene glycol and pentylene glycol. Example 4D which included glycerin, hexyldecanol, and the diols pentylene glycol and hexylene glycol and Example 4E which included glycerin, hexyldecanol, and the diols triethylene glycol and hexylene glycol also displayed superior average niacinamide penetration as compared to Example 4A. Interestingly, Example 4B which included glycerin, hexyldecanol, and a combination of the four diols butylene glycol, pentylene glycol, hexylene glycol, and hexanediol, provided significantly superior average niacinamide penetration results when compared to Example 4A. Interestingly, Example 4B with a ratio of diols/glycerin/hexyldecanol to niacinamide of 5:1 provided superior average niacinamide as compared to Examples 4C-4E which had a ratio of diols/glycerin/hexyldecanol to niacinamide of

3.3:1. This data suggests that it is possible to achieve superior (and/or more efficient) niacinamide penetration in the presence of glycerin by combining hexyldecanol with a combination of two or more diols such as propylene glycol, butylene glycol, triethylene glycol, pentylene glycol, hexylene glycol, and hexanediol. Table 7 also illustrates some of the many potential combinations of diols that can be included in cosmetic compositions also including glycerin, niacinamide, and hexyldecanol to achieve superior niacinamide penetration.

From Examples 2 and 3 and without intending to be bound by any theory, it appears that some overall qualitative observations may be made and/or inferred. First, the negative impact of glycerin on niacinamide penetration can be significantly reduced and/or obviated by adding an effective amount of hexyldecanol to a cosmetic composition. In addition, it appears that glycerin in the presence of hexyldecanol can in some instances increase, rather than decrease, niacinamide penetration. Second, generally increasing the ratio of diols/glycerin/hexyldecanol to niacinamide can increase niacinamide penetration, and ratios greater than 2:1 may provide at least a doubling of niacinamide penetration and ratios greater than 3:1 may provide even better results. Third, combining two or more diols with hexyldecanol in the presence of glycerin may provide superior niacinamide penetration results compared to merely increasing the concentration of hexyldecanol. Fourth, it may be possible to achieve similar penetration results with lower concentrations of ingredients when combining two or more diols with hexyldecanol versus merely increasing the concentration of hexyldecanol. Fifth, it appears that at least some diols may be providing a different and/or complimentary penetration mechanism of action from hexyldecanol in view of: i) the observation that the addition of hexyldecanol can substantially increase average niacinamide penetration in the presence of glycerin versus the addition pentylene glycol, and ii) the observation that hexyldecanol and pentylene glycol had similar average niacinamide penetration values in the absence of glycerin but quite different individual penetration enhancement effects in the presence of glycerin.

In some embodiments, the cosmetic compositions may have a concentration of one or more liquid diols, by weight of the cosmetic composition, of greater than 1%, 2%, 3%, 4%, 6%, 8%, 10%, 12%, 15%, or 20% and/or less than 30%, 25%, 20% or 15%. In some embodiments, the cosmetic compositions may have a concentration of one or more liquid diols, by weight of the cosmetic composition, of greater than about 1%, 2%, 3%, 4%, 6%, 8%, 10%, 12%, 15%, or 20% and/or less than about 30%, 25%, 20% or 15%. In some embodiments, the total

concentration of diols/glycerin/hexydecanol is greater than 10%, 11%, 12%, 13%, 14%, 16%, 18%, 20%, or 22% and/or less than 35%, 30%, 25%, or 20%. In some embodiments, the total concentration of diols/glycerin/hexydecanol is greater than about 10%, 11%, 12%, 13%, 14%, 16%, 18%, 20%, or 22% and/or less than about 35%, 30%, 25%, or 20%. In some embodiments, the ratio of the total concentration of diols/glycerin/hexyldecanol to niacinamide is at least 2:1, 3:1, 4:1, or 5:1. In some embodiments, the ratio of the total concentration of diols/glycerin/hexyldecanol to niacinamide is at least about 2:1, 3:1, 4:1, or 5:1. In some embodiments, the cosmetic compositions have a concentration of a vitamin B compound, by weight, of greater than 2%, 3%, 4%, or 5% and/or less than 10%, 8%, or 6%. In some  
10 embodiments, the cosmetic compositions have a concentration of a vitamin B compound, by weight, of greater than about 2%, 3%, 4%, or 5% and/or less than about 10%, 8%, or 6%. In some embodiments, the cosmetic composition has an average vitamin B total recovery, as a percentage of total dose using a Franz cell test method, greater than 50%, 60%, 70%, 80%, or 90% and/or less than 95%, 90%, 80%, or 70%. In some embodiments, the cosmetic composition  
15 has an average vitamin B total recovery, as a percentage of total dose using a Franz cell test method, greater than about 50%, 60%, 70%, 80%, or 90% and/or less than about 95%, 90%, 80%, or 70%.

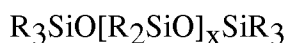
## V. OTHER INGREDIENTS

20 In addition to the previously described ingredients, the cosmetic compositions described herein may also comprise one or more optional ingredients. For example, the cosmetic composition may comprise from about 1% to about 95% by weight of water. The cosmetic composition may comprise from about 1% to about 95% by weight of one or more oils. The cosmetic composition may comprise from about 0.1%, 0.5%, 1%, 2%, 5%, 10%, 15%, 20%,  
25 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, or 90% to about 90%, 85%, 80%, 75%, 70%, 65%, 60%, 55%, 50%, 45%, 40%, 35%, 30%, 25%, 20%, 15%, 10%, 5%, or 3% of the one or more oils. Oils may be used to solubilize, disperse, or carry materials that are not suitable for water or water soluble solvents. Suitable oils include silicones, hydrocarbons, esters, amides, ethers, and mixtures thereof. Oils may be fluid at room  
30 temperature. The oils may be volatile or nonvolatile. "Non-volatile" means a material that exhibits a vapor pressure of no more than about 0.2 mm of mercury at 25°C at one atmosphere

and/or a material that has a boiling point at one atmosphere of at least about 300°C. "Volatile" means that the material exhibits a vapor pressure of at least about 0.2 mm. of mercury at 20° C. Volatile oils may be used to provide a lighter feel when a heavy, greasy film is undesirable. When the cosmetic composition is in the form of an emulsion, oils are carriers typically associated with the oil phase. The cosmetic composition can be in the form of a water-in-oil emulsion, an oil-in-water emulsion, or a water-in-silicone emulsion.

Suitable oils include volatile oils. In certain embodiments, the volatile oils may have a viscosity ranging from about 0.5 to 5 centistokes at 25°C. Volatile oils may be used to promote more rapid drying of the cosmetic composition after it is applied to skin. Nonvolatile oils are also suitable for use in the cosmetic composition. Nonvolatile oils are often used for emolliency and protective properties.

Suitable silicone oils include polysiloxanes. Polysiloxanes may have a viscosity of from about 0.5 to about 1,000,000 centistokes at 25°C. Such polysiloxanes can be represented by the general chemical formula:



wherein R is independently selected from hydrogen or C<sub>1-30</sub> straight or branched chain, saturated or unsaturated alkyl, phenyl or aryl, trialkylsiloxy; and x is an integer from 0 to about 10,000, chosen to achieve the desired molecular weight. In certain embodiments, R is hydrogen, methyl, or ethyl. Commercially available polysiloxanes include the polydimethylsiloxanes, which are also known as dimethicones, examples of which include the DM-Fluid series from Shin-Etsu, the Vicasil<sup>®</sup> series sold by Momentive Performance Materials Inc., and the Dow Corning<sup>®</sup> 200 series sold by Dow Corning Corporation. Specific examples of suitable polydimethylsiloxanes include Dow Corning<sup>®</sup> 200 fluids (also sold as Xiameter<sup>®</sup> PMX-200 Silicone Fluids) having viscosities of 0.65, 1.5, 50, 100, 350, 10,000, 12,500 100,000, and 300,000 centistokes.

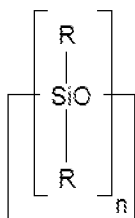
Suitable dimethicones include those represented by the chemical formula:



wherein R and R' are each independently hydrogen or C<sub>1-30</sub> straight or branched chain, saturated or unsaturated alkyl, aryl, or trialkylsiloxy; and x and y are each integers of 1 to 1,000,000 selected to achieve the desired molecular weight. Suitable silicones include phenyl dimethicone (Botansil<sup>™</sup> PD-151 from Botanigenics, Inc.), diphenyl dimethicone (KF-53 and KF-54 from Shin-Etsu), phenyl trimethicone (556 Cosmetic Grade Fluid from Dow Corning), or

trimethylsiloxyphenyl dimethicone (PDM-20, PDM-200, or PDM-1000 from Wacker-Belsil). Other examples include alkyl dimethicones wherein at least R' is a fatty alkyl (*e.g.*, C<sub>12-22</sub>). A suitable alkyl dimethicone is cetyl dimethicone, wherein R' is a straight C16 chain and R is methyl. Cetyl dimethicone, is available as 2502 Cosmetic Fluid from Dow Corning or as Abil  
 5 Wax 9801 or 9814 from Evonik Goldschmidt GmbH.

Cyclic silicones are one type of silicone oil that may be used in the cosmetic composition. Such silicones have the general formula:



wherein R is independently selected from hydrogen or C<sub>1-30</sub> straight or branched chain, saturated  
 10 or unsaturated alkyl, phenyl or aryl, trialkylsiloxy; and where n=3-8 and mixtures thereof. Commonly, a mixture of cyclomethicones is used where n is 4, 5, and/or 6. Commercially available cyclomethicones include Dow Corning UP-1001 Ultra Pure Fluid (*i.e.* n=4), Dow Corning XIAMETER<sup>®</sup> PMX-0245 (*i.e.* n=5), Dow Corning XIAMETER<sup>®</sup> PMX-0245 (*i.e.* n=6), Dow Corning 245 fluid (*i.e.* n=4 and 5), and Dow Corning 345 fluid (*i.e.* n=4, 5, and 6).

15 Suitable hydrocarbon oils include straight, branched, or cyclic alkanes and alkenes. The chain length may be selected based on desired functional characteristics such as volatility. Suitable volatile hydrocarbons may have between 5-20 carbon atoms or, alternately, between 8-16 carbon atoms.

Other suitable oils include esters. The suitable esters typically contained at least 10  
 20 carbon atoms. These esters include esters with hydrocarbyl chains derived from fatty acids or alcohols (*e.g.*, mono-esters, polyhydric alcohol esters, and di- and tri-carboxylic acid esters). The hydrocarbyl radicals of the esters hereof may include or have covalently bonded thereto other compatible functionalities, such as amides and alkoxy moieties (*e.g.*, ethoxy or ether linkages, etc.). Exemplary esters include, but are not limited to, isopropyl isostearate, hexyl  
 25 laurate, isohexyl laurate, isohexyl palmitate, isopropyl palmitate, decyl oleate, isodecyl oleate, hexadecyl stearate, decyl stearate, isopropyl isostearate, dihexyldecyl adipate, lauryl lactate, myristyl lactate, cetyl lactate, oleyl stearate, oleyl oleate, oleyl myristate, lauryl acetate, cetyl



propionate, C12-15 alkyl benzoate, diisopropyl adipate, dibutyl adipate, and oleyl adipate. Other suitable esters are further described in the Personal Care Product Council's *International Cosmetic Ingredient Dictionary and Handbook*, Thirteenth Edition, 2010, under the functional category of "Esters." Other esters suitable for use in the cosmetic composition include those  
5 known as polyhydric alcohol esters and glycerides.

Other suitable oils include amides. Amides include compounds having an amide functional group while being liquid at 25 °C and insoluble in water. Suitable amides include N-acetyl-N-butylaminopropionate, isopropyl N-lauroylsarcosinate, and N,N-diethyltoluamide. Other suitable amides are disclosed in U.S. Patent No. 6,872,401.

10 Other suitable oils include ethers. Suitable ethers include saturated and unsaturated fatty ethers of a polyhydric alcohol, and alkoxyated derivatives thereof. Exemplary ethers include C<sub>4-20</sub> alkyl ethers of polypropylene glycols, and di-C<sub>8-30</sub> alkyl ethers. Suitable examples of these materials include PPG-14 butyl ether, PPG-15 stearyl ether, dioctyl ether, dodecyl octyl ether, and mixtures thereof.

15 The cosmetic composition may comprise an emulsifier. An emulsifier is particularly suitable when the cosmetic composition is in the form of an emulsion or if immiscible materials are being combined. The cosmetic composition may comprise from about 0.05%, 0.1%, 0.2%, 0.3%, 0.5%, or 1% to about 20%, 10%, 5%, 3%, 2%, or 1% emulsifier. Emulsifiers may be nonionic, anionic, or cationic. Non-limiting examples of emulsifiers are disclosed in U.S. Patent  
20 3,755,560, U.S. Patent 4,421,769, and McCutcheon's, *Emulsifiers and Detergents*, 2010 Annual Ed., published by M. C. Publishing Co. Other suitable emulsifiers are further described in the Personal Care Product Council's *International Cosmetic Ingredient Dictionary and Handbook*, Thirteenth Edition, 2006, under the functional category of "Surfactants - Emulsifying Agents."

25 Suitable emulsifiers include the following classes of ethers and esters: ethers of polyglycols and of fatty alcohols, esters of polyglycols and of fatty acids, ethers of polyglycols and of fatty alcohols which are glycosylated, esters of polyglycols and of fatty acids which are glycosylated, ethers of C<sub>12-30</sub> alcohols and of glycerol or of polyglycerol, esters of C<sub>12-30</sub> fatty acids and of glycerol or of polyglycerol, ethers of oxyalkylene-modified C<sub>12-30</sub> alcohols and of glycerol or polyglycerol, ethers of C<sub>12-30</sub> fatty alcohols comprising and of sucrose or of glucose,  
30 esters of sucrose and of C<sub>12-30</sub> fatty acids, esters of pentaerythritol and of C<sub>12-30</sub> fatty acids, esters of sorbitol and/or of sorbitan and of C<sub>12-30</sub> fatty acids, ethers of sorbitol and/or of sorbitan and of

alkoxylated sorbitan, ethers of polyglycols and of cholesterol, esters of C<sub>12-30</sub> fatty acids and of alkoxylated ethers of sorbitol and/or sorbitan, and combinations thereof.

Linear or branched type silicone emulsifiers may also be used. Particularly useful polyether modified silicones include KF-6011, KF-6012, KF-6013, KF-6015, KF-6015, KF-6017, KF-6043, KF-6028, and KF-6038 from Shin Etsu. Also particularly useful are the polyglycerolated linear or branched siloxane emulsifiers including KF-6100, KF-6104, and KF-6105 from Shin Etsu.

Emulsifiers also include emulsifying silicone elastomers. Suitable emulsifying silicone elastomers may include at least one polyalkyl ether or polyglycerolated unit. Polyoxalylenated emulsifying silicone elastomers that may be used include those sold by Shin-Etsu Silicones under the names KSG-21, KSG-20, KSG-30, KSG-31, KSG-32, KSG-33; KSG-210 (dimethicone/PEG-10/15 crosspolymer dispersed in dimethicone); KSG-310 (PEG-15 lauryl dimethicone crosspolymer); KSG-320 (PEG-15 lauryl dimethicone crosspolymer dispersed in isododecane); KSG-330 (PEG-15 lauryl dimethicone crosspolymer dispersed in triethylhexanoin), KSG-340 (PEG-10 lauryl dimethicone crosspolymer and PEG-15 lauryl dimethicone crosspolymer). Other silicone emulsifying elastomers are supplied by Dow Corning™, including PEG-12 dimethicone crosspolymers (DC 9010 and 9011). Other suitable silicone emulsifiers sold by Dow Corning include DC9010 and DC9011. Polyglycerolated emulsifying silicone elastomers are disclosed in PCT/WO 2004/024798. Such elastomers include Shin-Etsu's KSG series, such as KSG-710 (dimethicone/polyglycerin-3 crosspolymer dispersed in dimethicone); or lauryl dimethicone/polyglycerin-3 crosspolymer dispersed in a variety of solvent such as isododecane, dimethicone, triethylhexanoin, available as KSG-810, KSG-820, KSG-830, or KSG-840 from Shin-Etsu.

Structuring agents may be used to increase viscosity, thicken, solidify, or provide solid or crystalline structure to the cosmetic composition. Structuring agents are typically grouped based on solubility, dispersibility, or phase compatibility. Examples of aqueous or water structuring agents include polymeric agents, natural or synthetic gums, polysaccharides, and the like. For example, the cosmetic composition may comprises from about 0.0001%, 0.001%, 0.01%, 0.05%, 0.1%, 0.5%, 1%, 2%, 3%, 5% to about 25%, 20%, 10%, 7%, 5%, 4%, or 2%, by weight of the cosmetic composition, of one or more structuring agents.

Polysaccharides and gums may be suitable aqueous phase thickening agents. Suitable classes of polymeric structuring agents include but are not limited to carboxylic acid polymers, polyacrylamide polymers, sulfonated polymers, high molecular weight polyalkylglycols or polyglycerins, copolymers thereof, hydrophobically modified derivatives thereof, and mixtures thereof.

Examples of oil structuring agents include silicone and organic based materials. Suitable ranges of oil structuring agents are from about 0.01%, 0.05%, 0.1%, 0.5%, 1%, 2.5%, 5%, or 10% to about 30%, 25%, 20%, 15%, 10%, or 5%. Suitable oil phase structuring agents may be silicone based, such as silicone elastomers, silicone gums, silicone waxes, linear silicones having a degree of polymerization allowing the silicone to increase the viscosity of the oil phase. Examples of silicone structuring agents include, but are not limited to, silicone elastomers, silicone gums, and silicone waxes,

Suitable silicone elastomers may be in the powder form, or dispersed or solubilized in solvents such as volatile or nonvolatile silicones, or silicone compatible vehicles such as paraffinic hydrocarbons or esters. Examples of silicone elastomer powders include vinyl dimethicone/methicone silsesquioxane crosspolymers like KSP-100, KSP-101, KSP-102, KSP-103, KSP-104, KSP-105, available from Shin-Etsu, hybrid silicone powders that contain a fluoroalkyl group like KSP-200, available from Shin-Etsu, which is a fluoro-silicone elastomer, and hybrid silicone powders that contain a phenyl group such as KSP-300, available from Shin-Etsu, which is a phenyl substituted silicone elastomer; and DC 9506 available from Dow Corning.

Examples of silicone elastomer dispersions include dimethicone/vinyl dimethicone crosspolymers supplied by a variety of suppliers including Dow Corning Corporation under the tradenames DC9040 or DC9041, Momentive under the tradename SFE 839, or Shin-Etsu Silicones under the tradenames KSG-15, 16, 18. KSG-15 has the INCI name cyclopentasiloxane (and) dimethicone/vinyl dimethicone crosspolymer. KSG- 18 has the INCI name diphenylsiloxyl phenyl trimethicone (and) dimethicone/phenyl vinyl dimethicone crosspolymer. Silicone elastomers may also be purchased from Grant Industries under the Gransil trademark. Other suitable silicone elastomers have long chain alkyl substitutions such as lauryl dimethicone/vinyl dimethicone crosspolymers supplied by Shin Etsu under the tradenames KSG-41, KSG-42, KSG-43, and KSG-44, wherein the elastomer is dispersed in solvents including mineral oil,

isodocane, triethylhexanoin, or squalene, respectively. Other suitable silicone elastomers may have polyglycerine substitutions such as lauryl dimethicone/polyglycerin-3 crosspolymers supplied by Shin Etsu under the tradenames KSG-810, KSG-820, KSG-830, and KSG-840, wherein the elastomer is dispersed in solvents including mineral oil, isodocane, triethylhexanoin, or squalene, respectively. Other suitable silicone elastomers may have polyglycol substitutions such as PEG-15/lauryl dimethiconecrosspolymers supplied by Shin Etsu under the tradenames KSG-310, KSG-320, KSG-330, and KSG-340, wherein the elastomer is dispersed in solvents including mineral oil, isodocane, triethylhexanoin, or squalene, respectively. Other suitable silicone elastomers having polyglycol substitutions include Shin Etsu's KSG-210, a dimethicone/PEG-10/15 crosspolymer in dimethicone.

Silicone gums are another oil phase structuring agent. The silicone gum typically has a viscosity ranging from about 500,000 to 100 million cst at 25° C, from about 600,000 to 20 million, from about 600,000 to 12 million cst. Suitable silicone gums include those sold by Wacker-Belsil under the trade names CM3092, Wacker-Belsil 1000, or Wacker-Belsil DM 3096. A particularly suitable silicone gum is as dimethiconol, available from Dow Corning Corporation under the trade name 1-1254 Fluid, 2-9023 Fluid, and 2-9026 Fluid. Dimethiconol is often sold as a mixture with a volatile or nonvolatile silicone such as Dow Corning 1401 Fluid, 1403 Fluid, and 1501 Fluid.

Another type of oily phase structuring agent includes silicone waxes. Silicone waxes may be referred to as alkyl silicone waxes and can be semi-solids or solids at room temperature. The term "alkyl silicone wax" means a polydimethylsiloxane having a substituted long chain alkyl (such as C16 to 30) that confers a semi-solid or solid property to the siloxane. Examples of such silicone waxes include stearyl dimethicone, which may be purchased from Evonik Goldschmidt GmbH under the tradename Abil Wax 9800 or from Dow Corning under the tradename 2503. Another example is bis-stearyl dimethicone (which may be purchased from Gransil Industries under the tradename Gransil A-18), behenyl dimethicone, or behenoxy dimethicone.

Other suitable viscosity increasing agents include polyamides and polysilicone-polyamide copolymers. Suitable polysilicone-polyamide copolymers are disclosed in U.S. Patent Application Publication No. 2004/0170586.

Other oil phase structuring agents may be one or more natural or synthetic waxes such as animal, vegetable, or mineral waxes. Suitable silicone waxes are disclosed in U.S. Patent Nos.

5,413,781 and 5,725,845, and further include alkylmethyl polysiloxanes, C10 – C60 alkyl dimethicones, and mixtures thereof.

Other structuring agents include natural or synthetic montmorillonite minerals, silicas, silicates, silica silylate, and alkali metal or alkaline earth metal derivatives thereof.

5       The cosmetic compositions may optionally contain a UV active. As used herein, “UV active” includes both sunscreen agents and physical sunblocks. Suitable UV actives may be organic or inorganic. Suitable UV actives are listed in the functional category of “Sunscreen Agents” in the Personal Care Product Council's *International Cosmetic Ingredient Dictionary and Handbook*, Thirteenth Edition, 2010. Suitable UV actives include those defined or proposed  
10 by regulatory agencies in the US (e.g., 21 CFR part 352, 68 Federal Register 41386, 70 Federal Register 72449, or 71 Federal Register 42405), Europe (Regulation No 1223/2009 of the EU Parliament; Annex VI ), Japan, China, Australia, New Zealand, or Canada. For example, the cosmetic composition may comprise from about 0.01% to about 20%, by weight of the cosmetic composition, of a UV active. The cosmetic composition may also comprise a sufficient amount of  
15 UV active to yield a Sun Protection Factor of at least about 15, 30 45, or 50. SPF testing is conventional and well understood in the art. A suitable SPF test is prescribed in 21 C.F.R. 352, Subpart D.

Suitable UV actives include dibenzoylmethane derivatives including 2-methyldibenzoylmethane, 4-methyldibenzoylmethane, 4-isopropyldibenzoylmethane, 4-tert-  
20 butyldibenzoylmethane, 2,4- dimethyldibenzoylmethane, 2,5- dimethyldibenzoylmethane, 4,4'-diisopropyldibenzoylmethane, 4,4'-dimethoxy dibenzoylmethane, 4-tert-butyl-4'-methoxy dibenzoylmethane (*i.e.*, butyl methoxydibenzoylmethane or avobenzene)(commercially available as PARSOL<sup>®</sup> 1789 from DSM), 2-methyl-5-isopropyl-4'-methoxy dibenzoylmethane, 2-methyl-5-tert-butyl-4'-methoxydibenzoylmethane, 2,4-dimethyl-4'-methoxy dibenzoylmethane, and 2,6-  
25 dimethyl-4-tert-butyl-4'-methoxy dibenzoylmethane. Other suitable UV actives include 2-ethylhexyl-p-methoxycinnamate (commercially available as PARSOL<sup>®</sup> MCX from DSM), 2-hydroxy-4-methoxybenzophenone, benzonphenone-3 (*i.e.* oxybeznone), octyldimethyl-p-aminobenzoic acid, digalloyltriolate, 2,2-dihydroxy-4-methoxybenzophenone, ethyl-4-(bis(hydroxy-propyl))aminobenzoate, 2-ethylhexyl-2-cyano-3,3-diphenylacrylate, 2-ethylhexyl-  
30 salicylate, glyceryl-p-aminobenzoate, 3,3,5-tri-methylcyclohexylsalicylate, methylantranilate, p-dimethyl-aminobenzoic acid or aminobenzoate, 2-ethylhexyl-p-dimethyl-amino-benzoate, 2-

phenylbenzimidazole-5-sulfonic acid, 2-(p-dimethylaminophenyl)-5-sulfonicbenzoxazoic acid, octocrylene, zinc oxide, titanium dioxide, and mixtures thereof.

Particularly suitable UV actives are 2-ethylhexyl-p-methoxycinnamate, 4-tert-butyl-4'-methoxy dibenzoylmethane, 2-hydroxy-4-methoxybenzo-phenone, 2-phenylbenzimidazole-5-sulfonic acid, octocrylene, zinc oxide, titanium dioxide, and mixtures thereof.

Other suitable UV actives include 4-methylbenzylidene camphor (commercially available as PARSOL<sup>®</sup> 5000 from DSM or Eusolex 6300 from Merck), methylene bis-benzotriazolyl tetramethylbutylphenol (*i.e.*, bisoctrizole, commercially available as Tinosorb<sup>®</sup> M from BASF), bis-ethylhexyloxyphenol methoxyphenol triazine (*i.e.*, bemotrizinol, commercially available as Tinosorb<sup>®</sup> S from BASF), disodium phenyl dibenzimidazole tetrasulfonate (*i.e.*, Bisdisulizole disodium, commercially available as Neo Heliopan<sup>®</sup> AP from Symrise), Ethylhexyl triazone (commercially available as Uvinul<sup>®</sup> T 150 from BASF), Drometrizole trisiloxane (marketed as Mexoryl XL by L'Oreal), Sodium Dihydroxy Dimethoxy Disulfobenzophenone (*i.e.*, benzophenone-9, commercially available as Uvinul<sup>®</sup> DS 49 from BASF), Diethylamino Hydroxybenzoyl Hexyl Benzoate (commercially available as Uvinul<sup>®</sup> A Plus from BASF), diethylhexyl butamido triazone (*i.e.*, Iscotrizinol, commercially available as Uvasorb<sup>®</sup> HEB by 3V Sigma), Polysilicone-15 (*i.e.*, commercially available as PARSOL<sup>®</sup> SLX from DSM), and Isoamyl p-Methoxycinnamate (*i.e.*, amiloxate, commercially available as Neo Heliopan<sup>®</sup> E 1000 from Symrise).

The cosmetic compositions may be generally prepared by conventional methods such as those known in the art of making cosmetic compositions. Such methods typically involve mixing of ingredients in one or more steps to a relatively uniform state, with or without heating, cooling, application of vacuum, and the like. Typically, emulsions are prepared by first mixing the aqueous phase materials separately from the fatty phase materials and then combining the two phases as appropriate to yield the desired continuous phase. The cosmetic compositions are preferably prepared such as to optimize stability (physical stability, chemical stability, photostability, etc.) and/or delivery of active materials. The cosmetic composition may be provided in a package sized to store a sufficient amount of the cosmetic composition for a treatment period. The size, shape, and design of the package may vary widely. Certain package examples are described in USPNs D 570,707; D391, 162; D516,436; D535,191; D542,660; D547,193; D547,661; D558,591; D563,221; 2009/0017080; 2007/0205226; and 2007/0040306.

## VI. METHODS OF USE

The cosmetic compositions disclosed herein may be applied to one or more skin surfaces as part of a user's daily routine. Additionally or alternatively, the cosmetic compositions herein may be used on an "as needed" basis. For example, the cosmetic composition may be applied to a facial skin care surface in need of treatment by the cosmetic composition. The facial skin surface may include one or more of the cheek, forehead, and peri-orbital areas of the face. In some examples, one or more of these skin surfaces may be identified as needing treatment and one or more of these skins surfaces may be treated with the cosmetic composition. For example, the cosmetic composition can also be applied to the facial skin surface at least once per day, twice per day, or three times per day for a period of 7, 14, 21, or 28 days or more. In another example, the cosmetic composition may be applied to a different skin surface or applied to facial skin and one or more different skin surfaces.

## VII. EXAMPLES

The following examples are given solely for the purpose of illustration and are not to be construed as limiting the invention, as many variations thereof are possible.

EXAMPLE 1 – NIACINAMIDE/GLYCERIN MEASUREMENTS

*In vitro* skin penetration studies were conducted to characterize the impact of glycerin upon *in vitro* skin penetration of radiolabeled niacinamide in several cosmetic compositions. The kinetics of *in vitro* radiolabeled niacinamide skin penetration were determined at a fixed glycerin concentration, and the impact of glycerin and niacinamide product concentrations upon the skin penetration of radiolabeled niacinamide and glycerin over six hours were measured. Table 9 provides a general description of the four cosmetic composition types that were tested. It should be noted that the individual products used in the studies may have varied somewhat in specific concentrations from the general values in Table 8. Also, composition #1 was repeated in two different studies with varying concentrations of niacinamide and glycerin.

**Table 8: General descriptions of the chassis used in the *in vitro* skin permeation experiments**

| Chassis | Composition #1 | Composition #2 | Composition #3 | Composition #4 |
|---------|----------------|----------------|----------------|----------------|
| Type    | O/W Emulsion   | W/Si Emulsion  | W/Si Emulsion  | Water Gel      |

|                    |                     |                     |                     |                    |
|--------------------|---------------------|---------------------|---------------------|--------------------|
| <b>Water</b>       | 72.3                | 65.7                | 48.8                | ~78                |
| <b>Polyols</b>     |                     | 2.0                 | 3.0                 | 3.2                |
| <b>Silicone</b>    | 2.0                 | 12.8                | 34.7                | 1.5                |
| <b>Oil</b>         | 5.0                 |                     |                     | 1.5                |
| <b>Emulsifiers</b> | Nonionic Surfactant | Silicone Elastomers | Silicone Elastomers | Nonionic           |
|                    | Acrylic Copolymers  |                     |                     | Acrylic Copolymers |
|                    | Fatty Alcohols      |                     |                     |                    |

Split thickness cadaver skin was obtained from AlloSource (Englewood, CO). Tritiated water was from PerkinElmer (Boston, MA) while  $^{14}\text{C}$  niacinamide was obtained from American Radiochemicals (St. Louis, MO). For all studies, split-thickness human cadaver skin was maintained at  $-70^{\circ}\text{C}$  until thawed at ambient conditions, rinsed with distilled water, cut into appropriately sized sections, and mounted in standard Franz-type diffusion cells ( $0.79\text{ cm}^2$ ) which were placed in heating/stirring blocks thermostatted to maintain a skin surface temperature of about  $34^{\circ}\text{C}$ . The receptors [ $\sim 5\text{ mL}$ ] were filled with a solution of 1% polysorbate 20 (VWR International, West Chester, PA) in Dulbecco's Phosphate Buffered Saline [PBS] (Sigma-Aldrich, Inc., St. Louis, MO) with agitation provided by magnetic stir bars, and the skin allowed to equilibrate for at least two hours.

Six cells were randomized to each treatment in a given study based upon  $^3\text{H}_2\text{O}$  flux through the mounted skin.  $150\text{ }\mu\text{L}$   $^3\text{H}_2\text{O}$  were applied to the mounted cadaver skin for five minutes and any non-absorbed liquid subsequently removed with a cotton swab. After a minimum of one hour to achieve equilibrium, the receptor contents were collected. Liquid scintillation cocktail, LCS, ( $14\text{ mL}$ ) was added to the contents of each receptor and also to triplicate  $150\text{ }\mu\text{L}$  aliquots of  $^3\text{H}_2\text{O}$ . The LSC solutions and appropriate blanks were assayed for total radiolabel by liquid scintillation counting for one minute using a pre-set quench curve. Blank corrected DPM (disintegrations per minute) in each receptor was converted to  $\mu\text{L}$   $^3\text{H}_2\text{O}$  using the mean of the blank corrected DPM of the  $150\text{ }\mu\text{L}$  aliquots of  $^3\text{H}_2\text{O}$ , and water flux for each cell was calculated as the quotient of the  $^3\text{H}_2\text{O}$  volume detected in the receptor and the available skin surface area. Fresh receptor fluid was then added to the receptor portions of the Franz cells and the cells allowed to further equilibrate overnight.

Following the overnight equilibration period, the receptor compartments were filled with fresh media. Except as noted below, approximately  $5\text{ }\mu\text{L}$  of product with radiotracer were applied to the individual cells using a positive displacement pipette. The receptor solution was collected and replaced at 2 and 4 hr with a final collection at 6 hr. At the end of the test time (s),



each skin sample was wiped two times with Whatman filter paper soaked with PBS containing 1% polysorbate 20 and once with filter paper soaked with 70%/30% ethanol/distilled water to remove unabsorbed (residual) product. The epidermis (including stratum corneum) was separated from the residual dermis by dissection.

5           Disintegrations-per-minute (DPM) obtained for the various components of each cell (all receptor collections, filter paper wipes, epidermis, and dermis) were blank corrected and summed to obtain a total recovered radiolabel value for a given cell. This value was then compared with the specific radiolabel activity of the product (DPM/theoretical dose) to estimate the percent recovery of the theoretical dose.

10           The blank corrected DPM of each compartment were then normalized to the total recovered radiolabel value to obtain a “percent recovered radiolabel” parameter for each component. This compensates for variations in the amount of product dosed due to its viscosity and improves study precision.

15           Cumulative receptor amounts were calculated as the sums of the various receptor collections to a given time point. A total skin value was calculated as the sum of the epidermis and dermis fractions, and a total permeated value calculated as the sum of total skin and total cumulative receptor.

20           For those studies which incorporated test products with varying concentrations of the permeant being investigated (e.g. niacinamide), the percent recovered values were subsequently converted to “fraction radiolabel recovered” by dividing by 100, and then to amount ( $\mu\text{g}$  – equivalents ( $\mu\text{g}$ -eq) permeant by multiplying by the target dose (5 mg) and fraction permeant in the test product.

25           The data from this series of studies, summarized in FIG. 1, suggest that the addition of glycerin decreases niacinamide skin penetration and that increasing the glycerin concentration further decreases niacinamide skin penetration from a variety of cosmetic compositions.

#### EXAMPLE 2 – NIACINAMIDE/GLYCERIN/HEXYLDECANOL MEASUREMENTS

The cosmetic compositions set forth in Table 8 were prepared.

TABLE 9

| Phase | Component                                              | 2A  | 2B  | 2C  | 2D  | 2E  | 2F  | 2G  | 2H  |
|-------|--------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|
| A     | Water                                                  | QS  | QS  | QS  | QS  | QS  | QS  | QS  | QS  |
|       | Acrylates/<br>C10-30 Alkyl<br>Acrylate<br>Crosspolymer | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 |
| B     | Glycerin                                               |     | 7   |     | 7   |     |     | 7   | 7   |
|       | Niacinamide                                            | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   |
| C     | Triethanolamine                                        | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| D     | Polyoxyethylene<br>(20) sorbitan<br>monolaurate        |     |     | 0.5 | 0.5 | 1   | 1.5 | 1   | 1.5 |
| E     | 2-Hexyl-1-<br>decanol                                  |     |     | 5   | 5   | 10  | 15  | 10  | 15  |
| F     | DMDM<br>Hydantoin<br>Iodopropynyl<br>Butylcarbamate    | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |

Components of Phase A were mixed together with stirring using a suitable mixer (e.g., Tekmar model RW20DZM) and blade while warming to approximately 50 C. Mixing continued until visually all crosspolymer is well dispersed. Components of Phase B are added to Phase A with continual mixing and Phase A was allowed to cool to room temperature. Phase C is added to Phase A/B with continual stirring. If necessary, components of Phase D and E are added followed by milling of product at approximately 8000 rpm for 5 minutes using a Tekmar T-25 mill. Phase F is added with to Phase A-E and mixed using a suitable mixer for approx. 5 minutes.

Next, human cadaver skin samples were mounted in standard Franz-type diffusion cells (0.79 cm<sup>2</sup> surface area) maintained at about 37°C. Six replicates for each compositional leg were prepared. The receptor compartments were filled with 5 mL phosphate buffered saline (PBS - pH 7.4) that included 1% polysorbate-20 and 0.02% sodium azide, and the skin allowed to

equilibrate for two hours. The cells were randomized to treatment group based upon  $^3\text{H}_2\text{O}$  flux through the mounted skin (150  $\mu\text{L}$  of  $^3\text{H}_2\text{O}$  applied for five minutes, removed and followed by collection of receptor fluid after 60 minutes). Diffusion cells were randomized by ranking each cell according to water flux and distributing cells across treatment legs such that each group  
5 included cells across the range of observed water flux. Each treatment group typically had 6 replicates.

Aliquots of the test products/formulations set forth in Table 8 were spiked with  $^{14}\text{C}$ -niacinamide with approximately 3  $\mu\text{Ci}$  per 300 mg product aliquot, mixed and assayed for total radioactivity in triplicate using Ultima Gold (available from Perkin-Elmer) liquid scintillation cocktail (LSC) and liquid scintillation counting (Tri-Carb 2500 TR Liquid Scintillation Analyzer,  
10 PerkinElmer, Boston, MA). The skin samples were topically dosed with 5  $\mu\text{L}$  of the radiolabeled niacinamide composition using a positive displacement pipette. The cosmetic composition was gently spread over the surface of the skin samples ( $0.79\text{ cm}^2$ ) using the pipet tip. The receptor solution was collected and replaced at 6 hours following application with a  
15 final collection at 24 hrs. After the final receptor collection, each skin sample was wiped two times with Whatman filter paper soaked with PBS/Tween 20 and once with 70%/30% ethanol/water to remove unabsorbed (residual) product. The epidermis was separated from the residual dermis by dissection. The skin sections were dissolved in 0.50 - 1.25 mL Soluene-350 (Perkin Elmer, Boston, MA) at  $60^\circ\text{C}$  overnight, and all receptor collections, filter paper wipes,  
20 and solubilized tissue sections were counted using liquid scintillation counting. Disintegrations-per-minute (DPM) for each compartment of each cell were blank corrected and summed to obtain a total recovered radiolabel value for a given cell. The DPM of each compartment were then normalized to the total recovered radiolabel value to obtain a "percent recovered radiolabel" parameter for each compartment (individual receptor collections, epidermis, dermis, and wipes  
25 for mass balance). Cumulative receptor values to each collection time point were calculated as the sum of the individual collections to that time point, with the total receptor value as the sum of all individual collections. The total recovered percentage value was the sum of the epidermis (including stratum corneum) and dermis values, and the total permeated value the sum of total skin and cumulative receptor values. Tables 1, 2, and 3 summarize the total percentage values of  
30 radiolabeled niacinamide recovered.

### EXAMPLE 3 – NIACINAMIDE/GLYCERIN/HEXYLDECANOL/DIOL MEASUREMENTS

The cosmetic compositions set forth in Table 10 were prepared in the same manner as previously described with respect to Example 2.

TABLE 10

[illegible]

Using generally the same test procedures as set forth in Example 2, DPM for each compartment of each cell were blank corrected and summed to obtain a total recovered radiolabel value for a given cell. The DPM of each compartment were then normalized to the total recovered radiolabel value to obtain a “percent recovered radiolabel” parameter for each compartment (individual receptor collections, epidermis, dermis, and wipes for mass balance). Cumulative receptor values to each collection time point were calculated as the sum of the individual collections to that time point, with the total receptor value as the sum of all individual collections. The total percentage recovered value was the sum of the epidermis (including stratum corneum) and dermis values, and the total permeated value the sum of total skin and cumulative receptor values. Tables 4, 5, and 6 summarize the total percentage values of radiolabeled niacinamide recovered for Examples 3A to 3H. Example 3I, however, produced an average total niacinamide recovery of 69.43 (std = 13.45, p-value = 0.004), which is less than Example 3C and less than would have been expected. It is not clear whether this result is an anomaly or perhaps related to detection limits of the instrumentation.

#### EXAMPLE 4 – NIACINAMIDE/GLYCERIN/HEXYLDECANOL/DIOL MEASUREMENTS

The cosmetic compositions set forth in Table 11 were prepared in the same manner as previously described with respect to Example 2.

TABLE 11

|                    | 4A | 4B | 4C | 4D | 4E |
|--------------------|----|----|----|----|----|
| Water              | QS | QS | QS | QS | QS |
| Glycerin           |    | 7  | 7  | 7  | 7  |
| Propylene glycol   |    |    | 3  |    |    |
| Butylene glycol    | 2  | 3  |    |    |    |
| Triethylene glycol |    |    |    |    | 3  |

|                     |      |      |      |      |      |
|---------------------|------|------|------|------|------|
| Pentylene glycol    | 3    | 6    |      | 3    |      |
| Hexylene glycol     |      | 3    | 1.5  | 1.5  | 1.5  |
| Hexanediol          |      | 1    |      |      |      |
| Benzyl alcohol      | 0.2  | 0.2  | 0.2  | 0.2  | 0.2  |
| Phenoxyethanol      | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Eldew               |      |      | 2    | 2    | 2    |
| Dibutyl adipate     |      |      | 1    | 1    | 1    |
| 2-Hexyl-1-decanol   |      | 5    | 5    | 5    | 5    |
| Isopropyl myristate |      |      | 1    | 1    | 1    |
| Oleic acid          |      | 1    | 1    | 1    | 1    |
| Isostearic acid     |      |      |      |      |      |
| Vitamin E acetate   |      | 1    | 0.5  | 0.5  | 0.5  |
| Niacinamide         | 5    | 5    | 5    | 5    | 5    |

Using generally the same test procedures as set forth in Example 2, DPM for each compartment of each cell were blank corrected and summed to obtain a total recovered radiolabel value for a given cell. The DPM of each compartment were then normalized to the total recovered radiolabel value to obtain a “percent recovered radiolabel” parameter for each compartment (individual receptor collections, epidermis, dermis, and wipes for mass balance). Cumulative receptor values to each collection time point were calculated as the sum of the individual collections to that time point, with the total receptor value as the sum of all individual collections. The total percentage recovered value was the sum of the epidermis (including stratum corneum) and dermis values, and the total permeated value the sum of total skin and cumulative receptor values. Tables 7 summarize the total percentage values of radiolabeled niacinamide recovered for Examples 4A-4E.

The dimensions and values disclosed herein are not to be understood as being strictly limited to the exact numerical values recited. Instead, unless otherwise specified, each such dimension is intended to mean both the recited value and a functionally equivalent range

surrounding that value. For example, a dimension disclosed as “40 mm” is intended to mean “about 40 mm.”

Every document cited herein, including any cross referenced or related patent or application, is hereby incorporated herein by reference in its entirety unless expressly excluded  
5 or otherwise limited. The citation of any document is not an admission that it is prior art with respect to any invention disclosed or claimed herein or that it alone, or in any combination with any other reference or references, teaches, suggests or discloses any such invention. Further, to the extent that any meaning or definition of a term in this document conflicts with any meaning or definition of the same term in a document incorporated by reference, the meaning or definition  
10 assigned to that term in this document shall govern.

While particular embodiments of the present invention have been illustrated and described, it would be obvious to those skilled in the art that various other changes and modifications can be made without departing from the spirit and scope of the invention. It is therefore intended to cover in the appended claims all such changes and modifications that are  
15 within the scope of this invention.

## CLAIMS

What is claimed is:

1. A cosmetic composition suitable for topical application, comprising:

- i) glycerin;
- ii) one or more materials selected from the group consisting of pentylene glycol, hexylene glycol, propylene glycol, triethylene glycol, butylene glycol, and hexanediol;
- iii) one or more penetration enhancers selected from the group consisting of hexyldecanol, butyldecanol, 4-methyl-5-decanol, 2-heptyldecanol, octyldecanol, decyltetradecanol, 2-butyl-1-octanol, 2-octyl-1-decanol, 2-dodecyl-1-hexadecanol, and 2-tetradecylotadecanol;

iv) a vitamin B compound; and

wherein the ratio of the combination of i) and ii) and iii) to iv) is at least 2:1.

2. A method of making a cosmetic composition useful for providing the enhanced skin penetration of a vitamin B compound, the method comprising:

preparing a cosmetic composition comprising

- i) glycerin;
- ii) one or more materials selected from the group consisting of pentylene glycol, hexylene glycol, propylene glycol, triethylene glycol, butylene glycol, and hexanediol;
- iii) one or more penetration enhancers selected from the group consisting of hexyldecanol, butyldecanol, 4-methyl-5-decanol, 2-heptyldecanol, octyldecanol, decyltetradecanol, 2-butyl-1-octanol, 2-octyl-1-decanol, 2-dodecyl-1-hexadecanol, and 2-tetradecylotadecanol;

iv) a vitamin B compound; and

wherein the ratio of the combination of i) and ii) and iii) to iv) is at least 2:1.

3. The cosmetic composition or method of any preceding claim, wherein the glycerin has a concentration from 5% to 25%, by weight of the cosmetic composition.

4. The cosmetic composition or method of any preceding claim, wherein the one or more materials have a concentration from 1% to 25%, by weight of the cosmetic composition.



5. The cosmetic composition or method of any preceding claim, wherein the penetration enhancer is hexyldecanol.
6. The cosmetic composition or method of claim 5, wherein the concentration of hexyldecanol is from 0.5% to 8%, preferably from 1% to 6%, more preferably from 2% to 5%, by weight of the cosmetic composition.
7. The cosmetic composition or method of any preceding claim, wherein the cosmetic composition is provided in the form selected from the group consisting of a water-in-oil emulsion, an oil-in-water emulsion, or a water-in-silicone emulsion.
8. The cosmetic composition or method of any preceding claim, wherein the vitamin B compound has a concentration from 1% to 10%, preferably from 3% to 10%, more preferably from 5% to 10%, by weight of the cosmetic composition.
9. The cosmetic composition or method of any preceding claim, wherein the vitamin B compound is niacinamide.
10. The cosmetic composition or method of any preceding claim, wherein the ratio of the combination of i) and ii) and iii) to iv) is selected from the group consisting of at least 3:1, at least 4:1, and at least 5:1.
11. The cosmetic composition or method of any preceding claim, wherein the combined concentrations of i) ii) and iii) is greater than 10% by weight of the cosmetic composition.
12. The cosmetic composition or method of any preceding claim, wherein the cosmetic composition comprises at least two materials selected from the group consisting of pentylene glycol, hexylene glycol, propylene glycol, triethylene glycol, butylene glycol, and hexanediol.

13. The cosmetic composition or method of any preceding claim, wherein the one or more materials are selected from the group consisting of 1,2-pentanediol; 1,4-pentanediol; 2,4-pentanediol; 1,5-pentanediol; 1,2-butanediol; 1,3-butanediol; 1,4-butanediol; 2,3-butanediol; 1,2-hexanediol; 1,5-hexanediol; 1,6-hexanediol; 2,5-hexanediol; hexylene glycol; and combinations thereof.

14. The cosmetic composition or method of any preceding claim, wherein the cosmetic composition is provided in a package.

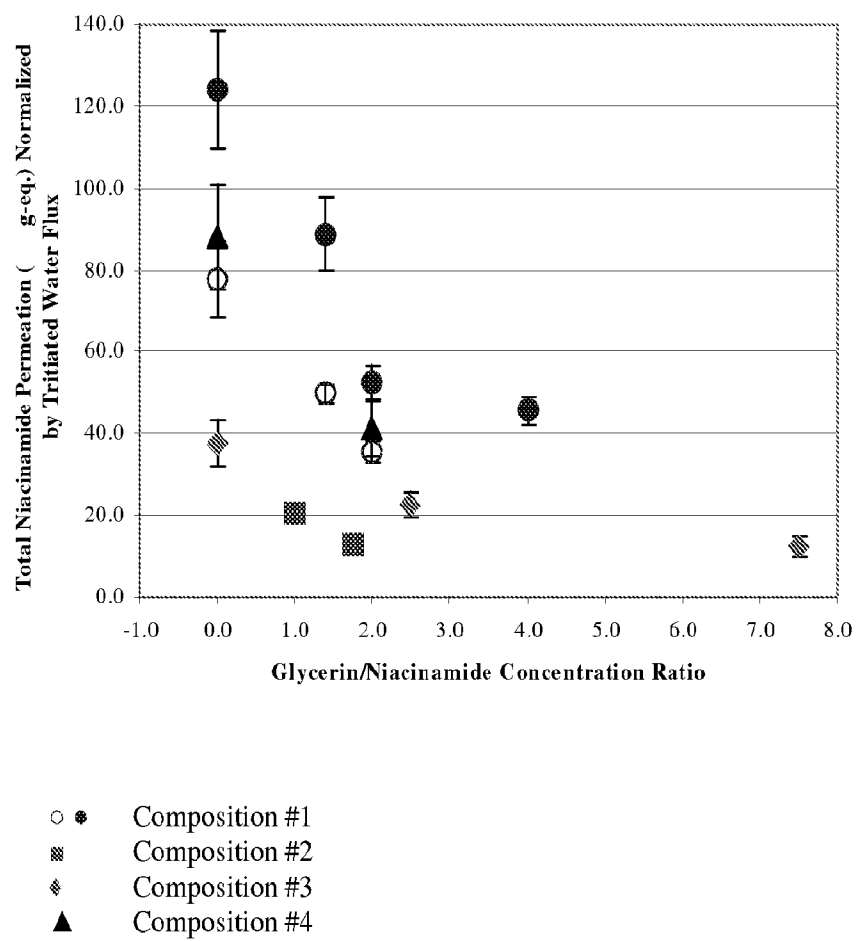


FIG. 1

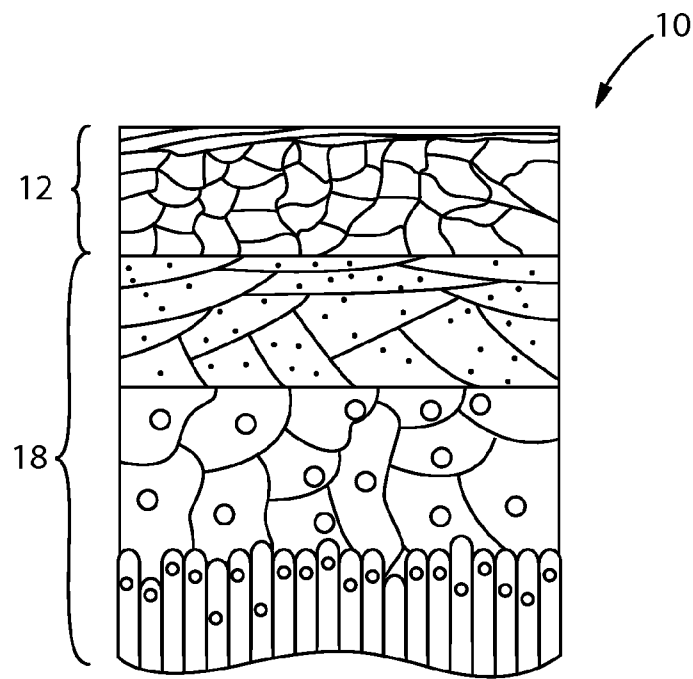


FIG. 2

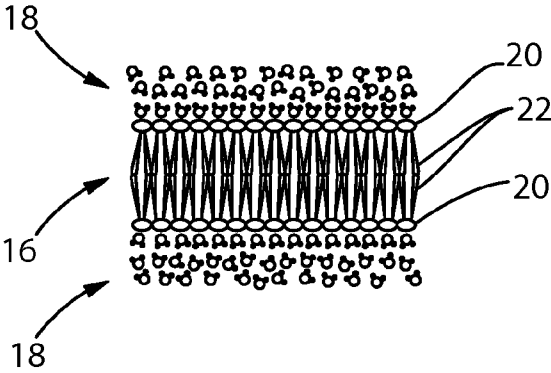


FIG. 3

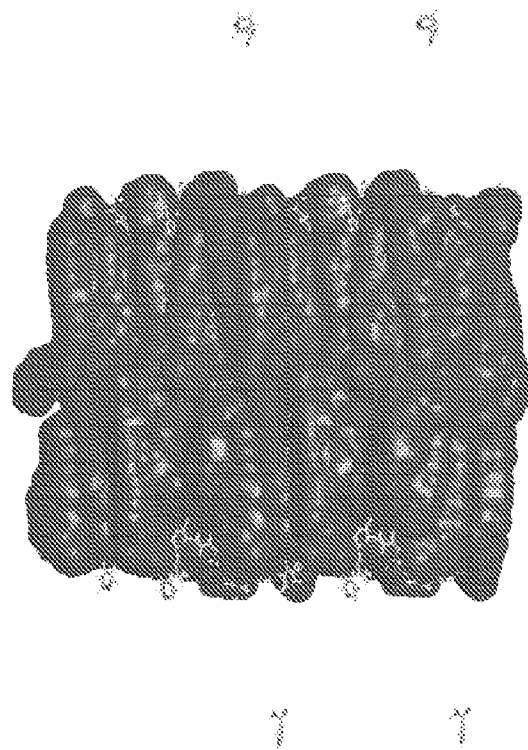


FIG. 4



FIG. 5

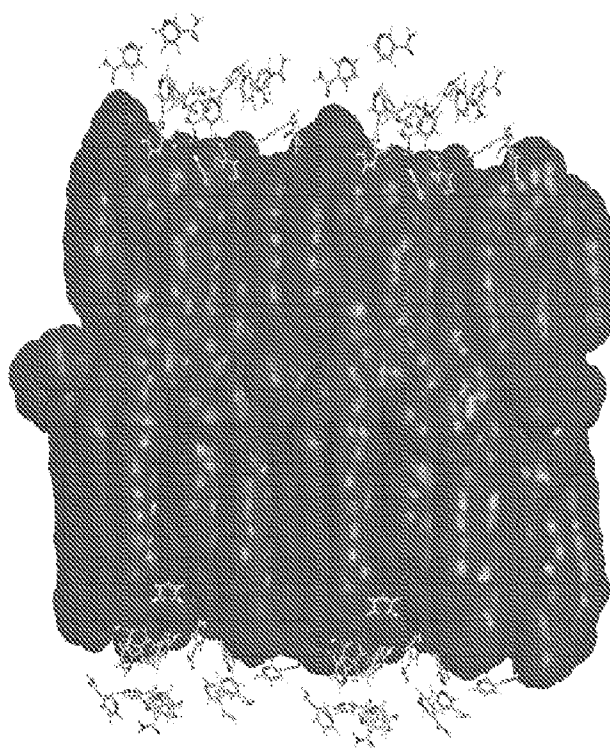


FIG. 6



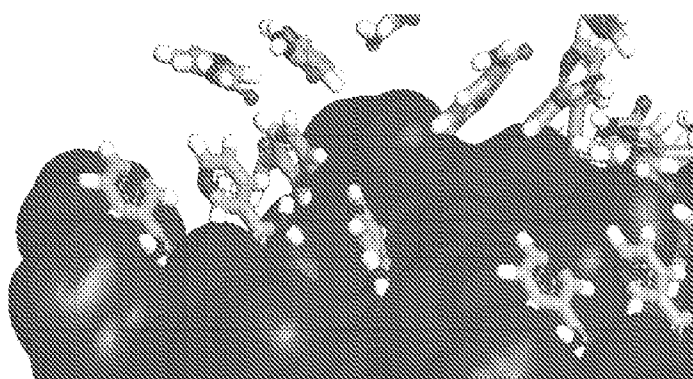


FIG. 7

## INTERNATIONAL SEARCH REPORT

International application No  
PCT/US2014/023985

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                       |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| <b>A. CLASSIFICATION OF SUBJECT MATTER</b><br>INV. A61K8/34 A61K8/67 A61Q17/00 A61Q19/00<br>ADD.                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                       |
| According to International Patent Classification (IPC) or to both national classification and IPC                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                       |
| <b>B. FIELDS SEARCHED</b><br>Minimum documentation searched (classification system followed by classification symbols)<br>A61K A61Q                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                       |
| Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                       |
| Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)<br>EPO-Internal                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                       |
| <b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                       |
| Category*                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Citation of document, with indication, where appropriate, of the relevant passages                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Relevant to claim No. |
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| X                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | DATABASE GNPD [Online]<br>MINTEL;<br>1 November 2011 (2011-11-01),<br>"Serum",<br>XP002725675,<br>Database accession no. 1670831<br>the whole document<br><div style="text-align: center;">-----</div> <div style="text-align: center;">-/--</div>                                                                                                                                                                                                                                                                                                                                                                                                                                       | 1-14                  |
| <div style="display: flex; justify-content: space-between;"> <span><input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C.</span> <span><input checked="" type="checkbox"/> See patent family annex.</span> </div>                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                       |
| * Special categories of cited documents :                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                       |
| "A" document defining the general state of the art which is not considered to be of particular relevance<br>"E" earlier application or patent but published on or after the international filing date<br>"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)<br>"O" document referring to an oral disclosure, use, exhibition or other means<br>"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<br>"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<br>"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<br>"&" document member of the same patent family |                       |
| Date of the actual completion of the international search<br><br><div style="text-align: center; font-size: 1.2em;">2 July 2014</div>                                                                                                                                                                                                                                                                                                                                                                                                                                      | Date of mailing of the international search report<br><br><div style="text-align: center; font-size: 1.2em;">17/07/2014</div>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                       |
| Name and mailing address of the ISA/<br>European Patent Office, P.B. 5818 Patentlaan 2<br>NL - 2280 HV Rijswijk<br>Tel. (+31-70) 340-2040,<br>Fax: (+31-70) 340-3016                                                                                                                                                                                                                                                                                                                                                                                                       | Authorized officer<br><br><div style="text-align: center; font-size: 1.2em;">Skulj, Primoz</div>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                       |

# INTERNATIONAL SEARCH REPORT

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| C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT |                                                                                                                                                                                                                                                             |                       |
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Information on patent family members

International application No

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