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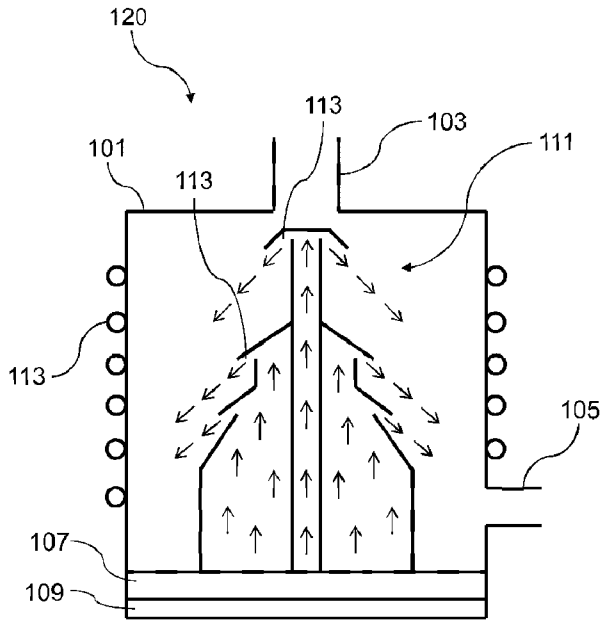
(54) Title: COMPOSITION FOR PERSONAL CARE, METHOD OF PREPARING THE COMPOSITION, AND TREATMENT METHOD INVOLVING THE COMPOSITION

FIGURE 3



(57) Abstract: A composition comprises nanoparticles. The nanoparticles are produced via a plasma process. The nanoparticles independently comprise a Group IV element. The composition further comprises at least one personal care ingredient. A method of preparing the composition ("preparation method") comprises producing the nanoparticles via a plasma process. The preparation method further comprises combining the nanoparticles with at least one personal care ingredient. A method of treating a substrate ("treatment method") comprises applying the composition to the substrate. The substrate generally comprises hair, skin, teeth, and/or nails.

[Continued on next page]

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COMPOSITION FOR PERSONAL CARE, METHOD OF PREPARING THE COMPOSITION, AND TREATMENT METHOD INVOLVING THE COMPOSITION

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The application claims priority to and all advantages of U.S. Provisional Patent Application No. 62/786,995 filed on 31 December 2018, the content of which is incorporated herein by reference.

FIELD OF THE INVENTION

[0002] disclosure relates to a composition and, more specifically, to a composition for personal care including nanoparticles and at least one personal care ingredient, and to a method of preparing the composition.

DESCRIPTION OF THE RELATED ART

[0003] Personal care compositions are known in the art and are utilized, for example, to treat hair, skin, and other parts of the human body. Personal care compositions include various components contingent on a desired end use thereof.

[0004] One example of a personal care composition is sunscreen. Sunscreens generally include conventional fillers, which at least partially reflect sunlight, including at least some ultraviolet (UV) light. These sunscreens are referred to as physical sunscreens, as they rely on physical light reflectance. For example, titanium dioxide (TiO_2) is most commonly utilized as conventional filler in sunscreens for its reflectance properties. Alternatively, sunscreens may include compounds or components that absorb UV light, which are referred to as chemical sunscreens. However, there are limitations to sunscreens and personal care compositions other than sunscreens based on the physical properties of conventional fillers.

BRIEF SUMMARY OF THE INVENTION

[0005] Disclosed is a composition. The composition comprises nanoparticles. The nanoparticles are produced via a plasma process. The nanoparticles independently comprise a Group IV element. The composition further comprises at least one personal care ingredient.

[0006] A method of preparing the composition is also disclosed. The preparation method comprises producing the nanoparticles via a plasma process. The preparation method further comprises combining the nanoparticles with at least one personal care ingredient.

[0007] A method of treating a substrate is also disclosed. The treatment method comprises applying the composition to the substrate. The substrate generally comprises hair, skin, teeth, and/or nails.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] Other advantages and aspects of this disclosure may be described in the following detailed description when considered in connection with the accompanying drawings wherein:

[0009] Figure 1 is illustrates one embodiment of a low pressure high frequency pulsed plasma reactor for producing nanoparticles;

[0010] Figure 2 illustrates an embodiment of a system including a low pressure pulsed plasma reactor to produce nanoparticles and a diffusion pump to collect the nanoparticles;

[0011] Figure 3 illustrates a schematic view of one embodiment of a diffusion pump for collecting nanoparticles produced via a reactor;

[0012] Figure 4 illustrates the wavelength-dependent extinction coefficient of sunscreens comprising nanoparticles in accordance with one embodiment;

[0013] Figure 5A illustrates the white light illumination of a substrate treated with a composition comprising nanoparticles in accordance with another embodiment; and

[0014] Figure 5B illustrates the ultraviolet light illumination of the treated substrate of FIG. 5A.

DETAILED DESCRIPTION OF THE INVENTION

[0015] A composition, a method of preparing the composition ("preparation method"), and a treatment method involving the composition ("treatment method") are disclosed and described in greater detail below. The composition may be prepared based on a desired end use application thereof and may be utilized in diverse end use applications. For example, the composition is particularly suited for personal care applications such as treatment methods involving substrates relating to personal care (e.g. hair, skin, teeth, and/or nails). In these instances, the composition can be referred to as a personal care composition. However, the composition is not limited to such applications, treatment methods, or designations.

[0016] The composition comprises nanoparticles. The nanoparticles are formed via a plasma process. The nanoparticles independently comprise a Group IV element. As used herein, the group designations of the periodic table are generally from the CAS or old IUPAC nomenclature, although Group IV elements are referred to as Group 14 elements under the modern IUPAC system, as readily understood in the art.

[0017] The composition further comprises at least one personal care ingredient. The nanoparticles and personal care ingredient are each described in detail below both with reference to the composition and the associated methods.

[0018] The composition may comprise two or more types of nanoparticles, which may be independently formed or selected, so long as at least one type of the nanoparticles of the composition is formed via the plasma process. Typically, if the composition includes two or more types of nanoparticles, the nanoparticles are each formed via the plasma process. The

types of nanoparticles may be distinguished, for example, by mean particle size distribution (PSD), composition, at least one property, etc. For clarity and consistency, the phrases "the nanoparticles" and "the nanoparticle" each encompasses embodiments where the composition includes but one or two or more types of nanoparticles.

[0019] Any plasma process may be utilized to form the nanoparticles. The nanoparticles may be obtained commercially in the event such nanoparticles formed via a plasma process are available. However, given limitations for obtaining nanoparticles formed via the plasma process, the nanoparticles may be synthesized or prepared. For example, the method of preparing the composition generally comprises producing the nanoparticles. In these embodiments, the nanoparticles are first prepared and subsequently utilized to form the composition. The typical plasma process utilized to prepare the nanoparticles is described below with reference to the nanoparticles and the method of preparing the composition therewith, particularly when the method of preparing the composition comprises producing the nanoparticles via the plasma process.

[0020] In certain embodiments where the plasma process is carried out in the low pressure reactor, the plasma process comprises forming a nanoparticle aerosol in the low pressure reactor, wherein the aerosol comprises nanoparticles in a gas. The nanoparticles are generally collected upon their formation. In certain embodiments as described below, the nanoparticles are collected by capturing the nanoparticles in a capture fluid, which is typically in fluid communication with the low pressure reactor.

[0021] Regardless of the particular plasma system and process utilized to produce the nanoparticles, the plasma system generally relies on a precursor gas. The precursor gas is generally selected based on the desired composition of the nanoparticles.

[0022] To this end, the precursor gas utilized generally comprises at least one compound comprising at least one of silicon, germanium and tin (which are Group IV elements). For example, when the nanoparticles comprise Si nanoparticles, the precursor gas generally comprises silicon. In this embodiment, the precursor gas may be selected from silanes, disilanes, halogen-substituted silanes, halogen-substituted disilanes, C_1-C_4 alkyl silanes, C_1-C_4 alkyldisilanes, and combinations thereof. In one form of the present disclosure, the precursor gas comprises silane, which accounts for 0.1 to 2% of the precursor gas, which may alternatively be referred to as the gas mixture or reactant gas mixture. Generally, the precursor gas designates the reactive gas utilized to nucleate the nanoparticles, and the precursor gas may be combined with other gases, as described below, to form the gas mixture or reactant gas mixture including the precursor gas. The gas mixture may also comprise other percentages of silane. The precursor gas may additionally or alternatively comprise $SiCl_4$, $HSiCl_3$, and H_2SiCl_2. Alternatively, when the nanoparticles comprise Ge

nanoparticles, the precursor gas generally comprises germanium. In this embodiment, the precursor gas may be selected from germane, digermanes, halogen-substituted germanes, halogen-substituted digermanes, C_1-C_4 alkyl germanes, C_1-C_4 alkyldigermanes, and mixtures thereof. The nanoparticles may comprise both silicon and germanium, with the precursor gas including combinations of the above precursor gases.

[0023] Further, organometallic precursor molecules may also be used in or as the precursor gas. These molecules include a Group IV metal and independently selected organic groups. Organometallic Group IV precursors include, but are not limited to, organosilicon, organogermanium and organotin compounds. Some examples of Group IV precursors include, but are not limited to, alkylgermaniums, alkylsilanes, alkylstannanes, chlorosilanes, chlorogermaniums, chlorostannanes, aromatic silanes, aromatic germaniums and aromatic stannanes. Other examples of silicon precursors include, but are not limited to, disilane (Si_2H_6), silicon tetrachloride ($SiCl_4$), trichlorosilane ($HSiCl_3$) and dichlorosilane (H_2SiCl_2). Still other suitable precursor molecules for use in forming silicon nanoparticles include alkyl and aromatic silanes, such as dimethylsilane (H_3C-SiH_2-CH_3), tetraethyl silane (($CH_3CH_2)_4Si$) and diphenylsilane (Ph-SiH_2-Ph). Particular examples of germanium precursor molecules that may be used to form germanium nanoparticles include, but are not limited to, tetraethyl germane (($CH_3CH_2)_4Ge$) and diphenylgermane (Ph-GeH_2-Ph).

[0024] In another form of the present disclosure, the nanoparticles may undergo an additional doping step. For example, the nanoparticles may undergo gas phase doping in the plasma, where a second precursor gas is dissociated and is incorporated in the nanoparticles as they nucleate. The nanoparticles may also or alternatively undergo doping in the gas phase downstream of the production of the nanoparticles, but before the nanoparticles are collected, e.g. by capturing in the capture fluid. Furthermore, when the capture fluid is utilized to collect the nanoparticles, doped nanoparticles may be produced in the capture fluid where the dopant is preloaded therein, in which case the nanoparticles become doped in situ in the capture fluid. Doped nanoparticles can be formed by contact with organosilicon gases or liquids, including, but not limited to trimethylsilane, disilane, and trisilane. Gas phase dopants may include, but are not limited to, BCl_3, B_2H_6, PH_3, GeH_4, or $GeCl_4$.

[0025] The precursor gas may be mixed with other gases, such as inert gases, in the gas mixture or reactant gas mixture. Examples of inert gases that may be included in the gas mixture include argon, xenon, neon, or a mixture of inert gases. When present in the gas mixture, the inert gas may be utilized in an amount of from 1 to 99 volume percent based on the total volume of the reactant gas mixture. The gas mixture may comprise the precursor

gas in an amount of from 0.1 to 50, alternatively from 1 to 50, volume percent based on the total volume of the reactant gas mixture.

[0026] In certain embodiments, the reactant gas mixture further comprises a second precursor gas which itself can make up from 0.1 to 49.9 volume percent based on the total volume of the reactant gas mixture. The second precursor gas may comprise BCl_3, B_2H_6, PH_3, GeH_4, or $GeCl_4$. The second precursor gas may also comprise other gases that contain carbon, germanium, boron, phosphorous, and/or nitrogen. The combination of the first precursor gas and the second precursor gas together may make up from 0.1 to 50 volume percent based on the total volume of the reactant gas mixture.

[0027] In another form of the present disclosure, the reactant gas mixture further comprises hydrogen gas. Hydrogen gas can be present in an amount of from 1 to 50, alternatively 1 to 25, alternatively 1 to 10, volume percent based on the total volume of the reactant gas mixture. However, it is also contemplated that the reactant gas mixture may comprise other percentages of hydrogen gas.

[0028] In one form of the present disclosure, the nanoparticles may comprise alloys of Group IV elements, e.g. silicon alloys. Silicon alloys that may be formed include, but are not limited to, silicon carbide, silicon germanium, silicon boron, silicon phosphorous, and silicon nitride. The silicon alloys may be formed by mixing at least one first precursor gas with the second precursor gas or using a precursor gas that contains the different elements. However, other methods of forming alloyed nanoparticles are also contemplated.

[0029] Notably, in certain embodiments, the nanoparticles may have surface functionality. For example, in various embodiments, the nanoparticles are MX-functional nanoparticles, where M is the independently selected group IV element and X is a functional group independently selected from H and a halogen atom. In these embodiments, the precursor gas (or gases in the reactant gas mixture) is generally selected based on the desired functional group of the MX-functional nanoparticles. For example, when X is H, the reactant gas mixture generally comprises hydrogen gas or a lesser concentration of halogenated species (e.g. $SiCl_4$, $HSiCl_3$, BCl_3, $GeCl_4$, etc.). In contrast, when X is the halogen atom, the precursor gas (or reactant gas mixture) comprises an increased concentration of halogenated species (e.g. $SiCl_4$, $HSiCl_3$, BCl_3, $GeCl_4$, etc.). Any of these chlorinated species may comprise halogen atoms other than chlorine, e.g. bromine, fluorine, or iodine. For example, $SiBr_4$ may be utilized in combination with or in lieu of $SiCl_4$ contingent on the desired functional group X. Further, in embodiments where the functional group X is a halogen atom, the reactant gas mixture may further comprise a halogen gas. For example, in embodiments where the functional group X is Cl, chlorine gas (Cl_2) may be utilized in the

reactant gas mixture, either as a separate feed or along with the precursor gas. The relative amount of the halogen gas, if utilized, may be optimized on a variety of factors, such as the precursor gas selected, etc. For example, lesser amounts of the halogen gas may be utilized to prepare halogen-functional nanoparticles when the precursor gas comprises halogenated species. In certain embodiments, the halogen gas may be utilized in an amount of from greater than 0 to 25, alternatively from 1 to 25, alternatively from 1 to 10, volume percent based on the total volume of the reactant gas mixture. Independent of whether the nanoparticles have such surface functionality, the nanoparticles are referred to herein merely as the nanoparticles.

[0030] Specific embodiments of plasma reactor systems particularly suitable for the instant method are described below. It is to be appreciated that the specific embodiments described below are merely exemplary and plasma process suitable for producing nanoparticles may be utilized.

[0031] Referring to the Figures, wherein like numerals indicate corresponding parts throughout the several views, a plasma reactor system is shown generally at 20. Referring to Figure 1, a plasma reactor system is shown at 20. In this embodiment, the plasma reactor system 20 comprises a plasma generating chamber 22 having a reactant gas inlet 29 and an outlet 30 having an aperture or orifice 31 defined thereby. A particle collection chamber 26 is configured to be in communication with the plasma generating chamber 22. The particle collection chamber 26 contains a capture fluid 27 in a container 32. The container 32 may be adapted to be agitated (not shown). For example, the container 32 may be positioned on a rotatable support (not shown) or may include a stirring mechanism. Typically, the capture fluid is a liquid at the temperatures of operation of the system. The plasma reactor system 5 also includes a vacuum source 28 in communication with the particle collection chamber 26 and plasma generating chamber 22.

[0032] The plasma generating chamber 22 comprises an electrode configuration 24 that is attached to a variable frequency RF amplifier 21. The plasma generating chamber 22 also comprises a second electrode configuration 25. The second electrode configuration 25 is either ground, DC biased, or operated in a push-pull manner relative to the electrode configuration 24. The electrodes 24, 25 are used to couple the high frequency (HF) or very high frequency (VHF) power to the reactant gas mixture to ignite and sustain a glow discharge of plasma within the area identified as 23. The first reactive precursor gas (or gases) is then dissociated in the plasma to provide charged atoms which nucleate to form MX-functional quantum dots. However, other discharge tube configurations are contemplated, and may be used in carrying out the method disclosed herein.

[0033] In the embodiment of Figure 1, the MX-functional quantum dots are collected in the particle collection chamber 26 in the capture fluid. To control the diameter of the MX-functional quantum dots which are formed, the distance between the aperture 31 in the outlet 30 of the plasma generating chamber 22 and the surface of the capture fluid ranges from 5 to 50 times a diameter of the aperture (i.e., from 5 to 50 aperture diameters). Positioning the surface of the capture fluid too close to the outlet of the plasma generating chamber may result in undesirable interactions of plasma with the capture fluid. Conversely, positioning the surface of the capture fluid too far from the aperture reduces particle collection efficiency. As collection distance is a function of the aperture diameter of the outlet and the pressure drop between the plasma generating chamber and the collection chamber, based on the operating condition described herein, an acceptable collection distance is from 1 to 20, alternatively from 5 to 10, cm. Said differently, an acceptable collection distance is from 5 to 50 aperture diameters.

[0034] The plasma generating chamber 22 also comprises a power supply. The power is supplied via a variable frequency radio frequency power amplifier 21 that is triggered by an arbitrary function generator to establish high frequency pulsed plasma in area 23. Typically, the radiofrequency power is capacitively coupled into the plasma using a ring electrode, parallel plates, or an anode/cathode setup in the gas. Alternatively, the radiofrequency power may be inductively coupled mode into the plasma using an rf coil setup around the discharge tube.

[0035] The plasma generating chamber 11 may also comprise a dielectric discharge tube. Typically, a reactant gas mixture enters the dielectric discharge tube where the plasma is generated. MX-functional quantum dots which form from the reactant gas mixture start to nucleate as the first reactive precursor gas molecules are dissociated in the plasma.

[0036] The vacuum source 28 may comprise a vacuum pump. Alternatively, the vacuum source 28 may comprise a mechanical, turbo molecular, or cryogenic pump.

[0037] In one embodiment, the electrodes 24, 25 for a plasma source inside the plasma generating chamber 22 comprise a flow-through showerhead design in which a VHF radio frequency biased upstream porous electrode plate 24 is separated from a downstream porous electrode plate 25, with the pores of the plates aligned with one another. The pores may be circular, rectangular, or any other desirable shape. Alternatively, the plasma generating chamber 22 may enclose an electrode 24 that is coupled to the VHF radio frequency power source and has a pointed tip that has a variable distance between the tip and a grounded ring inside the chamber 22.

[0038] In one embodiment, the HF or VHF radio frequency power source operates in a frequency range of 10 to 500 MHz. In an alternative embodiment, the pointed tip 13 can be

positioned at a variable distance from a VHF radio frequency powered ring 14 operated in a push-pull mode (180° out of phase). In yet another alternative embodiment, the electrodes 24, 25 include an inductive coil coupled to the VHF radio frequency power source so that radio frequency power is delivered to the reactant gas mixture by an electric field formed by the inductive coil. Portions of the plasma generating chamber 22 can be evacuated to a vacuum level ranging between $1x10^{-7}$ to 500 Torr. However, other electrode coupling configurations are also contemplated for use with the method disclosed herein.

[0039] In the illustrated embodiment of Figure 1, the plasma in area 23 is initiated with a high frequency plasma via an RF power amplifier such as, for example, an AR Worldwide Model KAA2040, or an Electronics and Innovation Model 3200L, or an EM Power RF Systems, Inc. Model BBS2E3KUT. The amplifier can be driven (or pulsed) by an arbitrary function generator (e.g., a Tektronix AFG3252 function generator) that is capable of producing up to 200 watts of power from 0.15 to 150 MHz. In several embodiments, the arbitrary function may be able to drive the power amplifier with pulse trains, amplitude modulation, frequency modulation, or different waveforms. The power coupling between the amplifier and the reactant gas mixture typically increases as the frequency of the rf power increases. The ability to drive the power at a higher frequency may allow more efficient coupling between the power supply and discharge. At frequencies below 30 MHz, only 2 - 15% of the power is delivered to the discharge. This has the effect of producing high reflected power in the rf circuit that leads to increased heating and limited lifetime of the power supply. In contrast, higher frequencies allow more power to be delivered to the discharge, thereby reducing the amount of reflected power in the rf circuit.

[0040] In one embodiment, the power and frequency of the plasma system is preselected to create an optimal operating space for the formation of the nanoparticles. Typically, tuning both the power and frequency creates an appropriate ion and electron energy distribution in the discharge to help dissociate the molecules of the reactive precursor gas and nucleate the nanoparticles.

[0041] The plasma reactor system 20 illustrated in Figure 1 may be pulsed to enable an operator to directly manage the resident time for particle nucleation, and thereby control the particle size distribution and agglomeration kinetics in the plasma. The pulsing function of the system 20 allows for controlled tuning of the particle resident time in the plasma, which affects the size of the nanoparticles. By decreasing the "on" time of the plasma, the nucleating particles have less time to agglomerate, and therefore the size of the nanoparticles may be reduced on average (i.e., the nanoparticles distribution may be shifted to smaller diameter particle sizes).

[0042] Advantageously, the operation of the plasma reactor system 20 at higher frequency ranges and pulsing the plasma provides the same conditions as in conventional constricted/filament discharge techniques that use a plasma instability to produce the high ion energies/densities, but with the additional advantage that users can control operating conditions to select and produce nanoparticles having various sizes, which impacts their characteristic physical properties, e.g. photoluminescence..

[0043] For a pulse injection, the synthesis of the nanoparticles can be done with a pulsed energy source, such as a pulsed very high frequency RF plasma, a high frequency RF plasma, or a pulsed laser for pyrolysis. Typically, the VHF radiofrequency is pulsed at a frequency ranging from 1 to 50 kHz.

[0044] Another method to transfer the nanoparticles to the capture fluid is to pulse the input of the reactant gas mixture while the plasma is ignited. For example, one could ignite the plasma in which a first reactive precursor gas is present to synthesize the nanoparticles, with at least one other gas present to sustain the discharge, such as an inert gas. The synthesis of the nanoparticles is stopped when the flow of first reactive precursor gas is stopped with a mass flow controller. The synthesis of the nanoparticles continues when the flow of the first reactive precursor gas is started again. This produces a pulsed stream of nanoparticles. This technique can be used to increase the concentration of nanoparticles in the capture fluid if the flux of nanoparticles impinging on the capture fluid is greater than the absorption rate of the nanoparticles into the capture fluid.

[0045] In another embodiment, the nucleated nanoparticles are transferred from the plasma generating chamber 22 to particle collection chamber 26 containing capture fluid via the aperture or orifice 31 which creates a pressure differential. It is contemplated that the pressure differential between the plasma generating chamber 22 and the particle collection chamber 26 can be controlled through a variety of ways. In one configuration, the discharge tube inside diameter of the plasma generating chamber 22 is much less than the inside diameter of the particle collection chamber 26, thus creating a pressure drop. In another configuration, a grounded physical aperture or orifice may be placed between the discharge tube and the collection chamber 26 that forces the plasma to reside partially inside the orifice, based on the Debye length of the plasma and the size of the chamber 22. Another configuration comprises using a varying electrostatic orifice in which a positive concentric charge is developed that forces the negatively charged plasma through the aperture 31.

[0046] As first introduced above, in the embodiment of Figure 1, upon the dissociation of the first reactive precursor gas in the plasma generation chamber 22, nanoparticles form and are entrained in the gas phase. The distance between the nanoparticles synthesis location and the surface of capture fluid must be short enough so that no unwanted functionalization

occurs while the nanoparticles are entrained. If the nanoparticles interact within the gas phase, agglomerations of numerous individual small nanoparticles will form and be captured in the capture fluid. If too much interaction takes place within the gas phase, the nanoparticles may sinter together and form nanoparticles having larger average diameters. The collection distance is defined as the distance from the outlet of the plasma generating chamber to the surface of the capture fluid. The capture fluid is described in detail below following the description of an alternative embodiment of a plasma reactor system.

[0047] Additional aspects relating to this particular embodiment in which the nanoparticles are produced via this plasma process are described in International (PCT) Publication No. WO 2011/109299 (PCT/US2011/026491), which is incorporated by reference herein in its entirety.

[0048] Referring to Figure 2, an alternative embodiment of a plasma reactor system is shown at 50. In this embodiment, the nanoparticles are prepared in a system having a reactor and a diffusion pump in fluid communication with the reactor for collecting the nanoparticles of the aerosol. For example, nanoparticles of various size distributions and properties can be prepared by introducing a nanoparticle aerosol produced in a reactor (e.g. a low-pressure plasma reactor) into a diffusion pump in fluid communication with the reactor, capturing the nanoparticles of the aerosol in a condensate from the capture fluid, and collecting the captured nanoparticles in a reservoir. In the embodiment of Figure 2, the capture fluid may alternatively be referred to as a diffusion pump fluid, although the capture fluid and diffusion pump fluid are generally referred to herein as “the capture fluid” and are described collectively below.

[0049] Example reactors are described in WO 2010/027959 and WO 2011/109229, with each of which being incorporated herein in its respective entirety. Such reactors can be, but are not limited to, low pressure high frequency pulsed plasma reactors. For example, Figure 2 illustrates the plasma reactor of the embodiment of Figure 1, but includes the diffusion pump in fluid communication with the reactor. To this end, description relative to this particular plasma reactor is not repeated herein with respect to the embodiment of Figure 2.

[0050] In the embodiment of Figure 2, the plasma reactor system 50 includes a diffusion pump 120. As such, the nanoparticles can be collected by the diffusion pump 120. A particle collection chamber 26 may be in fluid communication with the plasma generating chamber 22. The diffusion pump 120 may be in fluid communication with the particle collection chamber 26 and the plasma generating chamber 22. In other forms of the present disclosure, the system 50 may not include the particle collection chamber 26. For example, the outlet 30 may be coupled to an inlet 103 of the diffusion pump 120, or the diffusion pump

120 may be in substantially direct fluid communication with the plasma generating chamber 22.

[0051] Figure 3 is a cross-sectional schematic of an example diffusion pump 120 suitable for the system 50 of the embodiment of Figure 2. The diffusion pump 120 can include a chamber 101 having an inlet 103 and an outlet 105. The inlet 103 may have a diameter of 2 to 55 inches, and the outlet may have a diameter of 0.5 to 8 inches. The inlet 103 of the chamber 101 is in fluid communication with the outlet 30 of the reactor 20. The diffusion pump 120 may have, for example, a pumping speed of 65 to 65,000 liters/second or greater than 65,000 liters/second.

[0052] The diffusion pump 120 includes a reservoir 107 in fluid communication with the chamber 101. The reservoir 107 supports or contains the capture fluid. The reservoir may have a volume of 30 cc to 15 liters. The volume of the capture fluid in the diffusion pump may be 30 cc to 15 liters.

[0053] The diffusion pump 120 can further include a heater 109 for vaporizing the capture fluid in the reservoir 107 to a vapor. The heater 109 heats up the capture fluid and vaporizes the capture fluid to form a vapor (e.g., liquid to gas phase transformation). For example, the capture fluid may be heated to 100 to 400 °C or 180 to 250 °C.

[0054] A jet assembly 111 can be in fluid communication with the reservoir 107 comprising a nozzle 113 for discharging the vaporized capture fluid into the chamber 101. The vaporized capture fluid flows and rises up though the jet assembly 111 and emitted out the nozzles 113. The flow of the vaporized capture fluid is illustrated in Figure 3 with arrows. The vaporized capture fluid condenses and flows back to the reservoir 107. For example, the nozzle 113 can discharge the vaporized capture fluid against a wall of the chamber 101. The walls of the chamber 101 may be cooled with a cooling system 113 such as a water cooled system. The cooled walls of the chamber 101 can cause the vaporized capture fluid to condense. The condensed capture fluid can then flow along and down the walls of the chamber 101 and back to the reservoir 107. The capture fluid can be continuously cycled through diffusion pump 120. The flow of the capture fluid causes gas that enters the inlet 103 to diffuse from the inlet 103 to the outlet 105 of the chamber 101. A vacuum source 33 may be in fluid communication with the outlet 105 of the chamber 101 to assist removal of the gas from the outlet 105.

[0055] As the gas flows through the chamber 101, nanoparticles in the gas can be absorbed by the capture fluid, thereby collecting the nanoparticles from the gas. For example, a surface of the nanoparticles may be wetted by the vaporized and/or condensed capture fluid. Furthermore, the agitating of cycled capture fluid may further improve absorption rate of the

nanoparticles compared to a static fluid. The pressure within the chamber 101 may be less than 1 mTorr.

[0056] The capture fluid with the nanoparticles can then be removed from the diffusion pump 120. For example, the capture fluid with the nanoparticles may be continuously removed and replaced with capture fluid that substantially does not include nanoparticles.

[0057] Advantageously, the diffusion pump 120 can be used not only for collecting nanoparticles but also evacuating the reactor 20 (and collection chamber 26). For example, the operating pressure in the reactor 20 can be a low pressure, e.g. less than atmospheric pressure, less than 760 Torr, or between 1 and 760 Torr. The collection chamber 26 can, for example, range from 1 to 5 milliTorr. Other operating pressures are also contemplated.

[0058] The system 50 may also include a vacuum pump or vacuum source 33 in fluid communication with the outlet 105 of the diffusion pump 120. The vacuum source 33 can be selected in order for the diffusion pump 120 to operate properly. In one form of the present disclosure, the vacuum source 33 comprises a vacuum pump (e.g., auxiliary pump). The vacuum source 33 may comprise a mechanical, turbo molecular, or cryogenic pump. However, other vacuum sources are also contemplated.

[0059] One method of producing nanoparticles with the system 50 of Figure 2 can include forming a nanoparticle aerosol in the reactor 20. The nanoparticle aerosol can comprise nanoparticles in a gas, and the method further includes introducing the nanoparticle aerosol into the diffusion pump 120 from the reactor 5. In this embodiment, the method also may include heating the capture fluid in a reservoir 107 to form a vapor, sending the vapor through a jet assembly 111, emitting the vapor through a nozzle 113 into a chamber 101 of the diffusion pump 120, condensing the vapor to form a condensate, and flowing the condensate back to the reservoir 107. Furthermore, the method can further include capturing the nanoparticles of the aerosol in the condensate, which comprises the capture fluid, and collecting the captured nanoparticles in the reservoir 107. The step of capturing the nanoparticles of the aerosol in the condensation, which comprises the capture fluid, may be identical to the step of collecting the nanoparticles of the aerosol in the capture fluid. The method can further include removing the gas from the diffusion pump with a vacuum pump. In the embodiment described above and illustrated in Figure 1, the nanoparticles are collected directly in the capture fluid. However, in the embodiment described immediately above and illustrated in Figures 2 and 3, the capture fluid is vaporized and condensed in the diffusion pump, and the nanoparticles are ultimately capture or collected in the capture fluid (once condensed).

[0060] Additional aspects relating to this particular embodiment in which the nanoparticles are produced via this plasma process are described in U.S. Application No. 61/655,635, which is incorporated by reference herein in its entirety.

[0061] Independent of the particular low pressure reactor utilized to prepare the nanoparticle aerosol, the nanoparticles are collected, optionally in the capture fluid (or diffusion pump fluid, which may also serve as the capture fluid).

[0062] If utilized, the capture fluid may comprise any compounds, components, or fluids that may be suitable for capturing the nanoparticles. For example, conventional components utilized in conventional capture fluids may be utilized as the capture fluid. Specific examples of conventional capture fluids include silicone fluids, such as polydimethylsiloxane, phenylmethyl-dimethyl cyclosiloxane, tetramethyltetraphenyltrisiloxane, and/or pentaphenyltrimethyltrisiloxane; hydrocarbons; phenyl ethers; fluorinated polyphenyl ethers; and ionic fluids. The personal care ingredient is distinguished from these capture fluids, i.e., none of these capture fluids constitute the personal care ingredient of the composition. Combinations of different components may be utilized in the capture fluid. The capture fluid may have a dynamic viscosity of 0.001 to 1 Pa·s, 0.005 to 0.5 Pa·s, or 0.01 to 0.1 Pa·s, at 23 ± 3 °C. Furthermore, the capture fluid may have a vapor pressure of less than 1 x 10^{-4} Torr. In some embodiments, the capture fluid is at a temperature ranging from -20 °C to 150 °C and a pressure ranging from 1 to 5 milliTorr (0.133 Pa to 0.665 Pa). In some embodiments, the capture fluid has a vapor pressure less than the pressure in the particle collection chamber.

[0063] The nanoparticles can be of various sizes, provided they are generally in the nano (10^{-9}) meter range. Typically, the nanoparticles have a largest dimension or an average largest dimension less than 50, less than 40, less than 30, less than 20, or less than 10, nm, (while still being greater than 0 nm). Furthermore, the largest dimension or average largest dimension of the nanoparticles may be between greater than 0 to 50, between 1 and 50, between 1 and 40, between 1 and 30, between 1 to 20, or between 1 to 10, nm.

[0064] In embodiments where the nanoparticles have a largest dimension or an average largest dimension less than 10 nm, the nanoparticles may be referred to as quantum dots. In these embodiments, the quantum dots may have a largest dimension or average largest dimension less than 10, less than 9, less than 8, less than 7, less than 6, or less than 5, nm (while still being greater than 0 nm). Furthermore, the largest dimension or average largest dimension of the quantum dots may be between greater than 0 to 10, between 1 and 10, between 1 and 8, between 1.5 and 7, or between 2.2 and 4.7, nm.

[0065] The largest dimension of the nanoparticles (or quantum dots) can be measured by a variety of methods, such as with a transmission electron microscope (TEM). For example, as

understood in the art, particle size distributions are often calculated via TEM image analysis of hundreds of different nanoparticles. Nanoparticles have excitons confined in all three spatial dimensions and may comprise individual crystals, i.e., each nanoparticle is a single crystal.

[0066] The nanoparticles of the composition may exhibit a number of unique electronic, magnetic, catalytic, physical, optoelectronic and optical properties due to quantum confinement effects. For example, many semiconductor nanoparticles exhibit photoluminescence effects that are significantly greater than the photoluminescence effects of macroscopic materials having the same composition. This is especially the case when the nanoparticles are classified as quantum dots.

[0067] In various embodiments, the nanoparticles (and composition including the same) may be photoluminescent when excited by exposure to UV light. Depending on the average diameter of the nanoparticles, the nanoparticles may photoluminescence in any of the wavelengths in the visible spectrum and may visually appear to be red, orange, green, blue, violet, or any other color in the visible spectrum. For example, when the nanoparticles of the composition have an average diameter less than 5 nm, visible photoluminescence may be observed, and when the nanoparticles have an average diameter less than 10 nm, near infrared (IR) luminescence may be observed. In one form of the present disclosure, the nanoparticles have a photoluminescent intensity of at least 1×10^6 at an excitation wavelength of 365 nm. The photoluminescent intensity may be measured with a Fluorolog3 spectrofluorometer (commercially available from Horiba of Edison, NJ) with a 450 W Xe excitation source, excitation monochromator, sample holder, edge band filter (400 nm), emission monochromator, and a silicon detector photomultiplier tube. To measure photoluminescent intensity, the excitation and emission slit width are set to 2 nm and the integration time is set to 0.1s. In these or other embodiments, the nanoparticles may have a quantum efficiency of at least 4% at an excitation wavelength of 395 nm as measured on an HR400 spectrophotometer (commercially available from Ocean Optics of Dunedin, Florida) via a 1000 micron optical fiber coupled to an integrating sphere and the spectrophotometer with an absorption of >10% of the incident photons. Quantum efficiency was calculated by placing a sample into the integrating sphere and exciting the sample via a 395 nm LED driven by an Ocean Optics LED driver. The system is calibrated with a known lamp source to measure absolute irradiance from the integrating sphere. The quantum efficiency is then calculated by the ratio of total photons emitted by the nanoparticles to the total photons absorbed by the nanoparticles. Further, in these or other embodiments, the nanoparticles may have a full width at half maximum emission of from 20 to 250 at an excitation wavelength of 270-500 nm.

[0068] Furthermore, both the photoluminescent intensity and luminescent quantum efficiency may continue to increase over time, particularly when the nanoparticles (optionally as a part of the composition) are exposed to air. In another form of the present disclosure, the maximum emission wavelength of the nanoparticles shifts to shorter wavelengths over time when exposed to oxygen. The luminescent quantum efficiency of the nanoparticles may be increased by 200% to 2500% upon exposure to oxygen. However, other increases in the luminescent quantum efficiency are also contemplated. The photoluminescent intensity may increase from 400 to 4500% depending on the time exposure to oxygen and the concentration of the nanoparticles in the fluid. However, other increases in the photoluminescent intensity are also contemplated. The wavelength emitted from the direct capture composition also experiences a blue shift of the emission spectrum. In one form of the present disclosure, the maximum emission wavelength shifts 100 nm, based on a 1 nm decrease in nanoparticle core size, depending on the time exposed to oxygen. However, other maximum emission wavelength shifts are also contemplated.

[0069] The composition can include the nanoparticles in various amounts. One of ordinary skill in the art can readily select an appropriate amount based on want or need.

[0070] As introduced above, the composition further comprises at least one personal care ingredient. As with the nanoparticles, the composition may comprise two or more personal care ingredients, which may be independently selected. For clarity and consistency, "the personal care ingredient" encompasses embodiments where the composition includes but one or two or more personal care ingredients. In various embodiments, the personal care ingredient is different from a silicone fluid, a hydrocarbon, a phenyl ether, and an ionic fluid. The personal care ingredient is distinguished from the nanoparticles.

[0071] In certain embodiments, the personal care ingredient comprises a skin care ingredient. In these embodiments, the composition may be referred to as a skin care composition. If utilized to prepare the composition, the skin care ingredient is typically selected from water phase stabilizing agents, cosmetic biocides, conditioning agents (which may be silicone, cationic, hydrophobic, etc.), emollients, moisturizers, colorants, dyes, ultraviolet (UV) absorbers, sunscreen agents, antiperspirants, antioxidants, fragrances, antimicrobial agents, antibacterial agents, antifungal agents, antiaging actives, anti-acne agents, skin-lightening agents, pigments, preservatives, pH controlling agents, electrolytes, chelating agents, plant extracts, botanical extracts, sebum absorbents, sebum control agents, vitamins, waxes, surfactants, detergents, emulsifiers, thickeners, propellant gases, skin protectants, film forming polymers, and combinations thereof. With some of these skin care embodiments, the composition may be referred to as a sunscreen, a shower gel, a soap, a hydrogel, a cream, a lotion, a balm, foundation, lipstick, eyeliner, a cuticle coat, or

blush. Various species of such skin care ingredients are known by one of ordinary skill in the art.

[0072] Examples of emollients include volatile or non-volatile silicone oils; silicone resins such as polypropylsilsesquioxane and phenyl trimethicone; silicone elastomers such as dimethicone crosspolymer; alkylmethylsiloxanes such as C_{30-45} alkyl methicone; volatile or non-volatile hydrocarbon compounds, such as squalene, paraffin oils, petrolatum oils and naphthalene oils; hydrogenated or partially hydrogenated polyisobutene; isoeicosane; squalane; isoparaffin; isododecane; isodecane or isohexa-decane; branched C_8-C_{16} esters; isohexyl neopentanoate; ester oils such as isononyl isononanoate, cetostearyl octanoate, isopropyl myristate, palmitate derivatives, stearates derivatives, isostearyl isostearate and the heptanoates, octanoates, decanoates or ricinoleates of alcohols or of polyalcohols, or mixtures thereof; hydrocarbon oils of plant origin, such as wheatgerm, sunflower, grapeseed, castor, shea, avocado, olive, soybean, sweet almond, palm, rapeseed, cotton seed, hazelnut, macadamia, jojoba, blackcurrant, evening primrose; or triglycerides of caprylic/capric acids; higher fatty acids, such as oleic acid, linoleic acid or linolenic acid, and mixtures thereof.

[0073] Example of waxes include hydrocarbon waxes such as beeswax, lanolin wax, rice wax, carnauba wax, candelilla wax, microcrystalline waxes, paraffins, ozokerite, polyethylene waxes, synthetic wax, ceresin, lanolin, lanolin derivatives, cocoa butter, shellac wax, bran wax, capok wax, sugar cane wax, montan wax, whale wax, bayberry wax, silicone waxes (e.g. polymethylsiloxane alkyls, alkoxys and/or esters, C_{30-45} alkyldimethylsilyl polypropylsilsesquioxane), and mixtures thereof.

[0074] Examples of moisturizers include lower molecular weight aliphatic diols such as propylene glycol and butylene glycol; polyols such as glycerine and sorbitol; and polyoxyethylene polymers such as polyethylene glycol 200; hyaluronic acid and its derivatives, and mixtures thereof.

[0075] Examples of surface active materials may be anionic, cationic or non ionic, and include organomodified silicones such as dimethicone copolyol; oxyethylenated and/or oxypropylenated ethers of glycerol; oxyethylenated and/or oxypropylenated ethers of fatty alcohols such as ceteareth-30, C_{12-15} pareth-7; fatty acid esters of polyethylene glycol such as PEG-50 stearate, PEG-40 monostearate; saccharide esters and ethers, such as sucrose stearate, sucrose cocoate and sorbitan stearate, and mixtures thereof; phosphoric esters and salts thereof, such as DEA oleth-10 phosphate; sulphosuccinates such as disodium PEG-5 citrate lauryl sulphosuccinate and disodium ricinoleamido MEA sulphosuccinate; alkyl

ether sulphates, such as sodium lauryl ether sulphate; isethionates; betaine derivatives; and mixtures thereof.

[0076] Further examples of nonionic surfactants include polyoxyethylene alkyl ethers, polyoxyethylene alkylphenol ethers, polyoxyethylene lauryl ethers, polyoxyethylene sorbitan monoleates, polyoxyethylene alkyl esters, polyoxyethylene sorbitan alkyl esters, polyethylene glycol, polypropylene glycol, diethylene glycol, ethoxylated trimethylnonanols, polyoxyalkylene-substituted silicones (rake or ABn types), silicone alkanolamides, silicone esters, silicone glycosides, and mixtures thereof.

[0077] Nonionic surfactants include dimethicone copolyols, fatty acid esters of polyols, for instance sorbitol or glyceryl mono-, di-, tri- or sesqui-oleates or stearates, glyceryl or polyethylene glycol laurates; fatty acid esters of polyethylene glycol (polyethylene glycol monostearate or monolaurate); polyoxyethylenated fatty acid esters (stearate or oleate) of sorbitol; polyoxyethylenated alkyl (lauryl, cetyl, stearyl or octyl)ethers.

[0078] Anionic surfactants include carboxylates (sodium 2-(2-hydroxyalkyloxy)acetate)), amino acid derivatives (N-acylglutamates, N-acylgly-cinates or acylsarcosinates), alkyl sulfates, alkyl ether sulfates and oxyethylenated derivatives thereof, sulfonates, isethionates and N-acylisethionates, taurates and N-acyl N-methyltaurates, sulfosuccinates, alkylsulfoacetates, phosphates and alkyl phosphates, polypeptides, anionic derivatives of alkyl polyglycoside (acyl-D-galactoside uronate), and fatty acid soaps, and mixtures thereof.

[0079] Amphoteric and zwitterionic surfactants include betaines, N-alkylamidobetaines and derivatives thereof, proteins and derivatives thereof, glycine derivatives, sultaines, alkyl polyaminocarboxylates and alkylamphoacetates, and mixtures thereof.

[0080] Examples of thickeners include acrylamide copolymers, acrylate copolymers and salts thereof (such as sodium polyacrylate), xanthan gum and derivatives, cellulose gum and cellulose derivatives (such as methylcellulose, methylhydroxypropylcellulose, hydroxypropylcellulose, polypropylhydroxyethylcellulose), starch and starch derivatives (such as hydroxyethylamylose and starch amylase), polyoxyethylene, carbomer, sodium alginate, arabic gum, cassia gum, guar gum and guar gum derivatives, cocamide derivatives, alkyl alcohols, gelatin, PEG- derivatives, saccharides (such as fructose, glucose) and saccharides derivatives (such as PEG-120 methyl glucose diolate), and mixtures thereof.

[0081] Examples of water phase stabilizing agents include electrolytes (e.g. alkali metal salts and alkaline earth salts, especially the chloride, borate, citrate, and sulfate salts of sodium, potassium, calcium and magnesium, as well as aluminum chlorohydrate, and polyelectrolytes, especially hyaluronic acid and sodium hyaluronate), polyols (glycerine,

propylene glycol, butylene glycol, and sorbitol), alcohols such as ethyl alcohol, and hydrocolloids, and mixtures thereof.

[0082] Examples of pH controlling agents include any water soluble acid such as a carboxylic acid or a mineral acid such as hydrochloric acid, sulphuric acid, and phosphoric acid, monocarboxylic acid such as acetic acid and lactic acid, and polycarboxylic acids such as succinic acid, adipic acid, citric acid, and mixtures thereof.

[0083] Example of preservatives and cosmetic biocides include paraben derivatives, hydantoin derivatives, chlorhexidine and its derivatives, imidazolidinyl urea, phenoxyethanol, silver derivatives, salicylate derivatives, triclosan, ciclopirox olamine, hexamidine, oxyquinoline and its derivatives, PVP-iodine, zinc salts and derivatives such as zinc pyrithione, and mixtures thereof.

[0084] Examples of sebum absorbants or sebum control agents include silica silylate, silica dimethyl silylate, dimethicone/vinyl dimethicone crosspolymer, polymethyl methacrylate, cross-linked methylmethacrylate, aluminum starch octenylsuccinate, and mixtures thereof.

[0085] Examples of pigments and colorants include surface treated or untreated iron oxides, surface treated or untreated titanium dioxide, surface treated or untreated mica, silver oxide, silicates, chromium oxides, carotenoids, carbon black, ultramarines, chlorophyllin derivatives and yellow ocher. Examples of organic pigments include aromatic types including azo, indigoid, triphenylmethane, anthraquinone, and xanthine dyes which are designated as D&C and FD&C blues, browns, greens, oranges, reds, yellows, etc, and mixtures thereof. Surface treatments include those treatments based on lecithin, silicone, silanes, fluoro compounds, and mixtures thereof.

[0086] Examples of silicone conditioning agents include silicone oils such as dimethicone; silicone gums such as dimethiconol; silicone resins such as trimethylsiloxy silicate, polypropyl silsesquioxane; silicone elastomers; alkylmethylsiloxanes; organomodified silicone oils, such as amodimethicone, aminopropyl phenyl trimethicone, phenyl trimethicone, trimethyl pentaphenyl trisiloxane, silicone quaternium-16/glycidoxy dimethicone crosspolymer, silicone quaternium-16; saccharide functional siloxanes; carbinol functional siloxanes; silicone polyethers; siloxane copolymers (divinyldimethicone/dimethicone copolymer); acrylate or acrylic functional siloxanes; and mixtures or emulsions thereof.

[0087] Examples of cationic conditioning agents include guar derivatives such as hydroxypropyltrimethylammonium derivative of guar gum; cationic cellulose derivatives, cationic starch derivatives; quaternary nitrogen derivatives of cellulose ethers; homopolymers of dimethyldiallyl ammonium chloride; copolymers of acrylamide and dimethyldiallyl ammonium chloride; homopolymers or copolymers derived from acrylic acid or methacrylic acid which contain cationic nitrogen functional groups attached to the polymer

by ester or amide linkages; polymeric quaternary ammonium salts of hydroxyethyl cellulose reacted with a fatty alkyl dimethyl ammonium substituted epoxide; polycondensation products of N,N'-bis-(2,3-epoxypropyl)-piperazine or piperazine-bis-acrylamide and piperazine; and copolymers of vinylpyrrolidone and acrylic acid esters with quaternary nitrogen functionality. Specific materials include the various polyquats, e.g. Polyquaternium-7, Polyquaternium-8, Polyquaternium-10, Polyquaternium-11, and Polyquaternium-23. Other categories of conditioners include cationic surfactants such as cetyl trimethylammonium chloride, cetyl trimethylammonium bromide, stearyltrimethylammonium chloride, and mixtures thereof. In some instances, the cationic conditioning agent is also hydrophobically modified, such as hydrophobically modified quaternized hydroxyethylcellulose polymers; cationic hydrophobically modified galactomannan ether; and mixtures thereof.

[0088] Examples of hydrophobic conditioning agents include guar derivatives; galactomannan gum derivatives; cellulose derivatives; and mixtures thereof.

[0089] UV absorbers and sunscreen agents include those which absorb ultraviolet light between 290-320 nanometers (the UV-B region) and those which absorb ultraviolet light in the range of 320-400 nanometers (the UV-A region).

[0090] Some examples of sunscreen agents are aminobenzoic acid, cinoxate, diethanolamine methoxycinnamate, digalloyl trioleate, dioxybenzone, ethyl 4-[bis(Hydroxypropyl)] aminobenzoate, glyceryl aminobenzoate, homosalate, lawsone with dihydroxyacetone, menthyl anthranilate, octocrylene, ethyl hexyl methoxycinnamate, octyl salicylate, oxybenzone, padimate O, phenylbenzimidazole sulfonic acid, red petrolatum, sulisobenzone, titanium dioxide, trolamine salicylate, and mixtures thereof.

[0091] Some examples of UV absorbers are acetaminosalol, allatoin PABA, benzalphthalide, benzophenone, benzophenone 1-12, 3-benzylidene camphor, benzylidenecamphor hydrolyzed collagen sulfonamide, benzylidene camphor sulfonic Acid, benzyl salicylate, bornelone, bumetriozole, butyl methoxydibenzoylmethane, butyl PABA, ceria/silica, ceria/silica talc, cinoxate, DEA-methoxycinnamate, dibenzoxazol naphthalene, di-t-butyl hydroxybenzylidene camphor, digalloyl trioleate, diisopropyl methyl cinnamate, dimethyl PABA ethyl cetearyldimonium tosylate, dioctyl butamido triazone, diphenyl carbomethoxy acetoxy naphthopyran, disodium bisethylphenyl tiamminotriazine stilbenedisulfonate, disodium distyrylbiphenyl triaminotriazine stilbenedisulfonate, disodium distyrylbiphenyl disulfonate, drometrizole, drometrizole trisiloxane, ethyl dihydroxypropyl PABA, ethyl diisopropylcinnamate, ethyl methoxycinnamate, ethyl PABA, ethyl urocanate, etrocrylene ferulic acid, glyceryl octanoate dimethoxycinnamate, glyceryl PABA, glycol salicylate, homosalate, isoamyl p-methoxycinnamate, isopropylbenzyl salicylate, isopropyl dibenzolylmethane, isopropyl methoxycinnamate, menthyl anthranilate, menthyl salicylate, 4-

methylbenzylidene, camphor, octocrylene, octrizole, octyl dimethyl PABA, ethyl hexyl methoxycinnamate, octyl salicylate, octyl triazone, PABA, PEG-25 PABA, pentyl dimethyl PABA, phenylbenzimidazole sulfonic acid, polyacrylamidomethyl benzylidene camphor, potassium methoxycinnamate, potassium phenylbenzimidazole sulfonate, red petrolatum, sodium phenylbenzimidazole sulfonate, sodium urocanate, TEA-phenylbenzimidazole sulfonate, TEA-salicylate, terephthalylidene dicamphor sulfonic acid, titanium dioxide, triPABA panthenol, urocanic acid, VA/crotonates/methacryloxybenzophenone-1 copolymer, and mixtures thereof.

[0092] Examples of antiperspirant agents and deodorant agents include aluminum chloride, aluminum zirconium tetrachlorohydrex GLY, aluminum zirconium tetrachlorohydrex PEG, aluminum chlorohydrex, aluminum zirconium tetrachlorohydrex PG, aluminum chlorohydrex PEG, aluminum zirconium trichlorohydrate, aluminum chlorohydrex PG, aluminum zirconium trichlorohydrex GLY, hexachlorophene, benzalkonium chloride, aluminum sesquichlorohydrate, sodium bicarbonate, aluminum sesquichlorohydrex PEG, chlorophyllin-copper complex, triclosan, aluminum zirconium octachlorohydrate, zinc ricinoleate, and mixtures thereof.

[0093] Examples of skin protectants include allantoin, aluminium acetate, aluminium hydroxide, aluminium sulfate, calamine, cocoa butter, cod liver oil, colloidal oatmeal, dimethicone, glycerin, kaolin, lanolin, mineral oil, petrolatum, shark liver oil, sodium bicarbonate, talc, witch hazel, zinc acetate, zinc carbonate, zinc oxide, and mixtures thereof.

[0094] Examples of dyes include 1-acetoxy-2-methylnaphthalene; acid dyes; 5-amino-4-chloro-o-cresol; 5-amino-2,6-dimethoxy-3-hydroxypyridine; 3-amino-2,6-dimethylphenol; 2-amino-5-ethylphenol HCl; 5-amino-4-fluoro-2-methylphenol sulfate; 2-amino-4-hydroxyethylaminoanisole; 2-amino-4-hydroxyethylaminoanisole sulfate; 2-amino-5-nitrophenol; 4-amino-2-nitrophenol; 4-amino-3-nitrophenol; 2-amino-4-nitrophenol sulfate; m-aminophenol HCl; p-aminophenol HCl; m-aminophenol; o-aminophenol; 4,6-bis(2-hydroxyethoxy)-m-phenylenediamine HCl; 2,6-bis(2-hydroxyethoxy)-3,5-pyridinediamine HCl; 2-chloro-6-ethylamino-4-nitrophenol; 2-chloro-5-nitro-N-hydroxyethyl p-phenylenediamine; 2-chloro-p-phenylenediamine; 3,4-diaminobenzoic acid; 4,5-diamino-1-((4-chlorophenyl)methyl)-1H-pyrazole-sulfate; 2,3-diaminodihydropyrazolo pyrazolone dimethosulfonate; 2,6-diaminopyridine; 2,6-diamino-3-((pyridin-3-yl)azo)pyridine; dihydroxyindole; dihydroxyindoline; N,N-dimethyl-p-phenylenediamine; 2,6-dimethyl-p-phenylenediamine; N,N-dimethyl-p-phenylenediamine sulfate; direct dyes; 4-ethoxy-m-phenylenediamine sulfate; 3-ethylamino-p-cresol sulfate; N-ethyl-3-nitro PABA; gluconamidopropyl aminopropyl dimethicone; Haematoxylon brasiletto wood extract; HC dyes; Lawsonia inermis (Henna) extract; hydroxyethyl-3,4-methylenedioxyaniline HCl;

hydroxyethyl-2-nitro-p-toluidine; hydroxyethyl-p-phenylenediamine sulfate; 2-hydroxyethyl picramic acid; hydroxypyridinone; hydroxysuccinimidyl C_{21}-C_{22} isoalkyl acidate; isatin; Isatis tinctoria leaf powder; 2-methoxymethyl-p-phenylenediamine sulfate; 2-methoxy-p-phenylenediamine sulfate ; 6-methoxy-2,3-pyridinediamine HCl; 4-methylbenzyl 4,5-diamino pyrazole sulfate; 2,2'-methylenebis 4-aminophenol; 2,2'-methylenebis-4-aminophenol HCl; 3,4-methylenedioxyaniline; 2-methylresorcinol; methylrosanilinium chloride; 1,5-naphthalenediol; 1,7-naphthalenediol; 3-nitro-p-Cresol; 2-nitro-5-glyceryl methylaniline; 4-nitroguaiacol; 3-nitro-p-hydroxyethylaminophenol; 2-nitro-N-hydroxyethyl-p-anisidine; nitrophenol; 4-nitrophenyl aminoethylurea; 4-nitro-o-phenylenediamine dihydrochloride; 2-nitro-p-phenylenediamine dihydrochloride; 4-nitro-o-phenylenediamine HCl; 4-nitro-m-phenylenediamine; 4-nitro-o-phenylenediamine; 2-nitro-p-phenylenediamine; 4-nitro-m-phenylenediamine sulfate; 4-nitro-o-phenylenediamine sulfate; 2-nitro-p-phenylenediamine sulfate; 6-nitro-2,5-pyridinediamine; 6-nitro-o-toluidine; PEG-3 2,2'-di-p-phenylenediamine; p-phenylenediamine HCl; p-phenylenediamine sulfate; phenyl methyl pyrazolone; N-phenyl-p-phenylenediamine HCl; pigment blue 15:1; pigment violet 23; pigment yellow 13; pyrocatechol; pyrogallol; resorcinol; sodium picramate; sodium sulfanilate; solvent yellow 85; solvent yellow 172; tetraaminopyrimidine sulfate; tetrabromophenol blue; 2,5,6-triamino-4-pyrimidinol sulfate; 1,2,4-trihydroxybenzene.

[0095] Examples of antioxidants are acetyl cysteine, arbutin, ascorbic acid, ascorbic acid polypeptide, ascorbyl dipalmitate, ascorbyl methylsilanol pectinate, ascorbyl palmitate, ascorbyl stearate, BHA, p-hydroxyanisole, BHT, t-butyl hydroquinone, caffeic acid, Camellia sinensis oil, chitosan ascorbate, chitosan glycolate, chitosan salicylate, chlorogenic acids, cysteine, cysteine HCl, decyl mercaptomethylimidazole, erythorbic acid, diamylhydroquinone, di-t-butylhydroquinone, dicetyl thiodipropionate, dicyclopentadiene/t-butylcresol copolymer, digalloyl trioleate, dilauryl thiodipropionate, dimyristyl thiodipropionate, dioleyl tocopheryl methylsilanol, isoquercitrin, diosmine, disodium ascorbyl sulfate, disodium rutinyl disulfate, distearyl thiodipropionate, ditridecyl thiodipropionate, dodecyl gallate, ethyl ferulate, ferulic acid, hydroquinone, hydroxylamine HCl, hydroxylamine sulfate, isooctyl thioglycolate, kojic acid, madecassicoside, magnesium ascorbate, magnesium ascorbyl phosphate, melatonin, methoxy-PEG-7 rutinyl succinate, methylene di-t-butylcresol, methylsilanol ascorbate, nordihydroguaiaretic acid, octyl gallate, phenylthioglycolic acid, phloroglucinol, potassium ascorbyl tocopheryl phosphate, thiodiglycolamide, potassium sulfite, propyl gallate, rosmarinic acid, rutin, sodium ascorbate, sodium ascorbyl/cholesteryl phosphate, sodium bisulfite, sodium erythorbate, sodium metabisulfide, sodium sulfite, sodium thioglycolate, sorbityl furfural, tea tree (Melaleuca aftemifolia) oil, tocopheryl acetate, tetrahexyldecyl ascorbate, tetrahydrodiferuloylmethane,

tocopheryl linoleate/oleate, thiodiglycol, tocopheryl succinate, thiodiglycolic acid, thioglycolic acid, thiolactic acid, thiosalicylic acid, thiotaurine, retinol, tocophereth-5, tocophereth-10, tocophereth-12, tocophereth-18, tocophereth-50, tocopherol, tocophersolan, tocopheryl linoleate, tocopheryl nicotinate, tocoquinone, o-tolyl biguanide, tris(nonylphenyl) phosphite, ubiquinone, zinc dibutyldithiocarbamate, and mixtures thereof.

[0096] Examples of propellant gases include carbon dioxide, nitrogen, nitrous oxide, volatile hydrocarbons such as butane, isobutane, or propane, and chlorinated or fluorinated hydrocarbons such as dichlorodifluoromethane and dichlorotetrafluoroethane or dimethylether; and mixtures thereof.

[0097] In a specific embodiment, the composition is a sunscreen. In these embodiments, the nanoparticles themselves act as a sunscreen agent, although the sunscreen includes a sunscreen agent separate from and in addition to the nanoparticles. The sunscreen agent may be, for example, a sunscreen additive, an SPF booster, a photostabilizer, a carrier vehicle for the nanoparticles, a film-forming polymer, etc. The sunscreen may be also or alternatively be utilized in sunless tanning applications. Specific examples of sunscreen agents are set forth above.

[0098] The nanoparticles are particularly suited for sunscreens and provide sunscreens with excellent physical properties as compared to conventional sunscreens including conventional sunscreen agents, e.g. titanium oxide and/or zinc oxide. For example, sunscreens are commonly utilized to scatter UV light, and these conventional sunscreen agents are suited for scattering light, including at least some UV light. However, the nanoparticles of the inventive composition comprise a Group IV element and have a much greater extinction coefficient in the UV range than that of conventional sunscreen agents. This greater extinction coefficient allows for reduced loadings of the nanoparticles in the sunscreen, which reduces costs. Moreover, the nanoparticles of the inventive composition have excellent absorptive properties, and thus do not merely rely on scattering, as contrasted from conventional sunscreen agents. These absorptive properties of the nanoparticles may be utilized to provide sunscreens having not only excellent physical properties in use, but also to provide sunscreens having improved aesthetic qualities. For example, conventional sunscreen agents typically impart conventional sunscreens with an opaque white hue, which is undesirable. However, such whitening is minimized or eliminated in the inventive sunscreens due to the absorptive properties of the nanoparticles. Further, many conventional sunscreens include organic compounds, such as avobenzone, which have undesirable photostability, leading to poor shelf-life of such conventional sunscreens. However, the inventive composition need not rely on organic compounds, thus improving shelf-life and stability thereof.

[0099] In specific embodiments, a concentration of 0.1 wt.% of the silicon nanoparticles in a sunscreen impart the sunscreen with SPF 25. In these or other embodiments, a concentration of 0.125 wt.% of the silicon nanoparticles in a sunscreen impart the sunscreen with SPF 50. Thus, there can be a significant increase in SPF despite nominal increases in loadings.

[00100] In other embodiments, the personal care ingredient comprises a hair care ingredient. In these embodiments, the composition may be referred to as a hair care composition. If utilized to prepare the composition, the hair care ingredient is typically selected from conditioning agents (which may be silicone, cationic, hydrophobic, etc.), colorants, dyes, ultraviolet (UV) absorbers, preservatives, plant extracts, fatty alcohols, vitamins, fragrance, anti-dandruff agents, color care additives, pearlising agents, pH controlling agents, electrolytes, chelating agents, styling agents, ceramides, amino-acid derivatives, suspending agents, surfactants, detergents, emulsifiers, thickeners, oxidizing agents, reducing agents, film-forming polymers, and combinations thereof. With some of these hair care embodiments, the composition may be referred to as a shampoo, a rinse-off conditioner, a leave-in conditioner, a gel, a pomade, a serum, a spray, a coloring product, or mascara. Examples of many of these hair care ingredients are set forth above as suitable personal care ingredients.

[00101] Examples of oxidizing agents are ammonium persulfate, calcium peroxide, hydrogen peroxide, magnesium peroxide, melamine peroxide, potassium bromate, potassium caroate, potassium chlorate, potassium persulfate, sodium bromate, sodium carbonate peroxide, sodium chlorate, sodium iodate, sodium perborate, sodium persulfate, strontium dioxide, strontium peroxide, urea peroxide, zinc peroxide, and mixtures thereof.

[00102] Examples of reducing agents are ammonium bisufite, ammonium sulfite, ammonium thioglycolate, ammonium thiolactate, cystemaine HCl, cystein, cysteine HCl, ethanolamine thioglycolate, glutathione, glyceryl thioglycolate, glyceryl thioproprionate, hydroquinone, p-hydroxyanisole, isooctyl thioglycolate, magnesium thioglycolate, mercaptopropionic acid, potassium metabisulfite, potassium sulfite, potassium thioglycolate, sodium bisulfite, sodium hydrosulfite, sodium hydroxymethane sulfonate, sodium metabisulfite, sodium sulfite, sodium thioglycolate, strontium thioglycolate, superoxide dismutase, thioglycerin, thioglycolic acid, thiolactic acid, thiosalicylic acid, zinc formaldehyde sulfoxylate, and mixtures thereof.

[00103] Examples of antidandruff agents include pyridinethione salts, selenium compounds such as selenium disulfide, and soluble antidandruff agents, and mixtures thereof.

[00104] In other embodiments, the personal care ingredient comprises a nail care ingredient. In these embodiments, the composition may be referred to as a nail care composition. If utilized to prepare the composition, the nail care ingredient may be any ingredient utilized in

nail care compositions, e.g. nail polishes, nail gels, nail tips, acrylic finishes, etc. Examples of such nail care ingredients include pigments, resins, solvents, volatile halogenated compounds (e.g. methoxynonafluorobutane and/or ethoxynonafluorobutane), etc.

[00105] More specifically, examples of nail care ingredients include butyl acetate; ethyl acetate; nitrocellulose; acetyl tributyl citrate; isopropyl alcohol; adipic acid/neopentyl glycol/trimelitic anhydride copolymer; stearalkonium bentonite; acrylates copolymer; calcium pantothenate; Cetraria islandica extract; Chondrus crispus; styrene/acrylates copolymer; trimethylpentanediyl dibenzoate-1; polyvinyl butyral; N-butyl alcohol; propylene glycol; butylene glycol; mica; silica; tin oxide; calcium borosilicate; synthetic fluorphlogopite; polyethylene terephtalate; sorbitan laurate derivatives; talc; jojoba extract; diamond powder; isobutylphenoxy epoxy resin; silk powder; and mixtures thereof.

[00106] In other embodiments, the personal care ingredient comprises a tooth care ingredient. In these embodiments, the composition may be referred to as a tooth care composition. One specific example of such a tooth care composition is toothpaste. Another example of a tooth care composition is a tooth whitening composition. The tooth care ingredient may be any tooth care ingredient suitable for the tooth care composition, such as an abrasive compound (e.g. aluminum hydroxide, calcium carbonate, silica, zeolite), a fluoride compound, a surfactant, a flavorant, a remineralizer, an antibacterial agent, etc.

[00107] In certain embodiments, the personal care ingredient comprises a film-forming polymer, which may be utilized as the personal care ingredient whether the composition is utilized for skin care, hair care, etc. “Film-forming polymer,” as used herein, means a polymer or oligomer which is capable of, by itself or optionally in the presence of a film-forming agent, forming a film on a substrate. The film-forming polymer may form the film upon an application of a curing condition, e.g. the application of heat, exposure to atmospheric conditions, etc. Alternatively, the film-forming polymer may form the film upon evaporation of any carrier vehicle in which the film-forming polymer may optionally be disposed. The film-forming polymer may undergo a reaction, e.g. the film-forming polymer may become cross-linked or otherwise include additional bonds, when forming the film. However, the film-forming polymer may form the film in the absence of such a reaction. The film-forming polymer may be a gelling agent. The film-forming polymer is particularly advantageous when the composition is the sunscreen, although the personal care ingredient may comprise the film-forming polymer in other compositions as well.

[00108] The substrate on which the film is formed may be any substrate, although the substrate is generally a portion of a mammal, particularly a human, as described in greater detail below with reference to the treatment method. Specific examples of suitable substrates include skin, hair, and nails.

[00109] Generally, the film is continuous, although the film may have a varying thickness. By continuous, it is meant that the film does not define any apertures. The film may be referred to as being macroscopically continuous. The film may be supported by the substrate, or may be bonded, e.g. physically and/or chemically, to the substrate. In certain embodiments, the film is optionally removable from the substrate, e.g. the film may be peelable from the substrate. The film may remain intact as a free-standing film upon being separated from the substrate or may be separated through application of shear, which may damage and/or destroy continuity of the film.

[00110] Specific examples of film-forming polymers that are suitable include acrylic polymers, polyurethanes, polyurethane-acrylics, polyesters, polyester-polyurethanes, polyether-polyurethanes, polyesteramides, alkyds, polyamides, polyureas, polyurea-polyurethanes, cellulose-based polymers (e.g. nitrocellulose), silicones, acrylic-silicones, polyacrylamides, fluoropolymers, polyisoprenes, and any copolymers or terpolymers thereof or including one of these. The term "silicones," as used herein with reference to suitable film-forming polymers, includes linear, branched, and resinous silicones, although resinous silicones are generally referred to as silicone resins rather than polymers. The silicone may be modified, e.g. the silicone may be a silicone-grafted acrylic polymer.

[00111] As introduced above, the film-forming polymer may be disposed in a carrier vehicle, which may partially or fully solubilize the film-forming polymer. Depending on a selection of the film-forming polymer, the carrier vehicle may be, for example, an oil, e.g. an organic oil and/or a silicone oil, a solvent, water, etc. The film-forming polymer may be in the form of polymer particles, which are optionally surface-stabilized with at least one stabilizer, and the polymer particles may be present as a dispersion or emulsion.

[00112] The film-forming polymer may be a block polymer, which may be styrene-free. Typically, the block polymer comprises at least one first block and at least one second block, which may be linked together via an intermediate block comprising at least one constituent monomer of the first block and at least one constituent monomer of the second block. Generally, the glass transition temperatures of the first and second blocks are different from one another.

[00113] Monomers that may be utilized to prepare the block polymer include, for example, methyl methacrylate, isobutyl (meth)acrylate and isobornyl (meth)acrylate, methyl acrylate, isobutyl acrylate, n-butyl methacrylate, cyclodecyl acrylate, neopentyl acrylate, isodecylacrylamide 2-ethylhexyl acrylate and mixtures thereof.

[00114] In specific embodiments, the film-forming polymer be obtained or generated via free-radical polymerization. For example, the film-forming polymer may be generated via

free-radical polymerization of at least one acrylic monomer and at least one silicone- or hydrocarbon-based macromonomer including a polymerizable end group.

[00115] Specific examples of hydrocarbon-based macromonomers include homopolymers and copolymers of linear or branched C_8-C_{22} alkyl acrylate or methacrylate. The polymerizable end group may be a vinyl group or a (meth)acrylate group, e.g. poly(2-ethylhexyl acrylate) macromonomers; poly(dodecyl acrylate) or poly(dodecyl methacrylate) macromonomers; poly(stearyl acrylate) or poly(stearyl methacrylate) macromonomers, etc. Such macromonomers generally include one (meth)acrylate group as the polymerizable end group.

[00116] Additional examples of hydrocarbon-based macromonomers include polyolefins containing an ethylenically unsaturated end group (as the polymerizable end group), e.g. a (meth)acrylate end group. Specific examples of such polyolefins include polyethylene macromonomers, polypropylene macromonomers, polyethylene/polypropylene copolymer macromonomers, polyethylene/polybutylene copolymer macromonomers, polyisobutylene macromonomers; polybutadiene macromonomers; polyisoprene macromonomers; polybutadiene macromonomers; and poly (ethylene/butylene)-polyisoprene macromonomers .

[00117] Examples of silicone-based macromonomers include organopolysiloxanes containing the polymerizable end group, e.g. a (meth)acrylate end group. The organopolysiloxane may be linear, branched, partially branched, or resinous. In various embodiments, the organopolysiloxane is linear. In these embodiments, the organopolysiloxane may be polydimethylsiloxane, although hydrocarbon groups other than methyl groups may be present therein along with or in lieu of methyl groups. Typically, the polymerizable end group is terminal, although the polymerizable end group may optionally be pendant. One specific example of a silicone-based macromonomer is a monomethacryloxypropyl polydimethylsiloxane.

[00118] In certain embodiments, the film-forming polymer is an organic film-forming polymer that is soluble in oil as the carrier vehicle. In these embodiments, the film-forming polymer may be referred to as a liposoluble polymer. The liposoluble polymer may be of any type and specific examples thereof include those comprising or formed from olefins, cycloolefins, butadiene, isoprene, styrene, vinyl ethers, vinyl esters, vinyl amides, (meth)acrylic acid esters or amides, etc.

[00119] In one embodiment, the lipsoluble polymer is formed from monomers selected from the group consisting of isooctyl (meth)acrylate, isononyl (meth)acrylate, 2-ethylhexyl (meth)acrylate, lauryl (meth)acrylate, isopentyl (meth)acrylate, n-butyl (meth)acrylate,

isobutyl (meth)acrylate, methyl (meth)acrylate, tert-butyl (meth)acrylate, tridecyl (meth)acrylate, stearyl (meth)acrylate, and combinations thereof.

[00120] Alternatively still, the lipsoluble polymer may be an acrylic-silicone grafted polymer, which typically includes a silicone backbone and acrylic grafts or alternatively includes an acrylic backbone and silicone grafts.

[00121] The film-forming polymer may be halogenated, e.g. the film-forming polymer may include fluorine atoms.

[00122] Alternatively as introduced above, the film-forming polymer may be a cellulose-based polymer, such as nitrocellulose, cellulose acetate, cellulose acetobutyrate, cellulose acetopropionate or ethylcellulose. Alternatively still, the film-forming polymer may comprise a polyurethane, an acrylic polymer, a vinyl polymer, a polyvinyl butyral, an alkyd resin, or resins derived from aldehyde condensation products, such as arylsulfonamide-formaldehyde resins.

[00123] Further, as introduced above, the film-forming polymer may comprise the silicone, which may be linear, branched, or resinous. Resinous silicones generally include at least one T and/or Q unit, as understood in the art. Examples of resinous silicones include silsesquioxanes. The silicone may include any combination of M, D, T, and Q units so long as the silicone constitutes the film-forming polymer.

[00124] When the film-forming polymer comprises the silicone, the film-forming polymer may comprise an amphiphilic silicone. Amphiphilic silicones typically contain a silicone portion which is compatible with a silicone medium, and a hydrophilic portion. The hydrophilic portion may be, for example, the residue of a compound selected from alcohols and polyols, having 1 to 12 hydroxyl groups, and polyoxyalkylenes (e.g. those containing oxypropylene units and/or oxyethylene units).

[00125] The amphiphilic silicone may be an oil with or without gelling activity. Oils of this kind may comprise, for example, dimethicone copolyols.

[00126] In one embodiment, the film-forming polymer comprises a silicone organic elastomer gel. Silicone organic elastomer gels comprise linear organopolysiloxane chains crosslinked via polyoxyalkylenes. The silicone organic elastomer gel may further include hydrophilic polyether functionality pending from the linear organopolysiloxane chains. Specific examples of suitable silicone organic elastomer gels are disclosed in International (PCT) Appln. No. PCT/US2010/020110, which is incorporated by reference herein in its entirety.

[00127] Additional examples of cross-linked silicone compounds suitable for use as the film-forming polymer are disclosed in U.S. Appln. Ser. Nos. 10/269,758 and 10/228,890, the contents of which are incorporated by reference herein in their respective entireties.

Additional examples of other film-forming polymers suitable for the composition are disclosed in International (PCT) Serial Nos. PCT/EP2007/064259, PCT/EP2007/060682, and PCT/EP2005/013018, which are each incorporated by reference herein in their respective entireties.

[00128] When the personal care ingredient comprises the film-forming polymer, the film-forming polymer may be present in the composition in various amounts, e.g. from greater than 0 to less than 100, alternatively from 0.1 to 60, alternatively from 0.1 to 50 percent by weight based on the total weight of the composition. Combinations of different types of film-forming polymers may be utilized.

[00129] In various embodiments, the personal care ingredient may comprise or be referred to as a personal care active, a health care active, or combination thereof (collectively "active" or "actives"). As used herein, a "personal care active" means any compound or mixtures of compounds that are known in the art as additives in personal care formulations, typically for providing a cosmetic and/or aesthetic benefit. A "healthcare active" means any compound or mixtures of compounds that are known in the art to provide a pharmaceutical or medical benefit. Thus, "healthcare active" includes materials considered as an active ingredient or active drug ingredient as generally used and defined by the United States Department of Health & Human Services Food and Drug Administration, contained in Title 21, Chapter I, of the Code of Federal Regulations, Parts 200-299 and Parts 300-499. Specific personal care actives and health care actives are described below. These personal care actives and health care actives may constitute the personal care ingredient whether the personal care ingredient is utilized to form, for example, the skin care composition, the hair care composition, the nail care composition, and/or the tooth care composition. For example, in various embodiments, the same personal care ingredient may be utilized to form either the hair care composition or the skin care composition. As understood in the art, at least some of the personal care actives described below are species of certain personal care ingredients introduced above with respect to the skin care composition, the hair care composition, the nail care composition, and the tooth care composition, respectively. For example, numerous species of plant or vegetable extracts are described below, which are exemplary examples of plant extracts set forth above as suitable personal care ingredients. The active ingredients or actives described below may constitute the personal care ingredient of the composition or may be utilized in combination therewith.

[00130] Useful active ingredients for use in the composition include vitamins and vitamin derivatives, including "pro-vitamins". Vitamins useful herein include, but are not limited to, Vitamin A1, retinol, C2-C18 esters of retinol, vitamin E, tocopherol, esters of vitamin E, and mixtures thereof. Retinol includes trans-retinol, 1, 3-cis-retinol, 11-cis-retinol, 9-cis-retinol,

and 3,4-didehydro-retinol, Vitamin C and its derivatives, Vitamin B1, Vitamin B2, Pro Vitamin B5, panthenol, Vitamin B6, Vitamin B12, niacin, folic acid, biotin, and pantothenic acid. Other suitable vitamins and the INCI names for the vitamins considered included herein are ascorbyl dipalmitate, ascorbyl methylsilanol pectinate, ascorbyl palmitate, ascorbyl stearate, ascorbyl glucocide, sodium ascorbyl phosphate, sodium ascorbate, disodium ascorbyl sulfate, potassium (ascorbyl/tocopheryl) phosphate. In general, retinol, all trans retinoic acid and derivatives, isomers and analogs thereof, are collectively termed "retinoids".

[00131] RETINOL, it should be noted, is an International Nomenclature Cosmetic Ingredient Name (INCI) designated by The Cosmetic, Toiletry, and Fragrance Association (CTFA), Washington DC, for vitamin A. Other suitable vitamins and the INCI names for the vitamins considered included herein are RETINYL ACETATE, RETINYL PALMITATE, RETINYL PROPIONATE, α-TOCOPHEROL, TOCOPHERSOLAN, TOCOPHERYL ACETATE, TOCOPHERYL LINOLEATE, TOCOPHERYL NICOTINATE, and TOCOPHERYL SUCCINATE.

[00132] Some examples of commercially available products suitable for use herein are Vitamin A Acetate and Vitamin C, both products of Fluka Chemie AG, Buchs, Switzerland; COVI-OX T-50, a vitamin E product of Henkel Corporation, La Grange, Illinois; COVI-OX T-70, another vitamin E product of Henkel Corporation, La Grange, Illinois; and vitamin E Acetate, a product of Roche Vitamins & Fine Chemicals, Nutley, New Jersey.

[00133] The active can be a protein, such as an enzyme. Enzymes include, but are not limited to, commercially available types, improved types, recombinant types, wild types, variants not found in nature, and mixtures thereof. For example, suitable enzymes include hydrolases, cutinases, oxidases, transferases, reductases, hemicellulases, esterases, isomerases, pectinases, lactases, peroxidases, laccases, catalases, and mixtures thereof. Hydrolases include, but are not limited to, proteases (bacterial, fungal, acid, neutral or alkaline), amylases (alpha or beta), lipases, mannanases, cellulases, collagenases, lisozymes, superoxide dismutase, catalase, and mixtures thereof. Protease include, but are not limited to, trypsin, chymotrypsin, pepsin, pancreatin and other mammalian enzymes; papain, bromelain and other botanical enzymes; subtilisin, epidermin, nisin, naringinase(L-rhammnosidase) urokinase and other bacterial enzymes. Lipase include, but are not limited to, triacyl-glycerol lipases, monoacyl-glycerol lipases, lipoprotein lipases, e.g. steapsin, erepsin, pepsin, other mammalian, botanical, bacterial lipases and purified ones. In a specific embodiment, natural papain is utilized as the enzyme. Further, stimulating hormones, e.g. insulin, can be used together with the enzyme(s) to boost effectiveness.

[00134] The active may also be one or more plant or vegetable extract. Examples of these components are as follows: Ashitaba extract, avocado extract, hydrangea extract, Althea

extract, Arnica extract, aloe extract, apricot extract, apricot kernel extract, Ginkgo Biloba extract, fennel extract, turmeric[Curcuma] extract, oolong tea extract, rose fruit extract, Echinacea extract, Scutellaria root extract, Phellodendro bark extract, Japanese Coptis extract, Barley extract, Hyperium extract, White Nettle extract, Watercress extract, Orange extract, Dehydrated saltwater, seaweed extract, hydrolyzed elastin, hydrolyzed wheat powder, hydrolyzed silk, Chamomile extract, Carrot extract, Artemisia extract, Glycyrrhiza extract, hibiscustea extract, Pyracantha Fortuneana Fruit extract, Kiwi extract, Cinchona extract, cucumber extract, guanocine, Gardenia extract, Sasa Albo-marginata extract, Sophora root extract, Walnut extract, Grapefruit extract, Clematis extract, Chlorella extract, mulberry extract, Gentiana extract, black tea extract, yeast extract, burdock extract, rice bran ferment extract, rice germ oil, comfrey extract, collagen, cowberry extract, Gardenia extract, Asiasarum Root extract, Family of Bupleurum extract, Salvia extract, Saponaria extract, Bamboo extract, Crataegus fruit extract, Zanthoxylum fruit extract, shiitake extract, Rehmannia root extract, gromwell extract, Perilla extract, linden extract, Filipendula extract, peony extract, Calamus Root extract, white birch extract, Horsetail extract, Hedera Helix(Ivy) extract, hawthorn extract, Sambucus nigra extract, Achillea millefolium extract, Mentha piperita extract, sage extract, mallow extract, Cnidium officinale Root extract, Japanese green gentian extract, soybean extract, jujube extract, thyme extract, tea extract, clove extract, Gramineae imperata cyrillo extract, Citrus unshiu peel extract Japanese Angellica Root extract, Calendula extract, Peach Kernel extract, Bitter orange peel extract, Houttuyna cordata extract, tomato extract, natto extract, Ginseng extract, Green tea extract (camelliea sinesis), garlic extract, wild rose extract, hibiscus extract, Ophiopogon tuber extract, Nelumbo nucifera extract, parsley extract, honey, hamamelis extract, Parietaria extract, Isodonis herba extract, bisabolol extract, Loquat extract, coltsfoot extract, butterbur extract, Porid cocos wolf extract, extract of butcher's broom, grape extract, propolis extract, luffa extract, safflower extract, peppermint extract, linden tree extract, Paeonia extract, hop extract, pine tree extract, horse chestnut extract, Mizu-bashou [Lysichiton camtschatcese] extract, Mukurossi peel extract, Melissa extract, peach extract, cornflower extract, eucalyptus extract, saxifrage extract, citron extract, coix extract, mugwort extract, lavender extract, apple extract, lettuce extract, lemon extract, Chinese milk vetch extract, rose extract, rosemary extract, Roman Chamomile extract, royal jelly extract, and combinations thereof.

[00135] Representative, non-limiting examples of healthcare actives useful as drugs in the present compositions are described below. One or more of the drugs can be used, either alone or in combination with the actives and/or personal care ingredients described above.

[00136] The composition may include an antiparasite agent. The antiparasite agent can be of any type. Examples of antiparasite agents include, but are not limited to,

hexachlorobenzene, carbamate, naturally occurring pyrethroids, permethrin, allethrin, malathion, piperonyl butoxide, and combinations thereof.

[00137] The composition may include an antimicrobial agent, also referred to as germicidal agent. The antimicrobial agent can be of any type. Examples of antimicrobial agents include, but are not limited to, phenols, including cresols and resorcinols. Such compositions may be used to treat infections of the skin. An example of a very common skin infection is acne, which involve infestation of the sebaceous gland with *p. acnes*, as well as *Staphylococus aurus* or *Pseudomonas*. Examples of useful antiacne actives include the keratolytics such as salicylic acid (o-hydroxybenzoic acid), derivatives of salicylic acid such as 5-octanoyl salicylic acid, and resorcinol; retinoids such as retinoic acid and its derivatives (e.g. cis and trans); sulfur-containing D and L amino acids and their derivatives and salts, particularly their N-acetyl derivatives, an example of which is N-acetyl-L-cysteine; lipoic acid; antibiotics and antimicrobials such as benzoyl peroxide, octopirox, tetracycline, 2,4,4'-trichloro-2'-hydroxy diphenyl ether, 3,4,4'-trichlorobanilide, azelaic acid and its derivatives, phenoxyethanol, phenoxypropanol, phenoxyisopropanol, ethyl acetate, clindamycin and meclocycline; sebostats such as flavonoids; and bile salts such as scymnol sulfate and its derivatives, deoxycholate and cholate; parachlorometaxylenol; and combinations thereof.

[00138] Phenols, in concentrations of 0.2, 1.0, and 1.3, % by weight, are generally bacteriostatic, bactericidal, and fungicidal, respectively. Several phenol derivatives are more potent than phenol itself, and the most important among these are the halogenated phenols and bis-phenols, the alkyl-substituted phenols and the resorcinols. Hydrophobic antibacterials include triclosan, triclocarbon, eucalyptol, menthol, methylsalicylate, thymol, and combinations thereof.

[00139] The composition may include an antifungal agent. The antifungal agent can be of any type. Examples of antifungal agents include, but are not limited to, azoles, diazoles, triazoles, miconazole, fluconazole, ketoconazole, clotrimazole, itraconazole griseofulvin, ciclopirox, amorolfine, terbinafine, Amphotericin B, potassium iodide, flucytosine (5FC) and combinations thereof. U.S. Pat. No. 4,352,808 discloses 3-aralkyloxy-2, 3-dihydro-2-(1H-imidazolylmethyl)benzo[b]thiophene compounds having antifungal and antibacterial activity, which is incorporated herein by reference.

[00140] The composition may include a steroidal anti-inflammatory agent. The steroidal anti-inflammatory agent can be of any type. Examples of steroidal anti-inflammatory agents include, but are not limited to, corticosteroids such as hydrocortisone, hydroxyltriamcinolone alphamethyl dexamethasone, dexamethasone-phosphate, beclomethasone dipropionate, clobetasol valerate, desonide, desoxymethasone, desoxycorticosterone acetate, dexamethasone, dichlorisone, diflorasone diacetate, diflucortolone valerate, fluadrenolone,

fluclarolone acetonide, fludrocortisone, flumethasone pivalate, fluosinolone acetonide, fluocinonide, flucortine butylester, fluocortolone, fluprednidene (fluprednylidene)acetate, flurandrenolone, halcinonide, hydrocortisone acetate, hydrocortisone butyrate, methylprednisolone, triamcinolone acetonide, cortisone, cortodoxone, flucetonide, fludrocortisone, difluorosone diacetate, fluradrenalone acetonide, medrysone, amc, amcinafide, betamethasone and the balance of its esters, chlorprednisone, chlorprednisone acetate, clocortelone, clescinolone, dichlorisone, difluprednate, flucloronide, flunisolide, fluoromethalone, fluperolone, fluprednisolone, hydrocortisone valerate, hydrocortisone cyclopentylproprionate, hydrocortamate, meprednisone, paramethasone, prednisolone, prednisone, beclomethasone dipropionate, betamethasone dipropionate, triamcinolone, and combinations thereof.

[00141] Topical antihistaminic preparations currently available include 1 percent and 2 percent diphenhydramine (Benadryl® and Caladryl®), 5 percent doxepin (Zonalon®) cream, phrilamine maleate, chlorpheniramine and tripelennamine, phenothiazines, promethazine hydrochloride (Phenergan®) and dimethindene maleate. These drugs, as well as additional antihistamines can also be included in the composition. Additionally, so-called "natural" anti-inflammatory agents may be useful. For example, candelilla wax, alpha bisabolol, aloe vera, Manjistha (extracted from plants in the genus *Rubia*, particularly *Rubia cordifolia*), and Guggal (extracted from plants in the genus *Commiphora*, particularly *Commiphora mukul*, may be used as an active in the composition.

[00142] The composition may include a non-steroidal anti-inflammatory drug (NSAID). The NSAID can be of any type. Examples of NSAIDs include, but are not limited to, the following NSAID categories: propionic to acid derivatives; acetic acid derivatives; fenamic acid derivatives; biphenylcarboxylic acid derivatives; and oxicams. Such NSAIDs are described in the U.S. Pat. No. 4,985,459 which is incorporated herein by reference. Further examples include, but are not limited to, acetyl salicylic acid, ibuprofen, naproxen, benoxaprofen, flurbiprofen, fenoprofen, fenbufen, ketoprofen, indoprofen, pirprofen, carprofen, oxaprozin, pranoprofen, mniroprofen, tioxaprofen, suprofen, alminoprofen, tiaprofenic acid, fluprofen, bucloxic acid, and combinations thereof.

[00143] The composition may include an antioxidant/radical scavenger. The antioxidant can be of any type. Examples of antioxidants include, but are not limited to, ascorbic acid (vitamin C) and its salts, tocopherol (vitamin E), and its derivatives such as tocopherol sorbate, other esters of tocopherol, butylated hydroxy benzoic acids and their salts, 6-hydroxy-2,5,7,8-tetramethylchroman-2-carboxylic acid (commercially available under the trade name Trolox®), gallic acid and its alkyl esters, especially propyl gallate, uric acid and its salts and alkyl esters, sorbic acid and its salts, the ascorbyl esters of fatty acids, amines

(e.g. N,N-diethylhydroxylamine, amino-guanidine), sulfhydryl compounds (e.g. glutathione), and dihydroxy fumaric acid and its salts may be used, as well as EDTA, BHT and the like, and combinations thereof.

[00144] The composition may include an antibiotic. The antibiotic can be of any type. Examples of antibiotics include, but are not limited to, chloramphenicol, tetracyclines, synthetic and semi-synthesic penicillins, beta-lactames, quinolones, fluoroquinolnes, macrolide antibiotics, peptide antibiotics, cyclosporines, erythromycin, clindamycin, and combinations thereof.

[00145] The composition may include a topical anesthetic. The topical anesthetic can be of any type. Examples of topical anesthetics include, but are not limited to, benzocaine, lidocaine, bupivacaine, chlorprocaine, dibucaine, etidocaine, mepivacaine, tetracaine, dyclonine, hexylcaine, procaine, cocaine, ketamine, pramoxine, phenol, pharmaceutically acceptable salts thereof, and combinations thereof.

[00146] The composition may include an anti-viral agent. The anti-viral agent can be of any type. Examples of anti-viral agents include, but are not limited to, proteins, polypeptides, peptides, fusion protein antibodies, nucleic acid molecules, organic molecules, inorganic molecules, and small molecules that inhibit or reduce the attachment of a virus to its receptor, the internalization of a virus into a cell, the replication of a virus, or release of virus from a cell. In particular, anti-viral agents include, but are not limited to, nucleoside analogs (e.g. zidovudine, acyclovir, acyclovir prodrugs, famciclovir, gangcyclovir, vidarabine, idoxuridine, trifluridine, and ribavirin), n-docosanoll foscarnet, amantadine, rimantadine, saquinavir, indinavir, ritonavir, idoxuridine alpha-interferons and other interferons, AZT, and combinations thereof.

[00147] The composition may include an anti-cancer drug. The anti-cancer drug can be of any type. Examples of anti-cancer drugs include, but are not limited to, acivicin; aclarubicin; acodazole hydrochloride; acronine; adozelesin; aldesleukin; altretamine; ambomycin; ametantrone acetate; aminoglutethimide; amsacrine; anastrozole; anthramycin; asparaginase; asperlin; azacitidine; azetepa; azotomycin; batimastat; benzodepa; bicalutamide; bisantrene hydrochloride; bisnafide dimesylate; bisphosphonates (e.g., pamidronate (Aredria), sodium clondronate (Bonefos), zoledronic acid (Zometa), alendronate (Fosamax), etidronate, ibandornate, cimadronate, risedromate, and tiludromate); bizelesin; bleomycin sulfate; brequinar sodium; bropirimine; busulfan; cactinomycin; calusterone; caracemide; carbetimer; carboplatin; carmustine; carubicin hydrochloride; carzelesin; cedefingol; chlorambucil; cirolemycin; cisplatin; cladribine; crisnatol mesylate; cyclophosphamide; cytarabine; dacarbazine; dactinomycin; daunorubicin hydrochloride; decitabine; dexormaplatin; dezaguanine; dezaguanine mesylate; diaziquone; docetaxel;

doxorubicin; doxorubicin hydrochloride; droloxifene; droloxifene citrate; dromostanolone propionate; duazomycin; edatrexate; eflornithine hydrochloride; elsamitrucin; enloplatin; enpromate; epipropidine; epirubicin hydrochloride; erbulozole; esorubicin hydrochloride; estramustine; estramustine phosphate sodium; etanidazole; etoposide; etoposide phosphate; etoprine; fadrozole hydrochloride; fazarabine; fenretinide; floxuridine; fludarabine phosphate; fluorouracil; flurocitabine; fosquidone; fostriecin sodium; gemcitabine; gemcitabine hydrochloride; hydroxyurea; idarubicin hydrochloride; ifosfamide; ilmofosine; interleukin-2 (including recombinant interleukin 2, or rIL2), interferon alpha-2a; interferon alpha-2b; interferon alpha-n1; interferon alpha-n3; interferon beta-I a; interferon gamma-I b; iproplatin; irinotecan hydrochloride; lanreotide acetate; letrozole; leuprolide acetate; liarozole hydrochloride; lometrexol sodium; lomustine; losoxantrone hydrochloride; masoprocol; maytansine; mechlorethamine hydrochloride; anti-CD2 antibodies; megestrol acetate; melengestrol acetate; melphalan; menogaril; mercaptopurine; methotrexate; methotrexate sodium; metoprine; meturedepa; mitindomide; mitocarcin; mitocromin; mitogillin; mitomalcin; mitomycin; mitosper; mitotane; mitoxantrone hydrochloride; mycophenolic acid; nocodazole; nogalamycin; ormaplatin; oxisuran; paclitaxel; pegaspargase; peliomycin; pentamustine; peplomycin sulfate; perfosfamide; pipobroman; piposulfan; piroxantrone hydrochloride; plicamycin; plomestane; porfimer sodium; porfiromycin; prednimustine; procarbazine hydrochloride; puromycin; puromycin hydrochloride; pyrazofurin; riboprine; rogletimide; safingol; safingol hydrochloride; semustine; simtrazene; sparfosate sodium; sparsomycin; spirogermanium hydrochloride; spiromustine; spiroplatin; streptonigrin; streptozocin; sulofenur; talisomycin; tecogalan sodium; tegafur; teloxantrone hydrochloride; temoporfin; teniposide; teroxirone; testolactone; thiamiprine; thioguanine; thiotepa; tiazofurin; tirapazamine; toremifene citrate; trestolone acetate; triciribine phosphate; trimetrexate; trimetrexate glucuronate; triptorelin; tubulozole hydrochloride; uracil mustard; uredepa; vapreotide; verteporfin; vinblastine sulfate; vincristine sulfate; vindesine; vindesine sulfate; vinepidine sulfate; vinglycinate sulfate; vinleurosine sulfate; vinorelbine tartrate; vinrosidine sulfate; vinzolidine sulfate; vorozole; zeniplatin; zinostatin; zorubicin hydrochloride; and combinations thereof.

[00148] Other anti-cancer drugs include, but are not limited to, 20-epi-1,25 dihydroxyvitamin D3; 5-ethynyluracil; abiraterone; aclarubicin; acylfulvene; adecypenol; adozelesin; aldesleukin; ALL-TK antagonists; altretamine; ambamustine; amidox; amifostine; aminolevulinic acid; amrubicin; amsacrine; anagrelide; anastrozole; andrographolide; angiogenesis inhibitors; antagonist D; antagonist G; antarelix; anti-dorsalizing morphogenetic protein-1; antiandrogen, prostatic carcinoma; antiestrogen; antineoplaston; antisense oligonucleotides; aphidicolin glycinate; apoptosis gene modulators; apoptosis

regulators; apurinic acid; ara-CDP-DL-PTBA; arginine deaminase; asulacrine; atamestane; atrimustine; axinastatin 1; axinastatin 2; axinastatin 3; azasetron; azatoxin; azatyrosine; baccatin III derivatives; balanol; batimastat; BCR/ABL antagonists; benzochlorins; benzoylstaurosporine; beta lactam derivatives; beta-alethine; betaclamycin B; betulinic acid; bFGF inhibitor; bicalutamide; bisantrene; bisaziridinylspermine; bisnafide; bistratene A; bizelesin; breflate; bropirimine; budotitane; buthionine sulfoximine; calcipotriol; calphostin C; camptothecin derivatives; canarypox IL-2; capecitabine; carboxamide-amino-triazole; carboxyamidotriazole; CaRest M3; CARN 700; cartilage derived inhibitor; carzelesin; casein kinase inhibitors (ICOS); castanospermine; cecropin B; cetrorelix; chlorlns; chloroquinoxaline sulfonamide; cicaprost; cis-porphyrin; cladribine; clomifene analogues; clotrimazole; collismycin A; collismycin B; combretastatin A4; combretastatin analogue; conagenin; crambescidin 816; crisnatol; cryptophycin 8; cryptophycin A derivatives; curacin A; cyclopentanthraquinones; cycloplatam; cypemycin; cytarabine ocfosfate; cytolytic factor; cytostatin; dacliximab; decitabine; dehydrodidemnin B; deslorelin; dexamethasone; dexifosfamide; dexrazoxane; dexverapamil; diaziquone; didemnin B; didox; diethylnorspermine; dihydro-5-azacytidine; dihydrotaxol, 9-; dioxamycin; diphenyl spiromustine; docetaxel; docosanol; dolasetron; doxifluridine; droloxifene; dronabinol; duocarmycin SA; ebselen; ecomustine; edelfosine; edrecolomab; eflornithine; elemene; emitefur; epirubicin; epothilone A; epothilone B; epristeride; estramustine analogue; estrogen agonists; estrogen antagonists; etanidazole; etoposide phosphate; exemestane; fadrozole; fazarabine; fenretinide; filgrastim; finasteride; flavopiridol; flezelastine; fluasterone; fludarabine; fluorodaunorunicin hydrochloride; forfenimex; formestane; fostriecin; fotemustine; gadolinium texaphyrin; gallium nitrate; galocitabine; ganirelix; gelatinase inhibitors; gemcitabine; glutathione inhibitors; HMG CoA reductase inhibitors (e.g., atorvastatin, cerivastatin, fluvastatin, lescol, lupitor, lovastatin, rosuvastatin, and simvastatin); hepsulfam; heregulin; hexamethylene bisacetamide; hypericin; ibandronic acid; idarubicin; idoxifene; idramantone; ilmofosine; ilomastat; imidazoacridones; imiquimod; immunostimulant peptides; insulin-like growth factor-1 receptor inhibitor; interferon agonists; interferons; interleukins; iobenguane; iododoxorubicin; ipomeanol, 4-; iroplact; irsogladine; isobengazole; isohomohalicondrin B; itasetron; jasplakinolide; kahalalide F; lamellarin-N triacetate; lanreotide; leinamycin; lenograstim; lentinan sulfate; leptolstatin; letrozole; leukemia inhibiting factor; leukocyte alpha interferon; leuprolide+estrogen+progesterone; leuprorelin; levamisole; LFA-3TIP (Biogen, Cambridge, Mass.; U.S. Pat. No. 6,162,432, which is incorporated herein by reference); liarozole; linear polyamine analogue; lipophilic disaccharide peptide; lipophilic platinum compounds; lissoclinamide 7; lobaplatin; lombricine; lometrexol; lonidamine; losoxantrone; lovastatin; loxoribine; lurtotecan; lutetium texaphyrin;

lysofylline; lytic peptides; maitansine; mannostatin A; marimastat; masoprocol; maspin; matrilysin inhibitors; matrix metalloproteinase inhibitors; menogaril; merbarone; meterelin; methioninase; metoclopramide; MWF inhibitor; mifepristone; miltefosine; mirimostim; mismatched double stranded RNA; mitoguazone; mitolactol; mitomycin analogues; mitonafide; mitotoxin fibroblast growth factor-saporin; mitoxantrone; mofarotene; molgramostim; monoclonal antibody, human chorionic gonadotrophin; monophosphoryl-lipid A+myobacterium cell wall sk; mopidamol; multiple drug resistance gene inhibitor; multiple tumor suppressor 1-based therapy; mustard anticancer agent; mycaperoxide B; mycobacterial cell wall extract; myriaporone; N-acetyldinaline; N-substituted benzamides; nafarelin; nagrestip; naloxone+pentazocine; napavin; naphterpin; nartograstim; nedaplatin; nemorubicin; neridronic acid; neutral endopeptidase; nilutamide; nisamycin; nitric oxide modulators; nitroxide antioxidant; nitrullyn; O6-benzylguanine; octreotide; okicenone; oligonucleotides; onapristone; ondansetron; ondansetron; oracin; oral cytokine inducer; ormaplatin; osaterone; oxaliplatin; oxaunomycin; paclitaxel; paclitaxel analogues; paclitaxel derivatives; palauamine; palmitoylrhizoxin; pamidronic acid; panaxytriol; panomifene; parabactin; pazelliptine; pegaspargase; peldesine; pentosan polysulfate sodium; pentostatin; pentrozole; perflubron; perfosfamide; perillyl alcohol; phenazinomycin; phenylacetate; phosphatase inhibitors; picibanil; pilocarpine hydrochloride; pirarubicin; piritrexim; placetin A; placetin B; plasminogen activator inhibitor; platinum complex; platinum compounds; platinum-triamine complex; porfimer sodium; porfiromycin; prednisone; propyl bis-acridone; prostaglandin J2; proteasome inhibitors; protein A-based immune modulator; protein kinase C inhibitor; protein kinase C inhibitors, microalgal; protein tyrosine phosphatase inhibitors; purine nucleoside phosphorylase inhibitors; purpurins; pyrazoloacridine; pyridoxylated hemoglobin polyoxyethylene conjugate; raf antagonists; raltitrexed; ramosetron; ras farnesyl protein transferase inhibitors; ras inhibitors; ras-GAP inhibitor; retelliptine demethylated; rhenium Re 186 etidronate; rhizoxin; ribozymes; RII retinamide; rogletimide; rohitukine; romurtide; roquinimex; rubiginone B 1; ruboxyl; safingol; saintopin; SarCNU; sarcophytol A; sargramostim; Sdi 1 mimetics; semustine; senescence derived inhibitor 1; sense oligonucleotides; signal transduction inhibitors; signal transduction modulators; single chain antigen binding protein; sizofiran; sobuzoxane; sodium borocaptate; sodium phenylacetate; solverol; somatomedin binding protein; sonermin; sparfosic acid; spicamycin D; spiromustine; splenopentin; spongistatin 1; squalamine; stem cell inhibitor; stem-cell division inhibitors; stipiamide; stromelysin inhibitors; sulfinosine; superactive vasoactive intestinal peptide antagonist; suradista; suramin; swainsonine; synthetic glycosaminoglycans; tallimustine; 5-fluorouracil; leucovorin; tamoxifen methiodide; tauromustine; tazarotene; tecogalan sodium; tegafur; tellurapyrylium; telomerase inhibitors; temoporfin; temozolomide;

teniposide; tetrachlorodecaoxide; tetrazomine; thaliblastine; thiocoraline; thrombopoietin; thrombopoietin mimetic; thymalfasin; thymopoietin receptor agonist; thymotrinan; thyroid stimulating hormone; tin ethyl etiopurpurin; tirapazamine; titanocene bichloride; topsentin; toremifene; totipotent stem cell factor; translation inhibitors; tretinoin; triacetyluridine; triciribine; trimetrexate; triptorelin; tropisetron; turosteride; tyrosine kinase inhibitors; tyrphostins; UBC inhibitors; ubenimex; urogenital sinus-derived growth inhibitory factor; urokinase receptor antagonists; vapreotide; variolin B; vector system, erythrocyte gene therapy; thalidomide; velaresol; veramine; verdins; verteporfin; vinorelbine; vinxaltine; vorozole; zanoterone; zeniplatin; zilascorb; zinostatin stimalamer; and combinations thereof.

[00149] Additional examples of actives include analgesic agents and antihypertensive agents. Analgesic agents are known in the art and are colloquially referred to as painkillers. The analgesic agent may be selected from any known analgesic agents, and specific examples thereof include paracetamol (acetaminophen), non-steroidal anti-inflammatory agents, such as salicylates, and opioid agents, such as morphine and oxycodone. Antihypertensive agents are known in the art for treating or reducing hypertension, i.e., high blood pressure. The antihypertensive agent may be selected from any known antihypertensive agents, and specific examples thereof include diuretics, adrenergic receptor antagonists (e.g. beta blockers), benzodiazepines, calcium channel blockers, renin inhibitors, etc.

[00150] The composition can include the personal care ingredient in various amounts. One of ordinary skill in the art can readily select an appropriate amount based on want or need. Further, one of ordinary skill in the art readily understands how to select at least one of the personal care ingredients for preparing the composition in view of the desired application/function thereof. For example, the relative amounts of the components of the composition are contingent on the presence or absence of various optional components, along with the desired properties of the composition and its end use. One of skill in the art readily understands how to optimize relative amounts of these components. Due to the unique and excellent properties of the nanoparticles of the composition, the composition is suitable for numerous end uses and applications including, but not limited to, personal care applications as described herein.

[00151] The composition may further include various components depending on the end use thereof. For example, the nanoparticles and the personal care ingredient may be disposed in a carrier vehicle or matrix in the composition. The carrier vehicle or matrix may be a solvent, or may not solubilize the nanoparticles.

[00152] As but one example, the composition may further include a filler. Examples of fillers include talc, micas, kaolin, zinc or titanium oxides, calcium or magnesium carbonates, silica,

silica silylate, titanium dioxide, glass or ceramic beads, polymethylmethacrylate beads, boron nitride, aluminum silicate, aluminum starch octenylsuccinate, bentonite, magnesium aluminum silicate, nylon, silk powder metal soaps derived from carboxylic acids having 8-22 carbon atoms, non-expanded synthetic polymer powders, expanded powders and powders from natural organic compounds, such as cereal starches, which may or may not be crosslinked, copolymer microspheres, polytrap, silicone resin microbeads, and mixtures thereof. The fillers may be surface treated to modify affinity or compatibility with remaining components.

[00153] The composition may also include a diluent, e.g. to decrease the viscosity of the composition sufficiently for application.

[00154] Examples of diluents include silicon containing diluents such as hexamethyldisiloxane, octamethyltrisiloxane, and other short chain linear siloxanes such as octamethyltrisiloxane, decamethyltetrasiloxane, dodecamethylpentasiloxane, tetradecamethylhexasiloxane, hexadeamethylheptasiloxane, heptamethyl-3-{(trimethylsilyl)oxy)}trisiloxane, cyclic siloxanes such as hexamethylcyclotrisiloxane, octamethylcyclotetrasiloxane, decamethylcyclopentasiloxane, dodecamethylcyclohexasiloxane; organic diluents such as butyl acetate, alkanes, alcohols, ketones, esters, ethers, glycols, glycol ethers, hydrofluorocarbons or any other material which can dilute the formulation without adversely affecting any of the component materials of the cosmetic composition. Hydrocarbons include isododecane, isohexadecane, Isopar L (C_{11}-C_{13}), Isopar H (C_{11}-C_{12}), hydrogentated polydecene. Ethers and esters include isodecyl neopentanoate, neopentylglycol heptanoate, glycol distearate, dicaprylyl carbonate, diethylhexyl carbonate, propylene glycol n butyl ether, ethyl-3 ethoxypropionate, propylene glycol methyl ether acetate, tridecyl neopentanoate, propylene glycol methylether acetate (PGMEA), propylene glycol methylether (PGME), octyldodecyl neopentanoate, diisobutyl adipate, diisopropyl adipate, propylene glycol dicaprylate/dicaprate, and octyl palmitate. Additional organic diluents include fats, oils, fatty acids, and fatty alcohols.

Preparation Method

[00155] The preparation method comprises producing the nanoparticles via a plasma process. The plasma process can be any plasma process, but is generally one of the plasma processes described above. The preparation method further comprises combining the nanoparticles with at least one personal care ingredient.

[00156] The composition can be formed at any stage during and/or after formation of the nanoparticles. For example, the personal care ingredient may be present in the capture fluid such that the personal care ingredient and the nanoparticles are combined upon the formation and collection of the nanoparticles, in which case the composition is formed in situ

with the nanoparticles as they are collected in the capture fluid. Alternatively, the nanoparticles may be collected and optionally stored, removed from the capture fluid, isolated, and/or treated prior to forming the composition. For example, the nanoparticles may be separated from the capture fluid by centrifuging and/or decanting the capture fluid including the nanoparticles to form separated nanoparticles. The separated nanoparticles may be further washed by suspension in a solvent, e.g. toluene, followed by repeated separation from the solvent by centrifuging and/or decanting. The separated nanoparticles may ultimately be dried, e.g. in vacuo, to form a dried solid. In this embodiment, the separated nanoparticles are free-standing and not in solution or suspension. In such embodiments, the separated nanoparticles may be combined with the at least one personal care ingredient to form the composition via any technique, e.g. disposing the separated nanoparticles in the personal care ingredient, disposing both the personal care ingredient and the separated nanoparticles into a carrier vehicle or medium, etc.

[00157] The nanoparticles and personal care ingredient can be combined using conventional devices/methodologies understood by those of ordinary skill in the art and this disclosure is not limited to a particular one. For example, the nanoparticles and personal care ingredient can be combined using a low shear mixer.

[00158] As introduced above, the composition may include one or more additional components, such as those encountered with conventional personal care compositions, e.g. carrier fluids, additives, etc. For example, the composition may include an aqueous medium. The aqueous medium may comprise, in addition to water, other carrier vehicles or solvents, such as dipolar aprotic solvents. This disclosure is not limited to a particular additional component or components. If included, such components can be combined in a similar fashion to further form the composition, using various orders of, or simultaneous, addition. The carrier vehicle may be referred to as a cosmetically acceptable medium.

[00159] The compositions may be in the form of a cream, a gel, a powder (free flowing powder or pressed), a paste, a solid, freely pourable liquid, an aerosol. The cosmetic compositions may be in the form of monophasic systems, biphasic or alternate multi phasic systems; emulsions, e.g. oil-in-water, water-in-oil, silicone-in-water, water-in-silicone; multiple emulsions, e.g. oil-in-water-in-oil, polyol-in-silicone-in-water, oil-in-water-in-silicone.

Treatment Method

[00160] The treatment method comprises applying the composition to a substrate. Generally, the substrate comprises a portion of a mammal, particularly a human. One specific example of a suitable substrate is skin. However, the substrate need not be skin or dermis. For example, when the personal care composition comprises the hair care composition, the substrate is typically hair, which is a protein filament that grows from the

follicles of skin. Alternatively, when the personal care composition is the nail care composition, the substrate is a nail, which comprises keratin. Alternatively still, when the personal care composition is the tooth care composition, the substrate is at least one tooth.

[00161] The step of applying may be carried out via any technique for contacting the substrate with the composition. For example, the composition may simply be applied to the substrate by a user, e.g. the user supplying the substrate, or by another. The composition may be dispensed, spread, and/or applied on the substrate, optionally while applying a force to spread or apply the composition. In certain embodiments, the substrate may also take the form of a bandage or similar article. Such articles can thus carry and deliver the composition to the user's skin when contacted. Alternatively, the bandage or other article may be at least partially coated with the composition, and the substrate is contacted with the composition by applying and optionally adhering the bandage or other article including the composition to the substrate, e.g. the user's skin. As another example, when the personal care composition comprises the tooth care composition, the tooth care composition may contact the substrate (e.g. teeth) by applying via a brush.

[00162] More specifically, when the composition comprises the hair care composition, the hair care composition may be used on hair in a conventional manner. An effective amount of the composition for washing or conditioning hair is applied to the hair. Such effective amounts generally range from 1 to 50, alternatively from 1 to 20, grams. Application to the hair typically includes working the composition through the hair such that most or all of the hair is contacted with the composition. These steps can be repeated as many times as desired to achieve the desired benefit.

[00163] Benefits obtained from using the hair care composition on hair include one or more of the following benefits: color retention, improvement in coloration process, hair conditioning, softness, detangling ease, silicone deposition, anti-static, anti-frizz, lubricity, shine, strengthening, viscosity, tactile, wet combing, dry combing, straightening, heat protection, styling, or curl retention.

[00164] When the composition comprises the skin care composition, the skin care composition may be used on skin in a conventional manner. An effective amount of the composition for the purpose is applied to the skin. Such effective amounts generally range from 1 to 3, mg/cm^2. Application to the skin typically includes working the composition onto or into the skin. This method for applying to the skin comprises the steps of contacting the skin with the composition in an effective amount and then rubbing the composition into the skin. These steps can be repeated as many times as desired to achieve the desired benefit.

[00165] Benefits obtained from using the skin care composition on skin include one or more of the following benefits: stability in various formulations (o/w, w/o, anhydrous), utility as an

emulsifier, level of hydrophobicity, organic compatibility, substantivity/durability, wash off resistance, interactions with sebum, performance with pigments, pH stability, skin softness, suppleness, moisturization, skin feel, long lasting, long wear, long lasting color uniformity, color enhancement, foam generation, optical effects (soft focus), stabilization of actives.

[00166] The following examples, illustrating embodiments of this disclosure, are intended to illustrate and not to limit the invention.

[00167] **Prophetic Example 1: Sunscreen Compositions**

[00168] Compositions for personal care are prepared by suspending nanoparticles produced via a plasma process in a carrier vehicle for the nanoparticles, to give sunscreens having different concentrations of the nanoparticles in the carrier vehicle. Each sunscreen is analyzed via ultraviolet-visible (UV-Vis) spectroscopy to determine the wavelength-dependent extinction coefficient of the nanoparticles between 250 and 650 nm. The results of the UV-Vis analysis for each sunscreen is shown in FIG. 4.

[00169] As shown in FIG. 4, the extinction coefficient of the sunscreens comprising the nanoparticles is high at UV wavelengths (i.e., < 400 nm).

[00170] The extinction coefficients from 290-400 nm are then used to estimate sun protection factors (SPF) for the sunscreens using the following formula:

$$SPF = \frac{\int_{290\ nm}^{400\ nm} E_\lambda S_\lambda d\lambda}{\int_{290\ nm}^{400\ nm} E_\lambda S_\lambda T_\lambda d\lambda}$$

where E_λ is the CIE erythemal action spectrum effectiveness, S_λ is solar spectral irradiance (midday midsummer at 40°N), and T_λ is wavelength-dependent transmittance. From these calculations, it is estimated that a nanoparticle concentration of about 1,000 ppm (0.1 wt.%) provides an SPF of 20, while a concentration of 1,250 ppm (0.125 wt.%) provides an SPF of 50.

[00171] **Example 2: Nail Care Cosmetic Composition**

[00172] A composition for personal care is prepared by suspending nanoparticles produced via a plasma process in a carrier vehicle (100 cSt poly(dimethylsiloxane)) for the nanoparticles. A nail care ingredient (ethyl acetate) is then added to the suspension, which is then combined with a transparent fingernail polish additive formulation to give a fingernail polish comprising the nanoparticles.

[00173] **Example 3: Treated Substrate**

[00174] The fingernail polish of Example 2 is applied to a substrate (artificial fingernails) to give a treated substrate The applied polish shows glossy characteristics of untreated polish under white light (FIG. 5A), and exhibits a persistent photo-luminescent accent when viewed under UV illumination (FIG. 5B).

[00175] It is to be understood that the appended claims are not limited to express and particular compounds, compositions, or methods described in the detailed description, which may vary between particular embodiments which fall within the scope of the appended claims. With respect to any Markush groups relied upon herein for describing particular features or aspects of various embodiments, different, special, and/or unexpected results may be obtained from each member of the respective Markush group independent from all other Markush members. Each member of a Markush group may be relied upon individually and or in combination and provides adequate support for specific embodiments within the scope of the appended claims.

[00176] Further, any ranges and subranges relied upon in describing various embodiments of the present invention independently and collectively fall within the scope of the appended claims, and are understood to describe and contemplate all ranges including whole and/or fractional values therein, even if such values are not expressly written herein. One of skill in the art readily recognizes that the enumerated ranges and subranges sufficiently describe and enable various embodiments of the present invention, and such ranges and subranges may be further delineated into relevant halves, thirds, quarters, fifths, and so on. As just one example, a range "of from 0.1 to 0.9" may be further delineated into a lower third, i.e., from 0.1 to 0.3, a middle third, i.e., from 0.4 to 0.6, and an upper third, i.e., from 0.7 to 0.9, which individually and collectively are within the scope of the appended claims, and may be relied upon individually and/or collectively and provide adequate support for specific embodiments within the scope of the appended claims. In addition, with respect to the language which defines or modifies a range, such as "at least," "greater than," "less than," "no more than," and the like, it is to be understood that such language includes subranges and/or an upper or lower limit. As another example, a range of "at least 10" inherently includes a subrange of from at least 10 to 35, a subrange of from at least 10 to 25, a subrange of from 25 to 35, and so on, and each subrange may be relied upon individually and/or collectively and provides adequate support for specific embodiments within the scope of the appended claims. Finally, an individual number within a disclosed range may be relied upon and provides adequate support for specific embodiments within the scope of the appended claims. For example, a range "of from 1 to 9" includes various individual integers, such as 3, as well as individual numbers including a decimal point (or fraction), such as 4.1, which may be relied upon and provide adequate support for specific embodiments within the scope of the appended claims.

[00177] The present invention has been described herein in an illustrative manner, and it is to be understood that the terminology which has been used is intended to be in the nature of words of description rather than of limitation. Many modifications and variations of the present invention are possible in light of the above teachings. The present invention may be

practiced otherwise than as specifically described within the scope of the appended claims. The subject matter of all combinations of independent and dependent claims, both single and multiple dependent, is herein expressly contemplated.

CLAIMS

What is claimed is:

1. A composition for personal care, comprising:

nanoparticles produced via a plasma process and independently comprising a Group IV element; and

at least one personal care ingredient.

2. The composition of claim 1, wherein said at least one personal care ingredient is different from a silicone fluid, a hydrocarbon, a phenyl ether, and an ionic fluid.

3. The composition of claim 1 or 2, wherein said personal care ingredient comprises a skin care ingredient and wherein said composition is further defined as a skin care composition.

4. The composition of claim 3, wherein said skin care ingredient is selected from water phase stabilizing agents, cosmetic biocides, conditioning agents, emollients, moisturizers, colorants, dyes, ultraviolet (UV) absorbers, sunscreen agents, antiperspirants, antioxidants, fragrances, antimicrobial agents, antibacterial agents, antifungal agents, antiaging actives, anti-acne agents, skin-lightening agents, pigments, preservatives, pH controlling agents, electrolytes, chelating agents, plant extracts, botanical extracts, sebum absorbents, sebum control agents, vitamins, waxes, surfactants, detergents, emulsifiers, thickeners, propellant gases, skin protectors, film-forming polymers, and combinations thereof.

5. The composition of claim 3 or 4, further defined as a sunscreen, a shower gel, a soap, a hydrogel, a cream, a lotion, a balm, foundation, lipstick, eyeliner, a cuticle coat, or blush.

6. The composition of claim 5, further defined as a sunscreen.

7. The composition of claim 1, wherein said personal care ingredient is a hair care ingredient and wherein said composition is further defined as a hair care composition.

8. The composition of claim 7, wherein said hair care ingredient is selected from conditioning agents, colorants, dyes, ultraviolet (UV) absorbers, preservatives, plant extracts, fatty alcohols, vitamins, fragrance, anti-dandruff agents, color care additives, pearlising agents, pH controlling agents, electrolytes, chelating agents, styling agents, ceramides, amino-acid derivatives, suspending agents, surfactants, detergents, emulsifiers, thickeners, oxidizing agents, reducing agents, film-forming polymers, and combinations thereof.

9. The composition of claim 7 or 8, further defined as a shampoo, a rinse-off conditioner, a leave-in conditioner, a gel, a pomade, a serum, a spray, a coloring product, or mascara.

10. The composition of any one preceding claim, wherein the plasma process to produce said nanoparticles is carried out in a low pressure reactor.

11. The composition of claim 10, wherein the plasma process to produce said nanoparticles comprises:

forming a nanoparticle aerosol in the low pressure reactor, wherein the aerosol comprises said nanoparticles in a gas; and

collecting said nanoparticles.

12. The composition of claim 10, wherein the plasma process to produce said nanoparticles comprises:

applying a preselected VHF radio frequency having a continuous frequency ranging from 10 to 500 MHz and a coupled power ranging from 5 to 1000 W to a reactant gas mixture in the low pressure reactor having a reactant gas inlet and an outlet having an aperture therein, to generate a plasma for a time sufficient to form said nanoparticles, and

collecting said nanoparticles.

13. The composition of claim 11, wherein said nanoparticles are collected in a capture fluid in fluid communication with the low pressure reactor.

14. The composition of claim 11, wherein the plasma process to produce said nanoparticles further comprises:

introducing the nanoparticle aerosol into a diffusion pump from the low pressure reactor;

heating the capture fluid in a reservoir to form a vapor and sending the vapor through a jet assembly;

emitting the vapor through a nozzle into a chamber of the diffusion pump and condensing the vapor to form a condensate comprising the capture fluid;

flowing the condensate back into the reservoir; and

capturing said nanoparticles of the nanoparticle aerosol in the condensate comprising the capture fluid.

15. The composition of any one preceding claim, wherein said nanoparticles are photoluminescent and have an average largest dimension of from 1 to 50 nm.

16. The composition of any one of claims 1 to 14, wherein said nanoparticles are quantum dots and have an average largest dimension of from greater than 0 to less than 5 nm.

17. A method of preparing the composition of claim 1, comprising:

producing the nanoparticles via a plasma process; and

combining the nanoparticles with at least one personal care ingredient to prepare the composition.

18. A method of treating a substrate, said method comprising applying on the substrate the composition of claim 1.

19. The method of claim 18 wherein the substrate comprises hair, skin, teeth, and/or nails.

FIGURE 1

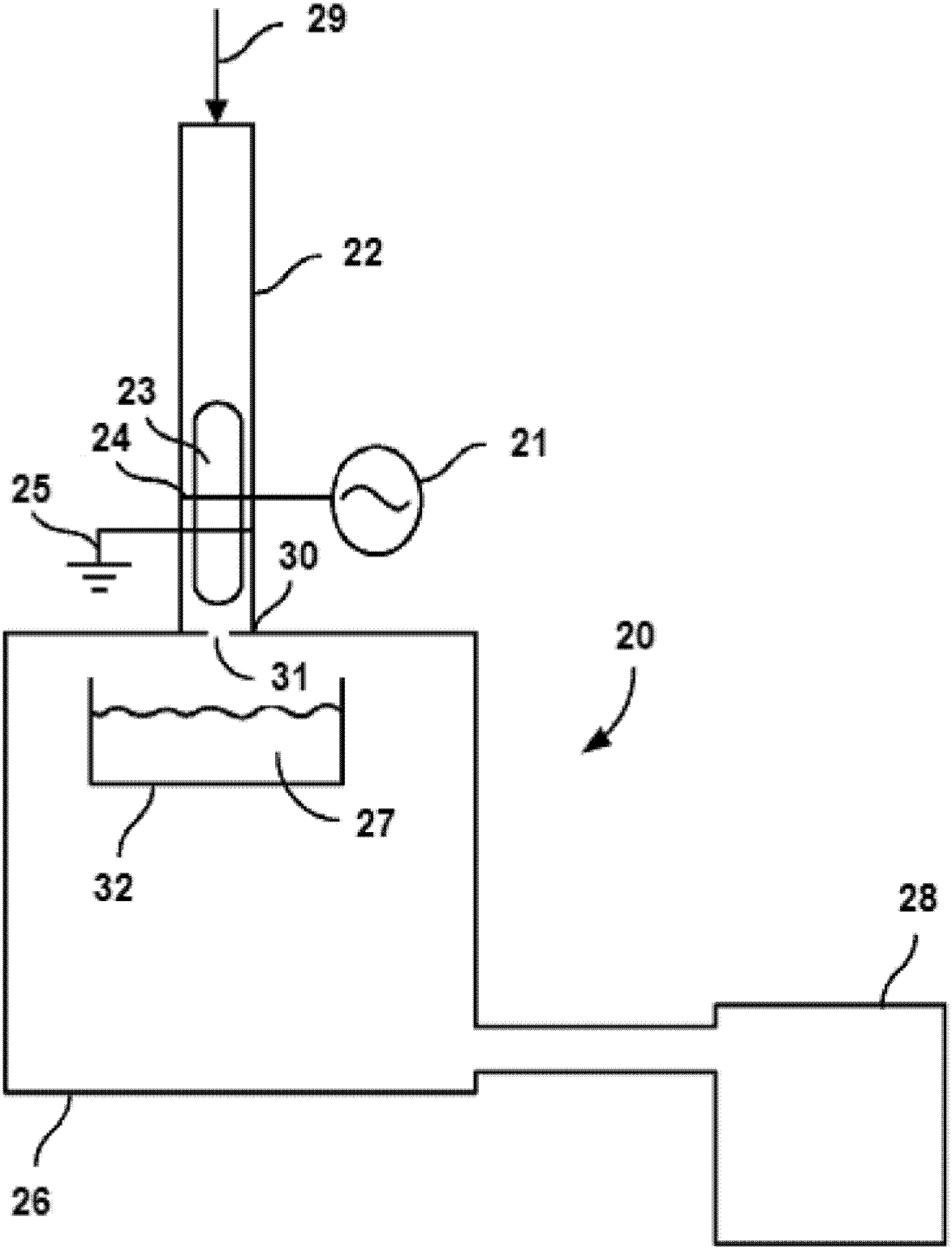

FIGURE 2

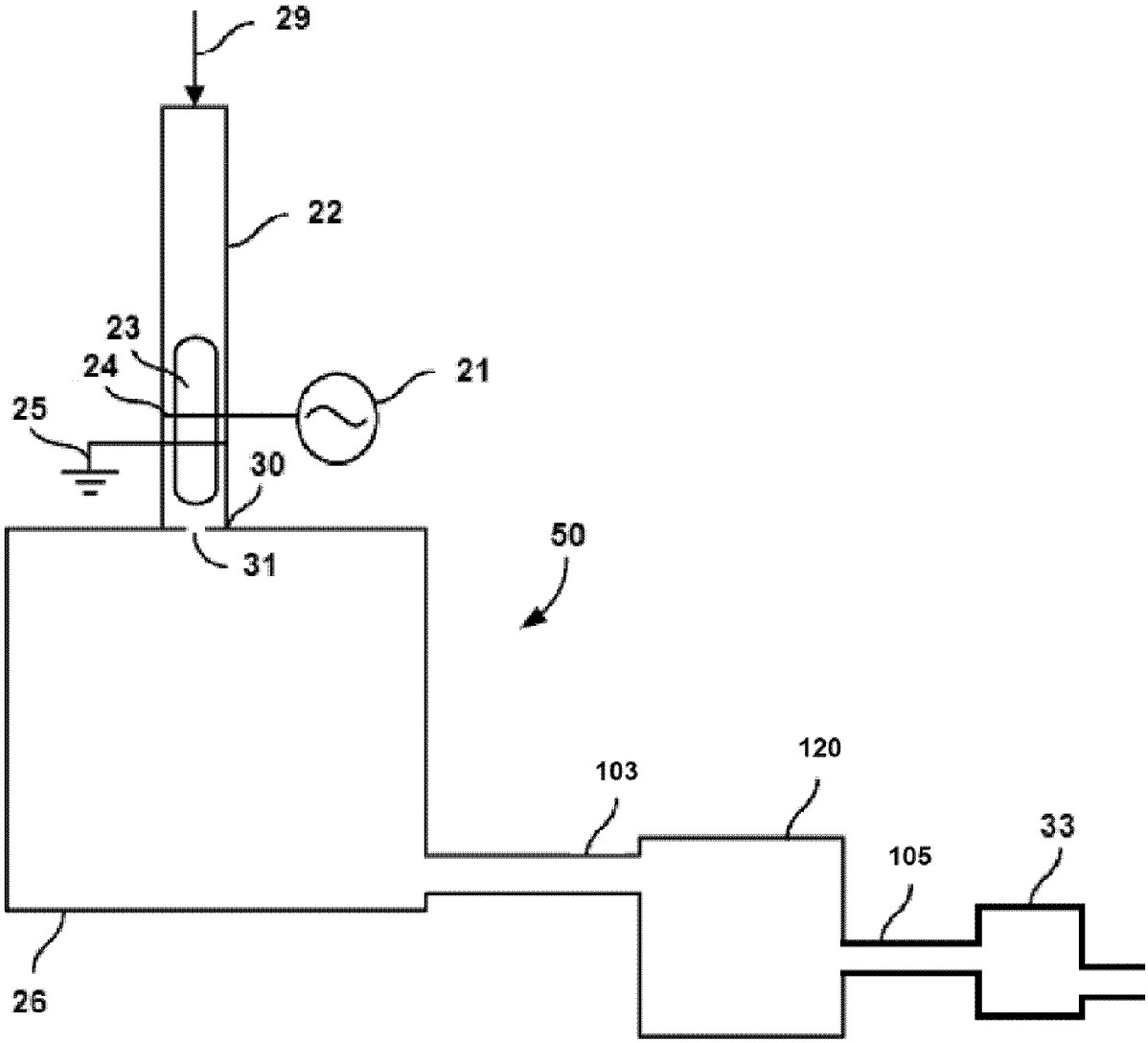

FIGURE 3

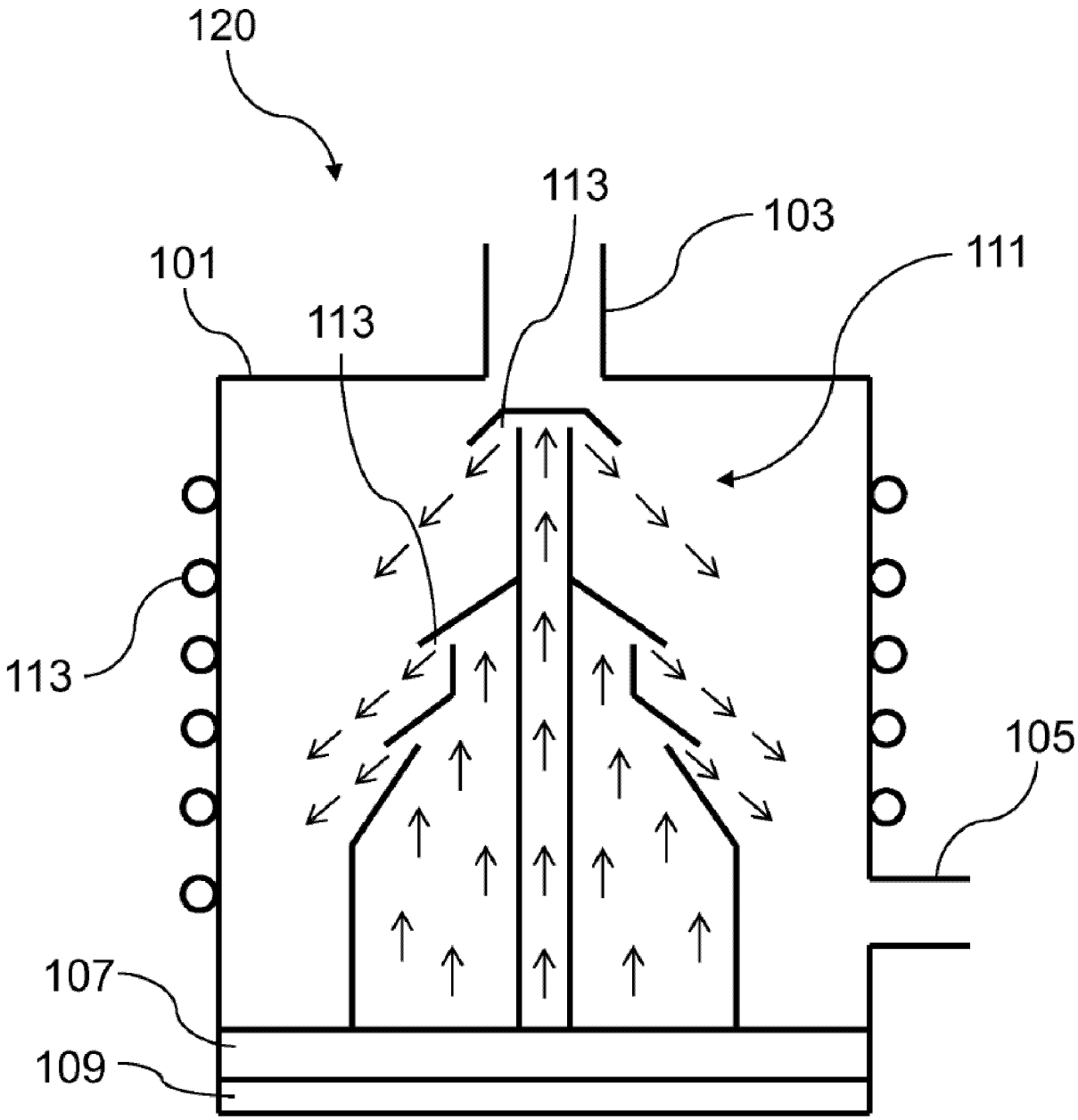

FIGURE 4

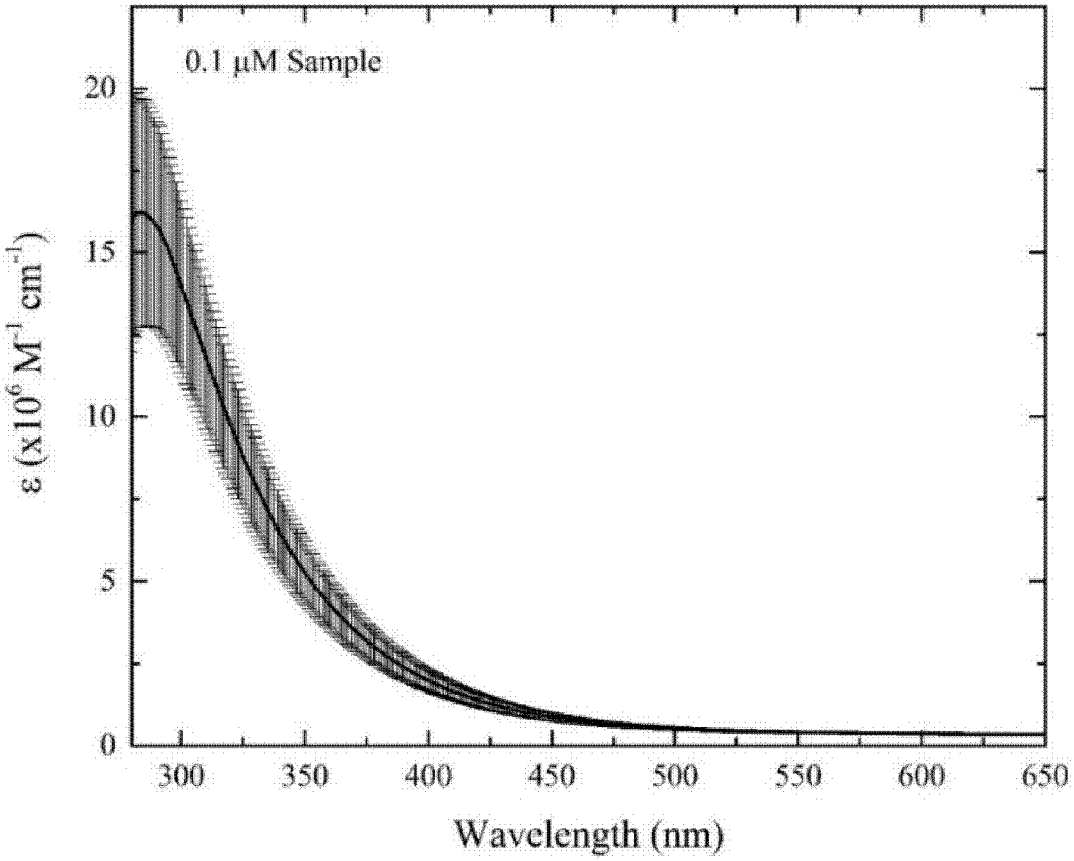

FIGURE 5A

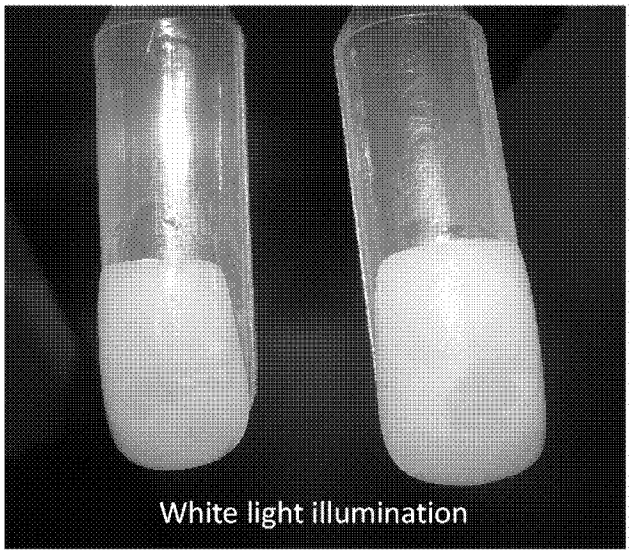

FIGURE 5B