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(54) Title: A POROUS, DISSOLVABLE SOLID SUBSTRATE AND SURFACE RESIDENT COATING COMPRISING MATRIX MICROSPHERES

(57) Abstract: The present invention relates to personal care compositions, especially those personal care compositions in the form of a personal care article that is a porous dissolvable solid substrate. The porous dissolvable solid substrate has a surface resident coating comprising a surface resident coating comprising from about 25% to about 70% of a starch derived material, from about 5% to about 60% of a cationic surfactant conditioner, and from about 5% to about 60% of a perfume, that can provide a consumer benefit.



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## A POROUS, DISSOLVABLE SOLID SUBSTRATE AND SURFACE RESIDENT COATING COMPRISING MATRIX MICROSPHERES

### FIELD OF THE INVENTION

The present invention relates to personal care compositions, especially those personal care compositions providing personal care benefits in the form of an article comprising a porous dissolvable solid substrate and surface resident coating comprising cationic surfactant conditioner and perfume.

### BACKGROUND OF THE INVENTION

Personal care compositions have traditionally been sold as liquid products. These liquid personal care products typically comprise a substantial amount of water and anionic surfactants in the formula, especially in cleansing compositions. In addition to being liquids, many of the personal care products contain fragrances, as consumers typically desire fragranced personal care products. Personal care compositions, particularly cleansing and conditioning compositions, have traditionally been marketed as being either a cleansing composition or a conditioning composition. While these independent compositions had such cleansing and conditioning benefits as to be acceptable to consumers, there remained a need for a two-in-one cleansing and conditioning composition. As a result, various “two-in-one” compositions were created. However, new conditioning actives had to be created for these two-in-one compositions, as the traditional conditioning actives (i.e. cationic surfactant conditioners) interacted negatively with the anionic surfactants included in the shampoo/cleaning products for foaming. These new conditioning actives did not necessarily reproduce the conditioning benefit that was achieved by the traditional conditioning actives (i.e. cationic surfactant conditioners).

Additionally, due to the water present in the personal care products, inclusion of fragrance is limited to either the solubilization or emulsification within aqueous amphiphile assemblies (micelles, liquid crystals etc.). As a result, a significant portion of the fragrance molecules are “trapped” within these aqueous assemblies which can limit the efficient delivery of the fragrance to the nostrils of the consumer during product usage (i.e. lower fragrance bloom) and to the target keratinous substrate (i.e. skin and hair). Moreover, choice of fragrance is limited to those that deliver a single scent

experience to the consumer (i.e. the scent of the product as packaged is the same and the only fragrance experienced during use), and precludes delivery of a fragrance that is activated by water during use.

Additionally, when matrix microspheres were created comprising both the cationic surfactant conditioner and a high impact perfume accord utilizing conventionally performed spray drying with gum arabic (as the emulsifying matrix material in combination with conventional matrix materials such as maltodextrin and starch derived materials) it was found that the gum arabic is incompatible with the cationic surfactant conditioners.

Thus it is an object of the invention to provide a personal care product that can more efficiently deliver the desired cationic surfactant conditioners and fragrances during consumer usage. It is also an object of the invention to provide a personal care product that delivers a fragrance that can be water activated, i.e., the release of the perfume being maximally triggered via the addition of water to the product during usage. It is additionally an object of the invention to provide a personal care product that can deliver not only a primary fragrance, but a secondary fragrance that results in a second burst of fragrance that is activated by water during use. For example the personal care product can have one fragrance prior to being combined with water, and after exposure to water the personal care product can have a second fragrance and/or a fragrance bloom of the same original fragrance. Further, it is an object of the invention to create a matrix microsphere comprising the desired level of cationic surfactant conditioner and a high impact perfume without formulation of a gel precipitate dispersion that cannot be spray dried.

### SUMMARY OF THE INVENTION

The present invention meets the aforementioned needs. The present invention provides a porous dissolvable solid substrate in the form of a unit dose personal care article that can be conveniently and quickly dissolved in the palm of the consumer's hand to reconstitute a liquid personal care composition for ease of application to hair while providing the consumer desired fragrances both before and during use.

A personal care article comprising: (i) a porous dissolvable solid substrate comprising: from about 10% to about 75% of a surfactant; from about 10% to about 50%

water-soluble polymer; from about 1% to about 30% plasticizer; and (ii) a surface resident coating comprising from about 10% to about 100% of matrix microspheres wherein the matrix microspheres comprise from about 25% to about 70% of a starch derived material, from about 5% to about 60% of a cationic surfactant conditioner, and from about 5% to about 60% of a perfume, and wherein the ratio of the dissolvable solid substrate to the surface resident coating comprising the matrix microspheres is from about 110:1 to about 0.5:1.

A method for making a personal care article, the method comprising applying a surface resident coating comprising from about 10% to about 100% of matrix microspheres wherein the matrix microspheres comprise from about 25% to about 70% of a starch derived material, from about 5% to about 60% of a cationic surfactant conditioner, and from about 5% to about 60% of a perfume to a porous dissolvable solid substrate comprising from about 10% to about 75% of a surfactant, from about 10% to about 50% water-soluble polymer, and from about 1% to about 30% plasticizer.

A method for making a personal care article, the method comprising: preparing a processing mixture comprising from about 5% to about 50% of a surfactant, from about 5% to about 35% water-soluble polymer, and from about 0.5% to about 20% plasticizer; aerating the processing mixture by introducing a gas into the processing mixture to form an aerated wet mixture; forming the aerated wet mixture into one or more desired shapes; drying the aerated wet mixture to form a porous dissolvable solid substrate; and applying a surface resident coating comprising from about 10% to about 100% of matrix microspheres wherein the matrix microspheres comprise from about 25% to about 70% of a starch derived material, from about 5% to about 60% of a cationic surfactant conditioner, and from about 5% to about 60% of a perfume to the porous dissolvable solid substrate.

### BRIEF DESCRIPTION OF THE DRAWINGS

While the specification concludes with claims which particularly point out and distinctly claim the present invention, it is believed that the present invention will be better understood from the following description of embodiments, taken in conjunction with the accompanying drawings, in which like reference numerals identify identical elements and wherein:

FIG. 1 is a schematic view of a porous dissolvable solid substrate with a surface resident coating;

FIG. 2 is a schematic view of two porous dissolvable solid substrates with a surface resident coating in between the two substrates;

FIG. 3 is a schematic view of a dimpled porous dissolvable solid substrate with a surface resident coating inside the dimples;

FIG. 4 is a schematic view of a porous dissolvable solid substrate that is folded over to enclose a surface resident coating;

FIG. 5 is a Micro-CT 3-D Image of porous dissolvable solid substrate; and

FIG. 6 is a Super-imposed Cross-Sectional SEM Images of Top-Middle-Bottom Regions of a porous dissolvable solid substrate.

## DETAILED DESCRIPTION OF THE INVENTION

In all embodiments of the present invention, all percentages are by weight of the total composition, unless specifically stated otherwise. All ratios are weight ratios, unless specifically stated otherwise. All ranges are inclusive and combinable. The number of significant digits conveys neither a limitation on the indicated amounts nor on the accuracy of the measurements. All numerical amounts are understood to be modified by the word “about” unless otherwise specifically indicated. Unless otherwise indicated, all measurements are understood to be made at 25°C and at ambient conditions, where “ambient conditions” means conditions under about one atmosphere of pressure and at about 50% relative humidity. All such weights as they pertain to listed ingredients are based on the active level and do not include carriers or by-products that may be included in commercially available materials, unless otherwise specified.

### **I. Definitions**

As used herein, the term “personal care composition” means a composition that may be applied to mammalian hair and skin without undue undesirable effects.

The term, “surface resident coating,” as used herein, refers to a surface resident coating that is adsorbed to at least a portion of the solid/air interface of the porous dissolvable solid substrate.

As used herein, “personal care article” means the porous dissolvable solid substrate comprising a surfactant, water-soluble polymer, and plasticizer, along with the surface resident coating of starch derived material, cationic surfactant conditioner, and perfume. The personal care article may be referred to herein as “the article.”

As used herein, “dissolvable” means that the porous dissolvable solid substrate has a dissolution rate that satisfies the Hand Dissolution Method Test described herein.

As used herein, “matrix microsphere” means an encapsulate of cationic surfactant conditioners and perfume. The matrix microsphere may also be referred to herein as “microsphere.”

As used herein “porous dissolvable solid substrate” means a solid polymer-containing matrix that defines an interconnected network of spaces or cells that contain the gas of the surrounding atmosphere, typically air. The interconnectivity of the structure may be described by a Star Volume, a Structure Model Index (SMI) or a Percent Open Cell Content.

## **II. Personal Care Article**

The personal care article of the present invention delivers a unique perfume/fragrance as well as conditioning experience to the consumer from a lathering/cleansing product by enabling the more efficient delivery of perfumes and conditioners during consumer usage. The surface resident coating of the present invention comprises matrix microspheres comprising both the cationic surfactant conditioner and perfumes. This material is generated without the gum arabic emulsifying material traditionally used, as this material can be incompatible with the cationic surfactant conditioner (as gum arabic is an anionic polymer). It has been found that the cationic surfactant conditioner can provide sufficient emulsifying properties without the use of a conventional emulsifying matrix mixture, resulting in a matrix microsphere comprising both cationic surfactant conditioner and perfume. These matrix microspheres deliver both a conditioning benefit and a fragrance benefit to the consumer; and by delivering two benefits from the same microsphere, the present invention also results in weight efficiency (i.e. delivering desired levels of actives in a particular area). This weight efficiency is particularly valuable for personal care articles of the present invention, as the amount of surface resident coating that can be adhered to the surfaces of

porous dissolvable solid substrates is limited by the size of the porous dissolvable solid substrate. For example, if each active was included in its own microsphere, and each microsphere is adhered to the surface of the porous dissolvable solid substrate, this may limit the amount of the beneficial actives that can be included on the porous dissolvable solid substrate.

#### **A. The Porous Dissolvable Solid Substrate**

The porous dissolvable solid substrate comprises a surfactant, a water-soluble polymer, and a plasticizer. The porous dissolvable solid substrate can be prepared such that it can be conveniently and quickly dissolved in the palm of the consumer resulting in a liquid personal care composition. Once dissolved, this personal care composition can be used in a manner similar to conventional liquid personal care compositions, i.e. applied to the scalp and/or hair. The porous dissolvable solid substrate has a maximum Cell Wall Thickness. The porous dissolvable solid substrate has a Cell Wall Thickness of from about 0.02 mm to about 0.15 mm, in one embodiment from about 0.025 mm to about 0.12 mm, in another embodiment from about 0.03 mm to about 0.09 mm, and in still another embodiment from about 0.035 mm to about 0.06 mm. The porous dissolvable solid substrate has a minimum level of interconnectivity between the cells, which is quantified by the Star Volume, the Structure Model Index (SMI), and the Percent Open Cell Content. The porous dissolvable solid substrate has a Star Volume of from about 1 mm<sup>3</sup> to about 90 mm<sup>3</sup>, in one embodiment from about 1.5 mm<sup>3</sup> to about 60 mm<sup>3</sup>, in another embodiment from about 2 mm<sup>3</sup> to about 30 mm<sup>3</sup>, and in still another embodiment from about 2.5 mm<sup>3</sup> to about 15 mm<sup>3</sup>. The porous dissolvable solid substrate has a non-negative Structure Model Index of from about 0.0 to about 3.0, in one embodiment from about 0.5 to about 2.75, and in another embodiment from about 1.0 to about 2.50. The porous dissolvable solid substrate has a Percent Open Cell Content of from about 80% to 100%, in one embodiment from about 85% to about 97.5%, and in another embodiment from about 90% to about 95%. The porous dissolvable solid substrate also has a minimum Specific Surface Area. The porous dissolvable solid substrate has a Specific Surface Area of from about 0.03 m<sup>2</sup>/g to about 0.25 m<sup>2</sup>/g, in one embodiment from about 0.035 m<sup>2</sup>/g to about 0.22 m<sup>2</sup>/g, in another embodiment from about 0.04 m<sup>2</sup>/g to about 0.19 m<sup>2</sup>/g, and in still another embodiment from about 0.045

$\text{m}^2/\text{g}$  to about  $0.16 \text{ m}^2/\text{g}$ . The porous dissolvable solid substrate has a basis weight of from about  $125 \text{ grams}/\text{m}^2$  to about  $3,000 \text{ grams}/\text{m}^2$ , in one embodiment from about  $300 \text{ grams}/\text{m}^2$  to about  $2,500 \text{ grams}/\text{m}^2$ , in another embodiment from about  $400 \text{ grams}/\text{m}^2$  to about  $2,000 \text{ grams}/\text{m}^2$ , in another embodiment from about  $500 \text{ grams}/\text{m}^2$  to about  $1,500 \text{ grams}/\text{m}^2$  and in another embodiment from about  $600 \text{ grams}/\text{m}^2$  to about  $1,200 \text{ grams}/\text{m}^2$ , and in another embodiment from about  $700$  to about  $1,000 \text{ grams}/\text{m}^2$ . The porous dissolvable solid substrate has a solid density of from about  $0.03 \text{ g}/\text{cm}^3$  to about  $0.40 \text{ g}/\text{cm}^3$ , in one embodiment from about  $0.05 \text{ g}/\text{cm}^3$  to about  $0.35 \text{ g}/\text{cm}^3$ , in another embodiment from about  $0.08 \text{ g}/\text{cm}^3$  to about  $0.30 \text{ g}/\text{cm}^3$ , in another embodiment from about  $0.10 \text{ g}/\text{cm}^3$  to about  $0.25 \text{ g}/\text{cm}^3$ , and in another embodiment from about  $0.12 \text{ g}/\text{cm}^3$  to about  $0.20 \text{ g}/\text{cm}^3$ .

In one embodiment, the porous dissolvable solid substrate of present invention is a flat, flexible substrate in the form of a pad, a strip or tape and having a thickness of from about  $0.5 \text{ mm}$  to about  $10 \text{ mm}$ , in one embodiment from about  $1 \text{ mm}$  to about  $9 \text{ mm}$ , in another embodiment from about  $2 \text{ mm}$  to about  $8 \text{ mm}$ , and in a further embodiment from about  $3 \text{ mm}$  to about  $7 \text{ mm}$  as measured by the below methodology. In another embodiment, the porous dissolvable solid substrate of the present invention can also take the form of a dissolvable fibrous web structure.

## **1. Surfactants**

The porous dissolvable solid substrates of the present invention may be lathering or non-lathering under consumer relevant usage instructions. The porous dissolvable substrates include at least one surfactant as a processing aid to generate a stable foam solid prior to drying (solidification) and in the case of a lathering substrate the surfactant may also serve dual functions as a foaming and/or cleansing agent.

### **a. Lathering Porous Dissolvable Solid Substrates**

Lathering porous dissolvable solid substrates for the purposes of lathering and/or cleaning comprise from about  $10\%$  to about  $75\%$ , in one embodiment from about  $30\%$  to about  $70\%$ , and in another embodiment from about  $40\%$  to about  $65\%$  by weight of the personal care article of surfactant; wherein the surfactant comprises one or more surfactants from Group I, wherein Group I includes anionic surfactants which are suitable for use in hair care or other personal care compositions, and optionally one or more



surfactants from Group II, wherein Group II includes a surfactant selected from the group consisting of amphoteric, zwitterionic and combinations thereof suitable for use in hair care or other personal care compositions; wherein the ratio of Group I to Group II surfactants is from about 100:0 to about 30:70. In another embodiment of the present invention the ratio of Group I to Group II surfactants is from about 85:15 to about 40:60. In yet another embodiment of the present invention the ratio of Group I to Group II surfactants is from about 70:30 to about 55:45.

Non limiting examples of anionic surfactants are described in U.S. Pat. Nos. 2,486,921; 2,486,922; and 2,396,278. The anionic surfactant can be selected from the group consisting of alkyl and alkyl ether sulfates, sulfated monoglycerides, sulfonated olefins, alkyl aryl sulfonates, primary or secondary alkane sulfonates, alkyl sulfosuccinates, acid taurates, acid isethionates, alkyl glycerylether sulfonate, sulfonated methyl esters, sulfonated fatty acids, alkyl phosphates, acyl glutamates, acyl sarcosinates, alkyl lactylates, anionic fluorosurfactants, sodium lauroyl glutamate, and combinations thereof.

Non limiting examples of suitable zwitterionic or amphoteric surfactants are described in U.S. Pat. Nos. 5,104,646 (Bolich Jr. et al.), 5,106,609 (Bolich Jr. et al.).

Additional suitable Group I and Group II surfactants include those disclosed in U.S. Patent Application No. 61/120,765 and those surfactants disclosed in McCutcheon's Detergents and Emulsifiers, North American Edition (1986), Allured Publishing Corp.; McCutcheon's, Functional Materials, North American Edition (1992), Allured Publishing Corp.; and U.S. Patent 3,929,678 (Laughlin et al.). Other non-limiting examples of suitable surfactants are included in U.S. Serial No. 61/120,790. In another embodiment, the porous dissolvable solid substrate of the present invention can also take the form of a dissolvable fibrous web structure.

#### **b. Non – lathering porous dissolvable solid substrates**

The non-lathering porous dissolvable solid substrates comprise from about 10% to about 75%, in another embodiment from about 15% to about 60%, and in another embodiment from about 20% to about 50% by weight of the personal care article of surfactant; wherein the surfactant comprises one or more of the surfactants described below.

(i) Anionic Surfactants

If the porous dissolvable solid substrate of the present invention is non lathering, the substrate may comprise a maximum level of 10% (or less than 10%) of anionic surfactants to be used primarily as a process aid in making a stable foam solid.

(ii) Cationic surfactants

In one embodiment cationic surfactants are included as a process aid in making a stable porous dissolvable solid substrate. Suitable cationic surfactants for use in the present invention include those described in McCutcheon's Detergents and Emulsifiers, North American edition (1986), Allured Publishing Corp., and McCutcheon's Functional Materials, North American edition (1992). Suitable quaternary ammonium cationic conditioner actives can include cetyltrimethylammonium chloride, behenyltrimethylammonium chloride (BTAC), stearyltrimethylammonium chloride, cetylpyridinium chloride, octadecyltrimethylammonium chloride, hexadecyltrimethylammonium chloride, octyldimethylbenzylammonium chloride, decyldimethylbenzylammonium chloride, stearyldimethylbenzylammonium chloride, didodecyldimethylammonium chloride, dioctadecyldimethylammonium chloride, distearyldimethylammonium chloride, tallowtrimethylammonium chloride, cocotrimethylammonium chloride, dipalmitoylethyldimethylammonium chloride, PEG-2 oleylammonium chloride and salts of these, where the chloride is replaced by halogen, (e.g., bromide), acetate, citrate, lactate, glycolate, phosphate nitrate, sulphate, or alkylsulphate.

In a particular embodiment, the quaternary ammonium cationic conditioner actives for use in the invention are cetyltrimethylammonium chloride, available commercially, for example as GENAMIN CTAC by Clariant and Arquad 16/29 supplied by Akzo Nobel, behenyltrimethylammonium chloride (BTMAC) such as GENAMIN KDMP supplied by Clariant, and distearyldimethylammonium chloride such as GENAMIN DSAP supplied by Clariant. Mixtures of any of the foregoing materials may also be suitable. In a preferred embodiment, the quaternary ammonium cationic conditioner active is behenyltrimethylammonium chloride (BTMAC).

(iii) Non-ionic surfactants

In one embodiment non-ionic surfactants are included as a process aid in making a stable porous dissolvable solid substrate. Suitable nonionic surfactants for use in the present invention include those described in McCutcheon's Detergents and Emulsifiers, North American edition (1986), Allured Publishing Corp., and McCutcheon's Functional Materials, North American edition (1992). Suitable nonionic surfactants for use in the personal care compositions of the present invention include, but are not limited to, polyoxyethylenated alkyl phenols, polyoxyethylenated alcohols, polyoxyethylenated polyoxypropylene glycols, glyceryl esters of alkanolic acids, polyglyceryl esters of alkanolic acids, propylene glycol esters of alkanolic acids, sorbitol esters of alkanolic acids, polyoxyethylenated sorbitol esters of alkanolic acids, polyoxyethylene glycol esters of alkanolic acids, polyoxyethylenated alkanolic acids, alkanolamides, N-alkylpyrrolidones, alkyl glycosides, alkyl polyglucosides, alkylamine oxides, and polyoxyethylenated silicones.

(iv) Polymeric surfactants

Polymeric surfactants can also be surfactants to be employed as a process aid in making the porous dissolvable solid substrate of the present invention, either alone or in combination with ionic and/or nonionic surfactants. Suitable polymeric surfactants for use in the personal care compositions of the present invention include, but are not limited to, block copolymers of ethylene oxide and fatty alkyl residues, block copolymers of ethylene oxide and propylene oxide, hydrophobically modified polyacrylates, hydrophobically modified celluloses, silicone polyethers, silicone copolyol esters, diquaternary polydimethylsiloxanes, and co-modified amino/polyether silicones.

**2. Water-Soluble Polymer ("Polymer Structurant")**

The porous dissolvable solid substrate comprises water-soluble polymers that function as a structurant. As used herein, the term "water-soluble polymer" is broad enough to include both water-soluble and water-dispersible polymers, and is defined as a polymer with a solubility in water, measured at 25°C, of at least about 0.1 gram/liter (g/L). In some embodiments, the polymers have solubility in water, measured at 25°C, of from about 0.1 gram/liter (g/L) to about 500 grams/liter (g/L). (This indicates production of a macroscopically isotropic or transparent, colored or colorless solution). The polymers for making these solids may be of synthetic or natural origin and may be modified by means

of chemical reactions. They may or may not be film-forming. These polymers should be physiologically acceptable, i.e., they should be compatible with the skin, mucous membranes, the hair and the scalp.

The one or more water-soluble polymers may be present from about 10% to about 50% by weight of the porous dissolvable solid substrate, in one embodiment from about 15% to about 40% by weight of the porous dissolvable solid substrate, and in yet another embodiment from about 20% to about 30% by weight of the porous dissolvable solid substrate.

The one or more water-soluble polymers of the present invention are selected such that their weighted average molecular weight is from about 40,000 to about 500,000, in one embodiment from about 50,000 to about 400,000, in yet another embodiment from about 60,000 to about 300,000, and in still another embodiment from about 70,000 to about 200,000. The weighted average molecular weight is computed by summing the average molecular weights of each polymer raw material multiplied by their respective relative weight percentages by weight of the total weight of polymers present within the porous dissolvable solid substrate.

In one embodiment, at least one of the one or more water-soluble polymers is chosen such that about 2% by weight solution of the water-soluble polymer gives a viscosity at 20°C of from about 4 centipoise to about 80 centipoise; in an alternate embodiment from about 5 centipoise to about 70 centipoise; and in another embodiment from about 6 centipoise to about 60 centipoise.

The water-soluble polymer(s) of the present invention can include, but are not limited to, synthetic polymers as described in U.S. Serial No. 61/120,786 including polymers derived from acrylic monomers such as the ethylenically unsaturated carboxylic monomers and ethylenically unsaturated monomers as described in US 5,582,786 and EP-A-397410. The water-soluble polymer(s) which are suitable may also be selected from naturally sourced polymers including those of plant origin examples which are described in U.S. Serial No. 61/120,786. Modified natural polymers are also useful as water-soluble polymer(s) in the present invention and are included in U.S. Serial No. 61/120,786. In one embodiment, water-soluble polymers of the present invention include polyvinyl alcohols, polyacrylates, polymethacrylates, copolymers of acrylic acid and

methyl acrylate, polyvinylpyrrolidones, polyalkylene oxides, starch and starch derivatives, pullulan, gelatin, hydroxypropylmethylcelluloses, methycelluloses, and carboxymethylcelluloses. In another embodiment, water-soluble polymers of the present invention include polyvinyl alcohols, and hydroxypropylmethylcelluloses. Suitable polyvinyl alcohols include those available from Celanese Corporation (Dallas, TX) under the CELVOL® trade name. Suitable hydroxypropylmethylcelluloses include those available from the Dow Chemical Company (Midland, MI) under the METHOCEL® trade name.

In a particular embodiment, the above mentioned water-soluble polymer(s) may be blended with any single starch or combination of starches as a filler material in such an amount as to reduce the overall level of water-soluble polymers required, so long as it helps provide the personal care article with the requisite structure and physical/chemical characteristics as described herein.

In such instances, the combined weight percentage of the water-soluble polymer(s) and starch-based material generally ranges from about 10% to about 50%, in one embodiment from about 15% to about 40%, and in a particular embodiment from about 20% to about 30% by weight relative to the total weight of the porous dissolvable solid substrate. The weight ratio of the water-soluble polymer(s) to the starch-based material can generally range from about 1:10 to about 10:1, in one embodiment from about 1:8 to about 8:1, in still another embodiment from about 1:7 to about 7:1, and in yet another embodiment from about 6:1 to about 1:6.

Typical sources for starch-based materials can include cereals, tubers, roots, legumes and fruits. Native sources can include corn, pea, potato, banana, barley, wheat, rice, sago, amaranth, tapioca, arrowroot, canna, sorghum, and waxy or high amylase varieties thereof. The starch-based materials may also include native starches that are modified using any modification known in the art, including those described in U.S. Serial No. 61/120,786.

### **3. Plasticizer**

The porous dissolvable solid substrate of the present invention comprises a water soluble plasticizing agent suitable for use in personal care compositions. In one embodiment, the one or more plasticizers may be present from about 1% to about 30% by

weight of the porous dissolvable solid substrate; in another embodiment from about 3% to about 25%; in another embodiment from about 5% to about 20%, and in yet another embodiment, from about 8% to about 15%. Non-limiting examples of suitable plasticizing agents include polyols, copolyols, polycarboxylic acids, polyesters and dimethicone copolyols. Examples of useful polyols include, but are not limited to, glycerin, diglycerin, propylene glycol, ethylene glycol, butylene glycol, pentyleneglycol, cyclohexanediol, hexanediol, polyethylene glycol (200-600), sugar alcohols such as sorbitol, mannitol, lactitol and other mono- and polyhydric low molecular weight alcohols (e.g., C2-C8 alcohols); mono di- and oligo-saccharides such as fructose, glucose, sucrose, maltose, lactose, and high fructose corn syrup solids and ascorbic acid. Suitable examples of polycarboxylic acids for use herein are disclosed in U.S. Serial No. 61/120,786.

In one embodiment, the plasticizers include glycerin or propylene glycol and combinations thereof. European Patent Number EP283165B1 discloses other suitable plasticizers, including glycerol derivatives such as propoxylated glycerol.

#### **4. Optional Ingredients**

The porous dissolvable solid substrate may further comprise other optional ingredients that are known for use or otherwise useful in personal care compositions, provided that such optional materials are compatible with the selected essential materials described herein, or do not otherwise unduly impair the performance of the personal care composition.

Such optional ingredients are most typically those materials approved for use in cosmetics and that are described in reference books such as the CTFA Cosmetic Ingredient Handbook, Second Edition, The Cosmetic, Toiletries, and Fragrance Association, Inc. 1988, 1992. Examples of such optional ingredients are disclosed in U.S. Serial No. 12/361,634, 10/392422 filed 3/18/2003; and US Publication 2003/0215522A1, dated 11/20/2003.

Other optional ingredients include organic solvents, especially water miscible solvents and co-solvents useful as solubilizing agents for polymeric structurant and as drying accelerators. Examples of suitable organic solvents are disclosed in U.S. Serial No. 12/361,634. Other optional ingredients include: latex or emulsion polymers,

thickeners such as water soluble polymers, clays, silicas, ethylene glycol distearate, deposition aids, including coacervate forming components. Additional optional ingredients include anti-dandruff actives including but not limited to zinc pyrithione, selenium sulfide and those actives disclosed in US Publication 2003/0215522A1.

**B. Surface Resident Coating Comprising Matrix Microspheres of Cationic Surfactant Conditioner and Perfume.**

In one embodiment, the porous dissolvable solid substrates provide a continuous and accessible high surface area “scaffold” (a 3-D network of “struts”) for the surface resident coating comprising the cationic surfactant conditioner and perfume containing matrix microsphere to be adsorbed or distributed across creating a high surface area thin coating. This location puts the coating in position to immediately contact water during use, releasing the cationic surfactant conditioner and perfume(s) from the encapsulate.

In one embodiment the surface resident coating comprises from about 10% to about 100% of the matrix microspheres comprising cationic surfactant conditioner and perfume; in another embodiment from about 25% to about 100%, and in yet another embodiment from about 40% to about 100%. In one embodiment the ratio of the porous dissolvable solid substrate to the surface resident coating is from about 110:1 to about 0.5:1, in another embodiment from about 20:1 to about 1:1, in another embodiment from about 10:1 to about 1.5:1, and in yet another embodiment from about 7:1 to about 3:1.

The matrix microsphere comprises (by weight of the matrix microsphere composition): i) a starch-derived material at a level of in one embodiment from about 25% to about 70%, in another embodiment from about 30% to about 60%, and in yet another embodiment from about 35% to about 50%; ii) a cationic surfactant conditioner at a level in one embodiment of from about 5% to about 60%, in another embodiment from about 15% to about 50%, and in yet another embodiment from about 20% to about 40%; and iii) a perfume at a level in one embodiment of from about 5% to about 60%, in another embodiment from about 15% to about 50%, and in yet another embodiment from about 20% to about 40%.

**Starch-derived Material**

The starch derived materials of the following invention comprise a wide variety of starch-based materials including starches derived from cereals, tubers, roots, legumes and

fruits. Native starch sources can include corn, pea, potato, banana, barley, wheat, rice, sago, amaranth, tapioca, arrowroot, canna, sorghum, oat, cassaya, amioca, and waxy or high amylase varieties thereof.

The starch-based materials can include native starches that are modified using any modification known in the art, including physically modified starches examples of which include sheared starches or thermally-inhibited starches; chemically modified starches including those which have been cross-linked, acetylated, and organically esterified, hydroxyethylated, and hydroxypropylated, phosphorylated, and inorganically esterified, cationic, anionic, nonionic, amphoteric and zwitterionic, and succinate and substituted succinate derivatives thereof; conversion products derived from any of the starches, including fluidity or thin-boiling starches prepared by oxidation, enzyme conversion, acid hydrolysis, heat or acid dextrinization, thermal and or sheared products may also be useful herein; and pregelatinized starches which are known in the art.

Starches that are suitable for use herein include those wherein the starch is gelatinised and the hydrophobic group comprises an alkyl, or an alkenyl group which contains at least five carbon atoms or an aralkyl or aralkenyl group which contains at least six carbon atoms. In one embodiment starches for use in the present invention are starch esters. These will typically have a degree of substitution in the range of from 0.01% to 10%. The hydrocarbon part of the modifying ester should be a C5 to a C16 carbon chain. In one embodiment the ester is octenyl succinate. In another embodiment octenyl succinate (OSAN) substituted waxy corn starches of various types such as 1) waxy starch, acid thinned and OSAN substituted, (2) blend of corn syrup solids: waxy starch, OSAN substituted and dextrinized, 3) waxy starch: OSAN substituted and dextrinised, 4) blend of corn syrup solids or maltodextrins with waxy starch: acid thinned OSAN substituted then cooked and spray dried, 5) waxy starch: acid thinned OSAN substituted then cooked and spray dried; and 6) the high and low viscosities of the above modifications (based on the level of acid treatment) can also be used in the present invention. Mixtures of these, particularly mixtures of the high and low viscosity modified starches are also suitable.

In one embodiment the modified starches comprise a starch derivative containing a hydrophobic group or both a hydrophobic and a hydrophilic group which has been



degraded by at least one enzyme capable of cleaving the 1,4 linkages of the starch molecule from the non-reducing ends to produce short chained saccharides to provide high oxidation resistance while maintaining substantially high molecular weight portions of the starch base. Such starches are described in EP-A-922 449.

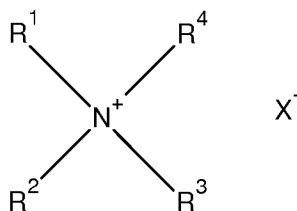
The starch or modified matrix microsphere may also include a plasticizer for the starch or modified starch. Suitable examples include monosaccharides, disaccharides, and oligosaccharides, such as glucose, sucrose, sorbitol, gum arabic, guar gums and maltodextrin.

Starch-derived materials suitable for use herein include hydrolyzed starches, acid modified starches, enzymatic hydrolyzed starches, octenyl succinic acid anhydride modified starches (OSAN starches), dextrinized OSAN starches, dextrans, maltodextrins, pregelatinized waxy maize starches, and mixtures thereof. Suitable examples of starch-derived materials include, but are not limited to MALTRIN® M100 Maltodextrin, manufactured by Grain Processing Corporation (Muscatine, IA); CAPSUL™, CAPSUL TA™, HI-CAP 100™, CAPSUL E™, NARLEX™ (ST and ST2), AND N-LOK™, manufactured by Akzo Nobel (Bridgewater, NJ); the EmCap™ series including 12633, 12634, 12635, 12639, 12635, and 12671, manufactured by Cargill Inc. (Cedar Rapids, Iowa); and STA-DEX® 90 and MIRA-CAP® Starch, manufactured by Tate & Lyle (Decatur, IL). Other examples of modified starches suitable for the present invention are disclosed for example in WO 99/55819, WO 01/40430, EP-A-858828, EP-A-1160311 and U.S. Pat. No. 5,955,419.

#### **Cationic Surfactant Conditioner**

Suitable cationic surfactant conditioner actives for use in compositions of the invention contain amino or quaternary ammonium hydrophilic moieties which are positively charged when dissolved in the composition.

Suitable quaternary ammonium cationic conditioner actives useful herein include, but are not limited to, those having the formula (I):



in which  $\text{R}^1$ ,  $\text{R}^2$ ,  $\text{R}^3$ , and  $\text{R}^4$  are each independently selected from (a) an aliphatic group of from 1 to 22 carbon atoms, or (b) an aromatic, alkoxy, polyoxyalkylene, alkylamido, hydroxyalkyl, aryl or alkylaryl group having up to 22 carbon atoms; and X is a salt-forming anion such as those selected from halogen, (e.g. chloride, bromide), acetate, citrate, lactate, glycolate, phosphate, nitrate, sulphate, and alkylsulphate radicals. In one embodiment, the alkylsulphate radical is methosulfate and/or ethosulfate.

The aliphatic groups can contain, in addition to carbon and hydrogen atoms, ether linkages, and other groups such as amino groups. The longer chain aliphatic groups, e.g., those of about 12 carbons, or higher, can be saturated or unsaturated and can be branched or unbranched. In one embodiment, the class of cationic conditioner actives of general formula (I),  $\text{R}^1$  and  $\text{R}^2$  are each independently selected from  $\text{C}_{16}$  to  $\text{C}_{22}$  hydrocarbyl chains comprising at least one ester linkage in both  $\text{R}^1$  and  $\text{R}^2$ , and  $\text{R}^3$  and  $\text{R}^4$  are each independently selected from  $\text{CH}_3$  and  $\text{CH}_2\text{CH}_2\text{OH}$ . In another embodiment, the class of cationic conditioner actives of general formula (I),  $\text{R}^1$  and  $\text{R}^2$  are each independently selected from  $\text{C}_{16}$  to  $\text{C}_{22}$  saturated or unsaturated, and  $\text{R}^3$  and  $\text{R}^4$  are each independently selected from  $\text{CH}_3$ ,  $\text{CH}_2\text{CH}_2\text{OH}$ , and  $\text{CH}_3$ . In yet another embodiment, the class of cationic conditioner actives of general formula (I),  $\text{R}^1$  is a  $\text{C}_{16}$  to  $\text{C}_{22}$  alkyl chain and  $\text{R}^2$ ,  $\text{R}^3$  and  $\text{R}^4$  are each independently selected from  $\text{CH}_3$ ,  $\text{CH}_2\text{CH}_2\text{OH}$ , and  $\text{CH}_3$ .

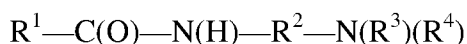
Suitable quaternary ammonium cationic conditioner actives of general formula (I) can include cetyltrimethylammonium chloride, behenyltrimethylammonium chloride (BTAC), stearyltrimethylammonium chloride, cetylpyridinium chloride, octadecyltrimethylammonium chloride, hexadecyltrimethylammonium chloride, octyldimethylbenzylammonium chloride, decyldimethylbenzylammonium chloride, stearyldimethylbenzylammonium chloride, didodecyldimethylammonium chloride, dioctadecyldimethylammonium chloride, distearyldimethylammonium chloride, tallowtrimethylammonium chloride, cocotrimethylammonium chloride, dipalmitoylethyldimethylammonium chloride, PEG-2 oleylammonium chloride and salts

of these, where the chloride is replaced by halogen, (e.g., bromide), acetate, citrate, lactate, glycolate, phosphate nitrate, sulphate, or alkylsulphate.

In a particular embodiment, the quaternary ammonium cationic conditioner actives for use in the invention are cetyltrimethylammonium chloride, available commercially, for example as GENAMIN CTAC by Clariant and Arquad 16/29 supplied by Akzo Nobel, behenyltrimethylammonium chloride (BTMAC) such as GENAMIN KDMP supplied by Clariant, and distearyltrimethylammonium chloride such as GENAMIN DSAP supplied by Clariant. Mixtures of any of the foregoing materials may also be suitable. In a preferred embodiment, the quaternary ammonium cationic conditioner active is behenyltrimethylammonium chloride (BTMAC).

Other suitable cationic surfactant conditioner actives can include salts of primary, secondary, and tertiary fatty amines. In one embodiment, the alkyl groups of such amines have from about 12 to about 22 carbon atoms, and can be substituted or unsubstituted. These amines are typically used in combination with an acid to provide the cationic species.

Suitable alkyl amine salts useful herein include, but are not limited to, those salts corresponding to alkyl amines having the general formula (II):



in which  $R^1$  is a fatty acid chain containing from 12 to 22 carbon atoms,  $R^2$  is an alkylene group containing from one to four carbon atoms, and  $R^3$  and  $R^4$  are, independently, an alkyl group having from one to four carbon atoms.  $R^1$  can be saturated or unsaturated and can be branched or unbranched.

Suitable materials of general formula (II) are stearamidopropyldimethylamine, stearamidopropyldiethylamine, stearamidoethyldiethylamine, stearamidoethyldimethylamine, palmitamidopropyldimethylamine, palmitamidopropyldiethylamine, palmitamidoethyldiethylamine, palmitamidoethyldimethylamine, behenamidopropyldimethylamine, behenamidopropyldiethylamine, behenamidoethyldiethylamine, behenamidoethyldimethylamine, arachidamidopropyldimethylamine, arachidamidopropyldiethylamine, arachidamidoethyldiethylamine, arachidamidoethyldimethylamine, and diethylaminoethylstearamide.

Other suitable alkyl amine salts can include dimethylstearamine, dimethylsoyamine, soyamine, myristylamine, tridecylamine, ethylstearylamine, N-tallowpropane diamine, ethoxylated (with 5 moles of ethylene oxide) stearylamine, dihydroxyethylstearylamine, and arachidyl behenylamine. In a preferred embodiment, the alkyl amine salt is stearamidopropyldimethylamine. Mixtures of any of the foregoing materials may also be suitable.

The acid used to provide the cationic conditioner active can be any organic acid or mineral acid of sufficient acid strength to neutralize a free amine nitrogen. Such acids include hydrochloric acid, sulphuric acid, nitric acid, phosphoric acid, lactic acid, citric acid, tartaric acid, acetic acid, gluconic acid, glycolic acid and propionic acid, or combinations thereof. In one embodiment, a sufficient amount of acid is added to neutralize the amidoamine compound and to adjust the final pH of the composition to within a range of from about 2.5 to about 6; in another embodiment, from about 3 to about 5. In one embodiment, the molar ratio of protonatable amine groups to  $H^+$  from the acid is from about 1:0.3 to about 1:1.2; and in another embodiment, from about 1:0.5 to about 1:1.1. Mixtures of any of the above-described cationic conditioner actives may also be suitable.

## **Perfume**

### **Primary Fragrance**

Personal care compositions of the present invention comprise a primary fragrance which provides the article with the desired perfume or unscented/neutral aroma prior to use (i.e., prior to contacting the article with water). The scented primary fragrance may include any perfume or perfume chemical suitable for topical application to the skin and suitable for use in personal care compositions.

The concentration of the primary fragrance in the personal care compositions should be effective to provide the desired aroma including, but not limited to, unscented. Generally, the concentration of the scented primary fragrance is from about 0.0% to about 30.0%, in one embodiment from about 1% to about 20%, in yet another embodiment from about 2% to about 10%, and in yet another embodiment from about 3% to about 8%, by weight of the solid article. The primary fragrance may be included in the personal care compositions of the present invention as a free perfume.

### Secondary Fragrance

In order to provide a secondary fragrance shift (e.g., a change from one fragrance to another), the secondary fragrance of the present invention should be substantially different and distinct from the composition of the primary fragrance in order to overcome the effect of fragrance habituation and to make the second fragrance noticeable over the primary fragrance. Alternatively, where the same fragrance is desired throughout the article's usage, the secondary fragrance should be substantially the same and indistinct from the composition of the primary fragrance in order to provide a single, continuous, long-lasting fragrance experience.

Generally, personal care compositions of the present invention may comprise a secondary fragrance from about 0.1%, to about 30.0%, in particular embodiments from about 1% to about 20%, in other embodiments from about 2% to about 10%, and in still other embodiments from about 3% to about 8%, by weight of the solid article.

Any perfume or perfume chemical suitable for topical application to the skin and suitable for use in personal care compositions may be used as the secondary fragrance, however, it will not be included within the composition as a free perfume. The secondary fragrance will be included in a surfactant-free and water-releasable matrix. The secondary fragrance may be selected from the group consisting of perfumes, highly volatile perfume materials having a boiling point of less than about 250°C, and mixtures thereof. Such fragrances will be included within a water-releasable matrix formed from an encapsulating material, as described herein.

In one embodiment, the secondary perfume is selected from high impact accord perfume ingredients having a ClogP of greater than about 2 and odor detection thresholds of less than or equal to 50 parts per billion (ppb).

The surface resident coatings comprising the cationic surfactant conditioner and perfume containing matrix microspheres according to the present invention are anhydrous. However, water remnants are likely to be present even immediately after manufacture as a result of processing limitations. It may typically occur that water will re-enter the particulate complexes subsequently, for example during storage. The aqueous phase may not only comprise water, but may also comprise additional water-soluble components, such as alcohols; humectants, including polyhydric alcohols (e.g.

glycerine and propylene glycol); active agents such as d-panthenol, vitamin B<sub>3</sub> and its derivatives (such as niacinamide) and botanical extracts; thickeners and preservatives. The aqueous phase does not represent more than 20% by weight of the encapsulate and may comprise from about 0.001% but no more than about 20%, no more than about 10%, no more than about 5%, or no more than about 2%, by weight of the particulate complex.

The surface resident coatings comprising the cationic surfactant conditioner and perfume containing matrix microspheres according to the invention may have a particle size from about 1 $\mu$ m to about 200 $\mu$ m, in another embodiment from about 2  $\mu$ m to about 100 $\mu$ m, and in yet another embodiment from about 3  $\mu$ m to about 50 $\mu$ m.

The surface resident coatings comprising the cationic surfactant conditioner and perfume containing matrix microspheres of the present invention may also impart other desirable attributes to the personal care article including, but not limited to, improved visual appearance. Moreover, the surface resident coatings comprising the cationic surfactant conditioner and high impact perfume containing matrix microspheres of the present invention may provide additional benefits such as imparting anti-stick properties to minimize sticking of the article to the product packaging or to other articles in the case to where they are delivered as a stack of articles.

### **III. Product Form of the Personal Care Article**

The personal care article can be produced in any of a variety of product forms, including porous dissolvable solid substrates along with the surface resident coating comprising the matrix microspheres used alone or in combination with other personal care components. Regardless of the product form, the product form embodiments contemplated herein include the selected and defined personal care article that comprises a combination of a porous dissolvable solid substrate and a surface resident coating comprising a matrix microsphere.

In one embodiment, the personal care article is in the form of one or more flat sheets or pads of an adequate size to be able to be handled easily by the user. It may have a square, rectangle or disc shape or any other suitable shape. The substrates can also be in the form of a continuous strip including delivered on a tape-like roll dispenser with individual portions dispensed via perforations and or a cutting mechanism. Alternatively,

the personal care articles are in the form of one or more cylindrical objects, spherical objects, tubular objects or any other shaped object.

The surface resident coating is applied to the porous dissolvable solid substrate. In one embodiment, the surface resident coating is in the form of a fine powder. As seen in FIG. 1, in certain embodiments of the present invention, the personal care article 10 contains a surface resident coating 12 that is located on at least a portion of the surface of the porous dissolvable solid substrate 14. It will be appreciated that the surface resident coating 12 may not always be adjacent to the porous dissolvable solid substrate 14. In certain embodiments, the surface resident coating 12 may permeate the porous dissolvable solid substrate 14 in whole or in part.

Alternatively, the surface resident coating can be included (e.g., sandwiched or encased) within the personal care article or parts thereof. Such a surface resident coating can be sprayed, dusted, sprinkled, coated, surface-printed (e.g., in the shape of a desired adornment, decoration, or pattern), poured on, injected into the interior, dipped, or by any other suitable means, such as by use of a depositor, sifter, or powder bed. In the embodiments depicted by FIGS. 3A, 3B, and 4, the personal care article 10 contains a surface resident coating that can be situated below the surface of the porous dissolvable solid substrate. As seen in FIG. 3B which is a cross sectional view of the personal care article 10, the surface resident coating 24 is located within the dimples 22 of the porous dissolvable solid substrate 26.

Referring now to FIG. 2, in certain embodiments the powder is sandwiched between two porous dissolvable solid substrate which are then joined together (e.g., via sealing the adjoining surfaces or edges with a thin layer of water and/or plasticizer so as to not substantially dissolve the porous dissolvable solid substrate and applied pressure to induce adhesion). In this embodiment, the personal care article 10 comprises two porous dissolvable solid substrates 16, 18 in between which a surface resident coating 20 is located.

Alternatively, in certain embodiments, the powder may be on one personal care article which is folded over to form a pouch, encasing the powder. As depicted in FIG. 4, the personal care article 10 comprises a surface resident coating 32 that is enclosed within a folded porous dissolvable solid substrate 34.

The personal care article may comprise one or more textured, dimpled or otherwise topographically patterned surfaces including letters, logos or figures. The textured substrate can result from the shape of the substrate, in that the outermost surface of the substrate contains portions that are raised with respect to other areas of the surface. The raised portions can result from the formed shape of the personal care article, for example the personal care article can be formed originally in a dimpled or waffle pattern. The raised portions can also be the result of creping processes, imprinted coatings, embossing patterns, laminating to other layers having raised portions, or the result of the physical form of the porous dissolvable solid substrate itself. The texturing can also be the result of laminating one porous dissolvable solid substrate to a second porous dissolvable solid substrate that is textured. In a particular embodiment, the personal care article can be perforated with holes or channels penetrating into or through the porous solid.

#### **IV. Method of Manufacture**

The personal care article can be prepared by the process comprising: (1) Preparing a processing mixture comprising surfactant(s), dissolved polymer structurant, and plasticizer; (2) Aerating the processing mixture by introducing a gas into the processing mixture to form an aerated wet mixture; (3) Forming the aerated wet mixture into one or more desired shapes; (4) Drying the aerated wet mixture to form a porous dissolvable solid substrate; and (5) Applying the surface resident coating comprising a matrix microsphere in powdered form to the porous dissolvable solid substrate.

##### **A. Preparation of Processing Mixture**

The processing mixture is generally prepared by dissolving the polymer structurant in the presence of water, plasticizer, surfactant and other optional ingredients by heating followed by cooling. This can be accomplished by any suitable heated batch agitation system or via any suitable continuous system involving either single screw or twin screw extrusion or heat exchangers together with either high shear or static mixing. Any process can be envisioned such that the polymer is ultimately dissolved in the presence of water, the surfactant(s), the plasticizer, and other optional ingredients including step-wise processing via pre-mix portions of any combination of ingredients.



The processing mixtures of the present invention comprise: from about 15% to about 60% solids, in one embodiment from about 20% to about 55% solids, in another embodiment from about 25% to about 50% solids, and in yet another embodiment from about 30% to about 45% solids by weight of the processing mixture before drying; and have a viscosity of from about 2,500 cps to about 150,000cps, in one embodiment from about 5,000 cps to about 100,000 cps, in another embodiment from about 7,500 cps to about 75,000 cps, and in still another embodiment from about 10,000 cps to about 60,000 cps.

The % solids content is the summation of the weight percentages by weight of the total processing mixture of all of the solid, semi-solid and liquid components excluding water and any obviously volatile materials such as low boiling alcohols. The processing mixture viscosity values are measured using a TA Instruments AR500 Rheometer with 4.0 cm diameter parallel plate and 1,200 micron gap at a shear rate of 1.0 reciprocal seconds for a period of 30 seconds at 23°C.

#### **B. Aeration of Processing Mixture**

The aeration of the processing mixture is accomplished by introducing a gas into the mixture. In one embodiment this is done by mechanical mixing energy. In another embodiment this may be achieved via chemical means. The aeration may be accomplished by any suitable mechanical processing means, including but not limited to: (i) Batch tank aeration via mechanical mixing including planetary mixers or other suitable mixing vessels, (ii) semi-continuous or continuous aerators utilized in the food industry (pressurized and non-pressurized), or (iii) spray-drying the processing mixture in order to form aerated beads or particles that can be compressed such as in a mould with heat in order to form the porous solid.

In a particular embodiment, it has been discovered that the personal care article can be prepared within continuous pressurized aerators that are conventionally utilized within the foods industry in the production of marshmallows. Suitable continuous pressurized aerators include the Morton whisk (Morton Machine Co., Motherwell, Scotland), the Oakes continuous automatic mixer (E.T. Oakes Corporation, Hauppauge, New York), the Fedco Continuous Mixer (The Peerless Group, Sidney, Ohio), and the Preswhip (Hosokawa Micron Group, Osaka, Japan).

Aeration can also be accomplished with chemical foaming agents by *in-situ* gas formation (via chemical reaction of one or more ingredients, including formation of carbon dioxide (CO<sub>2</sub> (g)) by an effervescent system. An additional possibility is aeration via volatile blowing agents such as low boiling hydrocarbons or alcohols including, but not limited to, isopentane, pentane, isobutene, ethanol etc.

In one embodiment, the pre-mixture is pre-heated immediately prior to the aeration process at above ambient temperature but below any temperatures that would cause undesirable degradation of any of the components. In one embodiment, the pre-mixture is kept at above about 40°C and below about 99°C, in another embodiment above about 50°C and below about 95°C, in another embodiment above about 60°C and below about 90°C. In one embodiment, when the viscosity at ambient temperature of the pre-mix is from about 20,000 cps to about 150,000 cps, the optional continuous heating should be utilized before the aeration step. In another embodiment, additional heat is applied during the aeration process to try and maintain an elevated temperature during the aeration. This can be accomplished via conductive heating from one or more surfaces, injection of steam, a surrounding hot water bath, or other processing means.

In one embodiment the wet density range of the aerated pre-mixture ranges from about 0.12 g/cm<sup>3</sup> to about 0.50 g/cm<sup>3</sup>, in another embodiment from about 0.15 g/cm<sup>3</sup> to about 0.45 g/cm<sup>3</sup>, in another embodiment from about 0.20 g/cm<sup>3</sup> to about 0.40 g/cm<sup>3</sup>, and in yet another embodiment from about 0.25 g/cm<sup>3</sup> to about 0.35 g/cm<sup>3</sup>.

### **C. Forming the Aerated Wet Processing Mixture**

The forming of the aerated wet processing mixture may be accomplished by any suitable means to form the mixture in a desired shape or shapes including, but not limited to (i) depositing the aerated mixture to moulds of the desired shape and size comprising a non-interacting and non-stick surface including aluminium, Teflon, metal, HDPE, polycarbonate, neoprene, rubber, LDPE, glass and the like; (ii) depositing the aerated mixture into cavities imprinted in dry granular starch contained in a shallow tray, otherwise known as starch moulding forming technique; and (iii) depositing the aerated mixture onto a continuous belt or screen comprising any non-interacting or non-stick material Teflon, metal, HDPE, polycarbonate, neoprene, rubber, LDPE, glass and the like which may be later stamped, cut, embossed or stored on a roll.

#### **D. Drying the Aerated Wet Processing Mixture into a Porous Dissolvable Solid Substrate**

The drying of the formed aerated wet processing mixture may be accomplished by any suitable means including, but not limited to (i) drying room(s) including rooms with controlled temperature and pressure or atmospheric conditions; (ii) ovens including non-convection or convection ovens with controlled temperature and optionally humidity; (iii) Truck/Tray driers, (iv) multi-stage inline driers; (v) impingement ovens; (vi) rotary ovens/driers; (vii) inline roasters; (viii) rapid high heat transfer ovens and driers; (ix) dual plenum roasters, and (x) conveyor driers, and combinations thereof. Any suitable drying means that does not comprise freeze-drying can be used.

The drying temperature may range from about 40°C to about 200°C. In a one embodiment, the drying environment is heated to a temperature between 100°C and 150°C. In one embodiment, the drying temperature is between 105°C and 145°C. In another embodiment, the drying temperature is between 110°C and 140°C. In a further embodiment, the drying temperature is between 115°C and 135°C.

Other suitable drying environments include “volumetric heating” techniques using high frequency electromagnetic fields such as Microwave Drying and Radio Frequency (RF) Drying. With these techniques, the energy is transferred electromagnetically through the aerated wet pre-mixture rather than by conduction or convection.

Optional ingredients may be imparted during any of the above described four processing steps or even after the drying process.

#### **E. Preparing the Surface Resident Coating Comprising the Matrix microsphere**

The cationic surfactant conditioner and perfume containing matrix microspheres of the present invention are prepared via spray drying. This process comprises:

- A. forming a solution of the starch-derived material and the cationic surfactant conditioner at an elevated temperature of in one embodiment from about 65 to about 95 degrees Celsius, in another embodiment from about 70 to about 90 degrees Celsius, and in yet another embodiment from about 75 to about 95 degrees Celsius, followed by cooling to a temperature of from about 32 to about 60 degrees Celsius;

- B. emulsifying the perfume oil in the solution wherein the solution and the resulting emulsion as it is being formed is maintained at a temperature of in one embodiment from about 32 to about 60 degrees Celsius, in another embodiment from about 35 to about 55 degrees Celsius and in yet another embodiment from about 40 to about 50 degrees Celsius; and
- C. spray drying the emulsion to remove water therefrom and wherein the emulsion is continuously stirred and maintained at a temperature of in one embodiment from about 32 to about 60 degrees Celsius, in another embodiment from about 35 to about 55 degrees Celsius and in yet another embodiment from about 40 to about 50 degrees Celsius during the spray drying process.

In some embodiments, inert fillers can be included within the particulate complex forming process or particulate complex after forming, for instance aluminum starch octenylsuccinate under the trade name DRY-FLO® PC and available from Akzo Nobel, at a level sufficient to improve the flow properties of the powder and to mitigate inter-particle sticking or agglomeration during powder production or handling. Other optional excipients or cosmetic actives, as described herein, can be incorporated into the powder during the particulate complex forming process. The resulting powder may also be blended with other powders, either of inert materials or other powder-active complexes as described herein.

#### **F. Combining Surface Resident Coating comprising the Matrix microspheres with the Porous Dissolvable Solid Substrate**

Any suitable application method can be used to apply the surface resident coating comprising the matrix microsphere to the personal care article such that it forms a part of the personal care article. For instance, the porous dissolvable solid substrate can have a tacky surface by drying the porous dissolvable solid substrate's surface to a specific water content before application of powder to facilitate the adherence of the surface resident coating comprising the matrix microsphere to the porous solid. In one embodiment, the porous dissolvable solid substrate is dried to a moisture content of from about 0.1 % to about 25%, in one embodiment from about 3% to about 25%, in another embodiment from about 5% to about 20% and in yet another embodiment from about 7%

to about 15%. Alternatively, a previously dried dissolvable porous solid substrate's surface can be made to reversibly absorb a desired level of atmospheric moisture prior to application of the powder within a controlled humidity environment for a specific period of time until equilibrium is achieved. In one embodiment, the humidity environment is controlled from about 20% to about 85% relative humidity; in another embodiment, from about 30% to about 75% relative humidity; and in yet another embodiment, from about 40% to about 60% relative humidity.

In another embodiment, the porous dissolvable solid substrate is placed in a bag, tray, belt, or drum containing or otherwise exposed to the powder and agitated, rolled, brushed, vibrated or shaken to apply and distribute the powder, either in a batch or continuous production manner. Other powder application methods may include powder sifters, electrostatic coating, tribo charging, fluidized beds, powder coating guns, corona guns, tumblers, electrostatic fluidized beds, electrostatic magnetic brushes, and/or powder spray booths. The surface resident coating comprising the matrix microsphere can be applied over portions or entire regions of the porous dissolvable solid substrate's exterior surface, and can be applied in a manner to adorn, decorate, form a logo, design, etc.

## **V. Test Methods**

### **A. Dissolution Rate**

The personal care article of present invention has a Dissolution Rate that allows the personal care article to rapidly disintegrate during use application with water. The Dissolution Rate of the personal care article is determined in accordance with the methodology described below.

Hand Dissolution Method: 0.5 to 1.5 g (approximately 10 to 20 square centimeters if in a 3 to 10mm thick sheet/pad form) of the personal care article (as described in the examples herein) is placed in the palm of the hand while wearing nitrile gloves. 7.5 cm<sup>3</sup> of warm tap water (from about 30°C to about 35°C) is quickly applied to the personal care composition via syringe. Using a circular motion, palms of hands are rubbed together 2 strokes at a time until dissolution occurs (up to 30 strokes). The hand dissolution value is reported as the number of strokes it takes for complete dissolution or as 30 strokes as the maximum. For the latter scenario, the weight of the undissolved material is also reported.

The personal care articles of the present invention have a hand dissolution value of from about 1 to about 30 strokes, in one embodiment from about 2 to about 25 strokes, in another embodiment from about 3 to about 20 strokes, and in still another embodiment from about 4 to about 15 strokes.

**B. Thickness**

The thickness of the personal care article and/or the porous dissolvable solid substrate is obtained using a micrometer or thickness gage, such as the Mitutoyo Corporation Digital Disk Stand Micrometer Model Number IDS-1012E (Mitutoyo Corporation, 965 Corporate Blvd, Aurora, IL, USA 60504). The micrometer has a 1 inch diameter platen weighing about 32 grams, which measures thickness at an application pressure of about 40.7 phi (6.32 gm/cm<sup>2</sup>).

The thickness of the personal care article and/or the porous dissolvable solid substrate is measured by raising the platen, placing a section of the sample on the stand beneath the platen, carefully lowering the platen to contact the sample, releasing the platen, and measuring the thickness of the sample in millimeters on the digital readout. The sample should be fully extended to all edges of the platen to make sure thickness is measured at the lowest possible surface pressure, except for the case of more rigid samples which are not flat. For more rigid samples which are not completely flat, a flat edge of the sample is measured using only one portion of the platen impinging on the flat portion of the sample. In the case of cylindrical, spherical, or other objects with more of a third dimension versus a pad or strip, the thickness is taken as the maximum distance of the shortest dimension, i.e., the diameter of a sphere or cylinder for instance, and the thickness ranges are the same as described above.

**C. Basis Weight**

The Basis Weight of the personal care article and/or the porous dissolvable solid substrate is calculated as the weight of the personal care article and/or the porous dissolvable solid substrate per area of the selected personal care article and/or the porous dissolvable solid substrate (grams/m<sup>2</sup>). The area is calculated as the projected area onto a flat surface perpendicular to the outer edges of the personal care article and/or the porous dissolvable solid substrate. For a flat object, the area is thus computed based on the area enclosed within the outer perimeter of the sample. For a spherical object, the area is thus

computed based on the average diameter as  $3.14 \times (\text{diameter}/2)^2$ . For a cylindrical object, the area is thus computed based on the average diameter and average length as diameter x length. For an irregularly shaped three dimensional object, the area is computed based on the side with the largest outer dimensions projected onto a flat surface oriented perpendicularly to this side.

#### **D. Solid Density**

The porous dissolvable solid substrate of the personal care compositions described herein can be characterized in terms of a solid density determination.

The solid density of the porous dissolvable solid substrate can be determined by dividing the weight of the solid by the known volume of the solid. The latter can be determined by a number of techniques including producing the solid within a mold of known x-y dimensions and measuring the resulting thickness to account for any shrinkage or expansion during the drying process. The solid can also be cut to known x-y dimensions, i.e., by using a circular or square cutting die of known diameter or dimensions and then by measuring the thickness. Alternatively, in the instances where there are not any significant thickness variations, the density can be calculated by the equation: Calculated Density = Basis Weight of porous solid / (Average porous Solid Thickness x 1,000).

#### **E. Cell Inter-connectivity**

The personal care article and/or the porous dissolvable solid substrate of the present invention have a high degree of cell inter-connectivity, i.e., are predominantly open-celled solid foams as opposed to being predominantly closed-cell solid foams. The cell inter-connectivity can be assessed by light microscopy, scanning electron microscopy, micro computed tomography imaging parameters (Star Volume and SMI Index), gas pycnometry parameters (% Open Cells), or other suitable methodology.

A qualitative method of determining cell inter-connectivity is via light microscopy. This is performed by cutting a 2-3 mm wide sliver of the personal care article and/or the porous dissolvable solid substrate in the z-direction using scissors or a sharp blade, measured across the normal x-y largest surface, and turning the resulting sliver by 90 degrees to reveal the internal cellular structure of the freshly cut cross-

sectional area. This cross-sectional area can be assessed by close visual inspection or, more accurately, by employing magnification under a stereo microscope such as the SZX12 Stereo microscope available from Olympus America Inc., Center Valley, PA. The open-celled personal care article and/or the porous dissolvable solid substrate of the present invention can easily be identified by examining the inner portion of the cross-sectional area which will comprise a predominantly three dimensional network of struts with open void spaces surrounding the struts that are inter-connected to one another including in the third dimension through the depth of the cross-section. In contrast, the inner cross-section of a closed-cell foam will appear as discrete bubbles that are cut across and then only being inter-connected at the cross-sectional surface in two dimensions by virtue of the cutting process employed to generate the exposed cross-sectional area.

Another means to determine the cell interconnectivity is via the Star Volume and the Structure Model Index. Disk-like samples, approximately 4 cm in diameter and 3 to 7 mm high, are scanned using a micro computed tomography system ( $\mu$ CT80, SN 06071200, Scanco Medical AG). Each sample is imaged while sitting flat on the bottom of a cylindrical tube. Image acquisition parameters are 45 kVp, 177  $\mu$ A, 51.2 mm field of view, 800 ms integration time, 1000 projections. The number of slices is adjusted to cover the height of the sample. The reconstructed data set consisted of a stack of images, each 2048x2048 pixels, with an isotropic resolution of 25  $\mu$ m. For data analysis, a volume of interest is selected to be fully within the sample, avoiding the surface region. A typical volume of interest is 1028x772x98 voxels.

Structure Model Index (SMI) is measured using Scanco Medical's Bone Trabecular Morphometry evaluation with a threshold of 17. With this index the structural appearance of trabecular bone is quantified (*see* T. Hildebrand, P. Rüegsegger. Quantification of bone microarchitecture with the structure model index. *Comp Meth Biomech Biomed Eng* 1997;1:15-23). The triangulated surface is dilated in normal direction by an infinitesimal amount, and the new bone surface and volume is calculated. By this, the derivative of the bone surface (dBS/dr) can be determined. The SMI is then represented by the equation:



$$SMI = 6 \cdot \frac{BV \cdot \frac{dBS}{dr}}{BS^2}$$

SMI relates to the convexity of the structure to a model type. Ideal (flat) plates have an SMI of 0 (no surface change with dilation of the plates), whereas ideal cylindrical rods have an SMI of 3 (linear increase in surface with dilation of rods). Round spheres have an SMI of 4. Concave structure gives negative dBS/dr, resulting in negative SMI values. Artificial boundaries at the edge of the volume of interest are not included in the calculation and thus suppressed.

In addition to the Scanco Medical Analysis, StarVolume measurements are made. Star Volume is a measure of the “openness” of the void space in a two phase structure. By choosing a random uniformly distributed set of points in the phase of interest (in our case this is the background), we can extend lines in random directions from each of these points. The lines are extended until they touch the foreground phase. The length of each of these lines is then recorded. The random points have a sampling of 10 in each direction (x/y/z) and at each point 10 random angles are chosen. If the line extends to the border of the ROI of interest that line is discarded (we only want to accept lines that actually intersect with the foreground phase). The final equation is based upon the research published in Star volume in bone research. A histomorphometric analysis of trabecular bone structure using vertical sections; Vesterby, A.; Anat Rec.; 1993 Feb;235(2):325–334.:

$$StarVolume = \frac{4}{3} \pi \cdot \frac{\sum dist^3}{N}$$

where “dist” is the individual distances and N is the number of lines examined.

The Percent Open Cell Content is measured via gas pycnometry. Gas pycnometry is a common analytical technique that uses a gas displacement method to measure volume accurately. Inert gases, such as helium or nitrogen, are used as the displacement medium. The sample is sealed in the instrument compartment of known volume, the appropriate inert gas is admitted, and then expanded into another precision internal volume. The pressure before and after expansion is measured and used to

compute the sample volume. Dividing this volume into the sample weight gives the gas displacement density.

ASTM Standard Test Method D2856 provides a procedure for determining the percentage of open cells using an older model of an air comparison pycnometer. This device is no longer manufactured. However, you can determine the percentage of open cells conveniently and with precision by performing a test which uses Micromeritics' AccuPyc Pycnometer. The ASTM procedure D2856 describes 5 methods (A, B, C, D, and E) for determining the percent of open cells of foam materials.

For these experiments, the samples can be analyzed using an Accupyc 1340 using nitrogen gas with the ASTM foampyc software. Method C of the ASTM procedure is to be used to calculate to percent open cells. This method simply compares the geometric volume as determined using calipers and standard volume calculations to the true volume as measured by the Accupyc. It is recommended that these measurements be conducted by Micromeritics Analytical Services, Inc. (One Micromeritics Dr, Suite 200, Norcross, GA 30093). More information on this technique is available on the Micromeritics Analytical Services web sites ([www.particletesting.com](http://www.particletesting.com) or [www.micromeritics.com](http://www.micromeritics.com)), or published in a book, "Analytical Methods in Fine particle Technology", by Clyde Orr and Paul Webb.

#### **F. Cell Wall Thickness**

The Cell Wall Thickness of the personal care article and/or the porous dissolvable solid substrate is computed from the scanned images via a micro computed tomography system ( $\mu$ CT80, SN 06071200, Scanco Medical AG) as described herein. The Cell Wall Thickness is determined according to the method defined for the measurement of Trabecular Thickness using Scanco Medical's Bone Trabecular Morphometry evaluation. The definition of Trabecular Thickness as taken from the Scanco User's manual: Trabecular Thickness uses a Euclidean distance transformation (EDM), which calculates the Euclidean distance from any point in the foreground to the nearest background point. The Trabecular Thickness measure represents twice the centerline values associated with the local maxima of the EDM, which represents the distance to the center of the object (twice this distance will yield the thickness).

#### **G. Specific Surface Area**

The Specific Surface Area of the personal care article and/or the porous dissolvable solid substrate is measured via a gas adsorption technique. Surface Area is a measure of the exposed surface of a solid sample on the molecular scale. The BET (Brunauer, Emmet, and Teller) theory is the most popular model used to determine the surface area and is based upon gas adsorption isotherms. Gas Adsorption uses physical adsorption and capillary condensation to measure a gas adsorption isotherm. The technique is summarized by the following steps; a sample is placed in a sample tube and is heated under vacuum or flowing gas to remove contamination on the surface of the sample. The sample weight is obtained by subtracting the empty sample tube weight from the degassed sample + sample tube weight. The sample tube is then placed on the analysis port and the analysis is started. The first step in the analysis process is to evacuate the sample tube, followed by a measurement of the free space volume in the sample tube using helium gas at liquid nitrogen temperatures. The sample is then evacuated a second time to remove the helium gas. The instrument then begins collecting the adsorption isotherm by dosing krypton gas at user specified intervals until the requested pressure measurements are achieved.

**Sample Preparation (Degassing):** A sample not adequately cleaned of adsorbed contaminants will outgas during an analysis and some portion of the surface will be inaccessible to measurement. The purpose of degassing is to remove these adsorbed molecules from the surface of the sample prior to analysis. Adsorptive molecules must reach all parts of the surface for the true surface area to be revealed. Samples are prepared by heating the sample while simultaneously evacuating the sample tube.

For these experiments, the samples are outgassed under evacuation at room temperature overnight. Samples may then analyzed using an ASAP 2420 with krypton gas adsorption. Krypton gas is preferred over nitrogen gas as it has a saturation pressure approximately 1/300 that of nitrogen at liquid nitrogen temperature (krypton: 2.5 torr; nitrogen: 760 torr). Therefore, compared to nitrogen, there is in the free space above the sample about 1/300 the number of krypton molecules present at the same relative pressure. Since about the same number of krypton and nitrogen molecules are required to form a monolayer, this number represents a far greater proportion of the quantity dosed than in the case of nitrogen. These measurements can be conducted by

Micromeritics Analytical Services, Inc. (One Micromeritics Dr, Suite 200, Norcross, GA 30093). More information on this technique is available on the Micromeritics Analytical Services web sites ([www.particletesting.com](http://www.particletesting.com) or [www.micromeritics.com](http://www.micromeritics.com)), or published in a book, "Analytical Methods in Fine particle Technology", by Clyde Orr and Paul Webb.

#### **H. Evaluation of Surface Resident Coating**

The presence of a surface resident coating comprising a starch-perfume complex of the present invention can be determined by a number of techniques. For detection of a particulate or powder coating, the surface of application as well as the cross-sections perpendicular to the larger surfaces of the porous dissolvable solid substrate can be examined by microscopic techniques. These microscopic techniques may include light microscopy and scanning electron microscopy (SEM). The light microscopy may include but are not necessarily limited to bright field, dark field, or confocal microscopy techniques. Other techniques for mapping unique elements such as silicon or distinctive functional groups such as quaternary ammonium groups on the cross-sectional surface include: time of flight secondary ion mass spectroscopy (ToF-SIMS), or infrared microscopy.

Potential methods for looking at the distribution of particles from the surface to the interior of the porous dissolvable solid substrate without sectioning the samples include: micro-Computed Tomography (micro-CT), Magnetic Resonance Imaging (MRI), Acoustic Imaging, Confocal Fluorescence Microscopy, Confocal Raman Spectroscopy, and Confocal Infrared Reflectance Spectroscopy.

The determination of surface-resident coating particles on cross-sectioned porous dissolvable solid substrate can be performed by comparing the distribution of the particles across the cut cross-section of the porous solid. Specifically, the surface resident coating particles should be present at the original solid/air interfaces, but not within the exposed cross sectioned interior of the solid cell walls as can be ascertained by analyzing the exposed freshly cut cross-sectional interiors of the solid. It should be noted that some contamination of the freshly cut cross-sectional solid cell wall interiors may occur as a consequence of the cutting process of the porous solid. However, the preponderance (in one embodiment, from about 50% to about 100%) of the surface

resident coating particle distribution will occur at the original solid/air interfaces and not within the exposed cut cross-sectional interiors of the cell walls.

It should also be noted that the surface resident coating particles of the present invention generally do not spread uniformly across all exposed solid/air interfaces. Rather, it has been found that the surface resident coatings of the present invention typically spread, from the point of coating application, into cavities down to about 0.5 to about 3.0 mm according to gravity. Accordingly, the determination of surface resident particles of cosmetic actives of the present invention (as described above), should be conducted across many different cross sections from top-to-bottom and from edge-to-edge of the porous solid. If present, the surface resident cosmetic active particle will generally be within the regional vicinity (to within about 0.5 to about 3.0 mm from the surface) of the surface to where the coating was first applied.

#### **I. Expert Perfume Panel**

An expert perfume sensory panel is conducted to quantify the fragrance performance within a normal shampoo protocol regimen with three expert perfumers evaluating the odor character and odor intensity on a 1 to 100 scale (no odor to the most intense odor possible) as described below. A retail liquid shampoo product is included within each panel as a control leg (Herbal Essences Drama Clean Shampoo, Distributed by Procter & Gamble).

The expert perfume panel assessment is performed on 15g/10" flat Oriental virgin hair switches. The hair switch is rinsed with 100°F tap water at 1.5 to 2.0 gallons/min for 20 seconds with a shower nozzle. For testing the liquid control products, the liquids are first smelled in an open glass jar for the neat product odor. 5 cm<sup>3</sup> of liquid product is then applied to the palm of a pre-wetted hand for the initial perfume bloom assessment in the hand. Next, the liquid is applied to the center of the switch with the palm and lathered for 40 seconds by repeatedly rubbing and squeezing the hair switch with both hands in a downward motion for the lather on switch odor assessment. The switch is then thoroughly rinsed for 45 seconds and assessed for wet hair odor. Additional assessments include the 4 hour damp hair odor, the 24 hour dry hair odor and the 24 hour re-wet odor.

When testing the dissolvable porous solids of the present invention, 1 substrate in the form of a pad (approximately 1.0 to 1.1 grams) is substituted for the 5 cm<sup>3</sup> of liquid. For testing the dissolvable porous solids, the pad is first smelled in a freshly opened wrapper for the neat product odor. The pad is then applied to the palm of a pre-wetted hand and diluted with 7.5 ml of 100°F tap water with rubbing of the palms (4 to 8 strokes) until the solid is fully dissolved for the initial perfume bloom assessment in the hand. Next, the resulting liquid mixture is applied to the center of the switch with the palm and lathered for 40 seconds by repeatedly rubbing and squeezing the hair switch with both hands in a downward motion for the lather on switch odor assessment. The switch is then thoroughly rinsed for 45 seconds and assessed for wet hair odor, 4 hour damp hair odor, 24 hour dry hair odor and 24 hour re-wet odor as described above.

#### **IV. Methods of Use**

The compositions of the present invention may be used for treating mammalian keratinous tissue such as hair and/or scalp, and provide rapid rinse-ability. The method for conditioning the hair may comprise the steps of: a) applying an effective amount of the personal care product to the hand, b) wetting the personal care product with water and rubbing to dissolve the solid, c) applying the dissolved material to either the hair or scalp such as to treat, and d) rinsing the diluted treatment from the hair or scalp using water. These steps can be repeated as many times as desired to achieve the desired treatment benefit.

#### **V. Examples**

The following examples further describe and demonstrate embodiments within the scope of the present invention. The examples are given solely for the purpose of illustration and are not to be construed as limitations of the present invention, as many variations thereof are possible without departing from the spirit and scope of the invention. All exemplified amounts are concentrations by weight of the total composition, i.e., wt/wt percentages, unless otherwise specified.

##### **Example 1: Preparation of Porous Dissolvable Solid Substrate**

The following surfactant/polymer liquid processing composition is prepared at the indicated weight percentages as described in Table 1 below.

**Table 1**

Component	Ex. 12
Glycerin	3.2
Polyvinyl alcohol <sup>1</sup>	8.1
Sodium Lauroamphoacetate (26% activity) <sup>2</sup>	31.8
Ammonium Laureth-3 sulfate (25% activity)	4.9
Ammonium Undecyl sulfate (24% activity)	19.9
Ammonium Laureth-1 sulfate (70% activity)	8.0
Cationic cellulose <sup>3</sup>	0.5
Citric Acid	1.6
Distilled water	22.0
Total	100.0
pH	5.8
Viscosity (cp)	35,400

<sup>1</sup> Sigma-Aldrich Catalog No. 363081, MW 85,000-124,000, 87-89% hydrolyzed

<sup>2</sup> McIntyre Group Ltd, University Park, IL, Mackam HPL-28ULS

<sup>3</sup> UCARE™ Polymer LR-400, available from Amerchol Corporation (Plaquemine, Louisiana)

A target weight of 300 grams of the above composition is prepared with the use of a conventional overhead stirrer (IKA® RW20DZM Stirrer available from IKA® Works, Inc., Wilmington, DE) and a hot plate (Corning Incorporated Life Sciences, Lowell, MA). Into an appropriately sized and cleaned vessel, the distilled water and glycerin are added with stirring at 100-150 rpm. The cationic polymer, when present, is then slowly added with constant stirring until homogenous. The polyvinyl alcohol is weighed into a suitable container and slowly added to the main mixture in small increments using a spatula while continuing to stir while avoiding the formation of visible lumps. The mixing speed is adjusted to minimize foam formation. The mixture is slowly heated to 80°C after which surfactants are added. The mixture is then heated to 85°C while continuing to stir and then allowed to cool to room temperature. Additional distilled water is added to compensate for water lost to evaporation (based on the original tare weight of the container). The final pH is between 5.2 - 6.6 and adjusted with citric acid

or diluted sodium hydroxide if necessary. The resulting processing mixture viscosity is measured.

A porous dissolvable solid substrate (also referred to in the examples herein as “substrate”) was prepared from the above liquid processing mixture as described in Table 2 below.

**Table 2**

Aeration Time (sec)	62
Wet Density (g/cm <sup>3</sup> )	0.26
Oven Temperature (°C)	130
Drying Time (min)	38
Average dry substrate weight (g)	1.10
Average dry substrate thickness (cm)	0.62
Average substrate shrinkage (%)	4.6%
Average dry substrate density (g/cm <sup>3</sup> )	0.11
Average basis weight (g/m <sup>2</sup> )	650

300 grams of the processing mixture (from Examples 1) is stored within a convection oven for greater than two hours at 70°C to pre-heat the processing mixture. The mixture is then transferred into a pre-heated 5 quart stainless steel bowl (by placing into 70°C oven for greater than 15 minutes) of a KITCHENAID® Mixer Model K5SS (available from Hobart Corporation, Troy, OH) fitted with a flat beater attachment and with a water bath attachment comprising tap water at 70-75°C. The mixture is vigorously aerated at a maximum speed setting of 10 until a wet density of approximately 0.26 grams/cm<sup>3</sup> is achieved (time recorded in table). The density is measured by weighing a filling a cup with a known volume and evenly scraping off the top of the cup with a spatula. The resulting aerated mixture is then spread with a spatula into square 160 mm x 160 mm aluminum molds with a depth of 6.5 mm with the excess wet foam being removed with the straight edge of a large metal spatula that is held at a 45° angle and slowly dragged uniformly across the mold surface. The aluminum molds are then placed into a 130°C convection oven for approximately 35 to 45 minutes. The molds are



allowed to cool to room temperature with the substantially dry porous dissolvable solid substrates removed from the molds with the aid of a thin spatula and tweezers.

Each of the resulting 160 mm x 160 mm square substrates is cut into nine 43 mm x 43 mm squares (with rounded edges) using a cutting die and a Samco SB20 cutting machine (each square representing surface area of approximately 16.9 cm<sup>2</sup>). The resulting smaller substrates are then equilibrated overnight (14 hours) in a constant environment room kept at 70°F and 50% relative humidity within large zip-lock bags that are left open to the room atmosphere. Each substrate is then weighed and placed on an individual weight boat with the original mold side facing downward. The average substrate weights are recorded and the basis weight computed by dividing the average substrate weight by 0.00169 square meters. The resulting substrate thickness is measured with a digital caliper and recorded. The bags are sealed within the 50% relative humidity environment.

### **Example 2: Structural Characterization of Porous Dissolvable Solid Substrate**

The below Table 3 summarizes the structural measurements and qualitative physical integrity ratings taken on the porous dissolvable solid substrates of Example 1. SEM and micro-CT images were also taken for the lower density Articles and are referenced in the attached figures. The data was collected by the methods as described herein.

**Table 3**

Example	Kr BET Surface Area (m <sup>2</sup> /g)	Pycnometry % Open Cells	Micro-CT Cell Wall thickness (mm)	Micro- CT Star Volume (mm <sup>3</sup> )	Micro- CT SMI Index	SEM Image	μCT Image
Ex. 1	0.036	89.1%	0.074	5.1	1.5	Fig 1	Fig 2

The above data and referenced images demonstrate the porous dissolvable solid substrate of Example 1 to be predominantly open-celled and to have good physical integrity. Correspondingly, the predominantly open-celled porous dissolvable solid

substrate also exhibits fast dissolution performance (6 to 8 strokes) within the simulated hand dissolution protocol as described herein.

**Comparative Example 2: Preparation of matrix microspheres comprising gum arabic, maltodextrin and perfume accord 2a**

The following liquid processing composition is prepared at the indicated weight percentages as described below (all percentages are weight percentages) in Table 4.

**Table 4**

Distilled Water	70%
Maltodextrin <sup>1</sup>	16%
Gum Arabic <sup>2</sup>	7%
Perfume Accord 2a	7%
Total	100%

<sup>1</sup> Sigma-Aldrich Catalog No. 419699, CAS 9050-36-6, melting point 240 degrees Celsius, Dextrose equivalent 16.5 – 19.5.

<sup>2</sup> Sigma-Aldrich Catalog No. G9752, CAS 9000-01-5, reagent grade.

200 grams of the above mixture is prepared within a 400ml PYREX® beaker with a magnetic stirring bar and continuously stirred and heated on a stirrer/hot plate. The gum Arabic is added to the water with vigorous stirring and heated to approximately 50 degrees Celsius. The maltodextrin is added with continued heating to approximately 80 degrees Celsius followed by cooling to between 30 and 50 degrees Celsius. Additional distilled water is added to compensate for water lost to evaporation (based on the original tare weight of the container). The perfume is added and high shear mixed into the mixture for approximately 3 minutes with an IKA Ultra-Turax T25 Basic High Shear Mixer which is operated at a speed of 4. Analysis of the mixture under a light microscope demonstrates perfume to be emulsified to droplet sizes below 5 microns.

The resulting emulsion is spray dried with a Mini Spray Dryer (Model B-290 available from BÜCHI Labortechnik AG, CH-9230 Flawil 1 / Switzerland) with the aspirator set to 100%, the compressed air set at 4 cm, the pump set at 30% and with the inlet temperature operated from 165 to 180 degrees Celsius and the outlet temperature operated from 70 to 80 degrees Celsius. Approximately 30.2 grams of a fine powder was

recovered from the product vessel representing a yield of approximately 50.4%. The resulting microspheres have a calculated theoretical solid composition (assuming 0% moisture for calculation purposes only) of approximately 53.33% maltodextrin, 23.33% gum arabic, and 23.33% perfume accord 2a.

**Comparative Example 3: Unsuccessful preparation of matrix microspheres comprising gum arabic, maltodextrin, perfume accord 2a and cationic surfactant conditioner**

The following liquid processing composition is prepared at the indicated weight percentages as described below (all percentages are weight percentages) in Table 5.

**Table 5**

Distilled Water	70%
Maltodextrin <sup>1</sup>	13%
Gum Arabic <sup>2</sup>	7%
Behentrimonium Chloride <sup>3</sup>	3%
Perfume Accord 2a	7%
Total	100%

<sup>1</sup> Sigma-Aldrich Catalog No. 419699, CAS 9050-36-6, melting point 240 degrees Celsius, Dextrose equivalent 16.5 – 19.5.

<sup>2</sup> Sigma-Aldrich Catalog No. G9752, CAS 9000-01-5, reagent grade.

<sup>3</sup> GENAMIN KDMP, CAS 67-63-0, available from Clariant Corporation

200 grams of the above mixture is prepared within a 400ml PYREX® beaker with a magnetic stirring bar and continuously stirred and heated on a stirrer/hot plate. The gum Arabic is added to the water with vigorous stirring and heated to approximately 50 degrees Celsius. The cationic surfactant conditioner (behentrimonium chloride) and maltodextrin is added with continued heating to approximately 80 degrees Celsius followed by cooling to between 30 and 50 degrees Celsius. Additional distilled water is added to compensate for water lost to evaporation (based on the original tare weight of the container). Visible phase separated gel pieces are present within the mixture which is not homogenous. The beaker and contents is poured into a covered jar and stored within a convection oven set at 65 degrees Celsius and held overnight and then allowed to cool.

The mixture is still cloudy with visible gel pieces and not homogenous. The experiment is deemed to be unsuccessful as the subsequent emulsification and spray drying is not attempted due to the visible gel pieces which would be expected clog the nozzle of the spray dryer. While not being bound to theory, the complexation is believed to be due to physical incompatibility between the gum arabic and the cationic surfactant conditioner.

**Example 4: Preparation of matrix microspheres comprising maltodextrin, and perfume accord 2a and additional cationic surfactant conditioner (to compensate for removal of the gum arabic relative to Example 3)**

The following liquid processing composition is prepared according to the present invention at the indicated weight percentages as described below (all percentages are weight percentages) in Table 6.

**Table 6**

Distilled Water	80%
Maltodextrin <sup>1</sup>	8%
Gum Arabic <sup>2</sup>	0%
Behentrimonium Chloride <sup>3</sup>	6%
Perfume Accord 2a	6%
Total	100%

<sup>1</sup> Sigma-Aldrich Catalog No. 419699, CAS 9050-36-6, melting point 240 degrees Celsius, Dextrose equivalent 16.5 – 19.5.

<sup>2</sup> Sigma-Aldrich Catalog No. G9752, CAS 9000-01-5, reagent grade.

<sup>3</sup> GENAMIN KDMP, CAS 67-63-0, available from Clariant Corporation

300 grams of the above mixture is prepared within a 400ml PYREX® beaker with a magnetic stirring bar and continuously stirred and heated on a stirrer/hot plate. The behentrimonium chloride and maltodextrin is added with continued heating to approximately 80 degrees Celsius followed by cooling to between 40 and 50 degrees Celsius. Additional distilled water is added to compensate for water lost to evaporation (based on the original tare weight of the container). The perfume is added and high shear mixed into the mixture for approximately 3 minutes with an IKA Ultra-Turax T25 Basic High Shear Mixer which is operated at a speed of 4. Importantly, the mixture must be

kept above about 35 degrees Celsius before and during spray drying to maintain a clear solution (a cloudy precipitate forms at lower temperatures).

The resulting emulsion is continuously stirred with a stirring bar and heated to between 40 and 50 degrees Celsius on a stirrer/hot plate while being spray dried with a Mini Spray Dryer (Model B-290 available from BÜCHI Labortechnik AG, CH-9230 Flawil 1 / Switzerland) with the aspirator set to 100%, the compressed air set at 4.2 cm, the pump set from 20 to 25% and with the inlet temperature operated from 170 to 180 degrees Celsius and the outlet temperature operated from 70 to 80 degrees Celsius. Approximately 36.4 grams of a fine powder is recovered from the product vessel representing a yield of approximately 60.6%. The resulting microspheres have a calculated theoretical solid composition (assuming 0% moisture for calculation purposes only) of approximately 40% maltodextrin, 30% behentrimonium chloride, and 30% perfume accord 2a.

**Example 5: Preparation of matrix microspheres comprising maltodextrin, and perfume accord 2b and additional cationic surfactant conditioner (to compensate for removal of the gum arabic relative to Example 3)**

Matrix microspheres are prepared according to the identical formulation and procedures as described in Example 4, but with the replacement of the perfume accord 2a with a different perfume accord 2b. Approximately 43.8 grams of a fine powder is recovered from the product vessel representing a yield of approximately 73.0%. The resulting microspheres have a calculated theoretical solid composition (assuming 0% moisture for calculation purposes only) of approximately 40% maltodextrin, 30% behentrimonium chloride, and 30% perfume accord 2b.

**Example 6: Preparation of matrix microspheres comprising maltodextrin, and perfume accord 2c and additional cationic surfactant conditioner (to compensate for removal of the gum arabic relative to Example 3)**

Matrix microspheres are prepared according to the identical formulation and procedures as described in Example 4, but with at total 250 grams of the prepared liquid mixture and the replacement of the perfume accord 2a with a different perfume accord

2c. Approximately 33.3 grams of a fine powder is recovered from the product vessel representing a yield of approximately 67.0%. The resulting microspheres have a calculated theoretical solid composition (assuming 0% moisture for calculation purposes only) of approximately 40% maltodextrin, 30% behentrimonium chloride, and 30% perfume accord 2c.

**Example 7: Porous dissolvable solid substrate shampoo with a surface coating of aminosilicone, a surface coating of primary fragrance 1a, and surface coated microspheres comprising a cationic surfactant conditioner and a secondary perfume accord 2c**

A dissolving porous shampoo substrate from example 1 (and corresponding weigh boat) is removed from the sealed plastic bag and tared to zero on a 4 place weigh balance. 65 microliters of aminosilicone fluid (available from Momentive, Performance Materials, Albany NY, Product code 65850 Y-14945 with a viscosity of 14,500cps at 25°C and an amine content of 0.050 meq/g) is coated onto the top surface of the substrate (the side exposed to the atmosphere during the drying process and opposite the side in contact with the aluminum mold during production) with a positive displace micro-dispenser with a glass tube and plunger. The aminosilicone fluid is dispensed by placing five drops (about 1/5 the total volume each) on five spots (center and four corners on substrate). The side of the glass tube is used to distribute the aminosilicone fluid across the top surface of the substrate as evenly as possible. The substrate and weigh boat are returned to the plastic bag and sealed and left to sit for several hours.

The first porous substrate within it's weigh boat is later removed from the zip-lock bag and tared again to zero weight on a 4 place weigh balance. Within a fume hood, the dissolving porous shampoo substrate is mounted on a stainless steel easel that rests at about a 60 degree angle and with notches holding the substrate from sliding downward and with a hole in plate so that the substrate can easily be removed from the mount by pushing from the easel. It is important that the top surface of the substrate (the side that was exposed to the air in the drying oven and opposite the side that was in direct contact with the aluminum mold during the drying process) is facing away from the easel. A small glass bottle with a pump spray is filled with the primary perfume fragrance oil 1a

and then sprayed onto the surface of the solid from a distance of 2 to 3 inches. The solid is then removed from the easel and returned to the weigh boat on the balance with the top side facing upwards. The weight of perfume applied is recorded and in the instance that the target weight is not achieved, either another spray amount is applied or a Kim wipe to absorb excess perfume away from the substrate. This iterative process is repeated until the target weight range is achieved. The target amount of primary perfume fragrance 1a applied is 0.06 grams. The resulting substrate resting on the small weigh boat is stored within a zip-lock bag and sealed from the atmosphere. The above process is repeated on subsequent substrates from Example 1 that have been previously coated with aminosilicone. A measured average of approximately 0.062 +/- 0.001 grams of perfume fragrance 1a is coated across multiple coated substrates.

A porous dissolvable solid substrate shampoo (and corresponding weigh boat) from example 1 that has been previously coated with both aminosilicone and primary fragrance 1a is removed from the sealed plastic bag and tared to zero weight on a 4 place weigh balance. The matrix microspheres comprising maltodextrin, perfume accord 2c and cationic surfactant conditioner from Example 6 is then applied to the surface of each substrate. The substrate is coated with the microspheres by gently shaking the substrate in a tray (or other suitable container) containing an excess of the microspheres in a side-to-side manner ten times (the process is repeated for the other side). The resulting powder coated substrate is then picked up (with gloved hands) and gently shaken and tapped several times to remove any excess powder that is not sufficiently adhered to the substrate. The resulting weight of the microspheres adsorbed is recorded. The substrate within its weigh boat is then returned the zip lock bag and sealed from the atmosphere. This powder coating process is repeated on subsequent substrates from Example 1 that have been previously coated with aminosilicone and perfume. A measured average of approximately 0.154 +/- 0.003 grams of microspheres is coated across multiple coated substrates.

**Example 8:** Porous dissolvable solid substrate shampoo with a surface coating of aminosilicone, a surface coating of primary fragrance 1a, and a surface coated powder blend comprising 15% of a calcium silicate complex of a secondary perfume

**accord 2c and 85% of microspheres comprising a cationic surfactant conditioner and a secondary perfume accord 2c**

The preparation of a calcium silicate complex of a secondary fragrance 2c is prepared with the use of a Flacktek Speemixer™ DAC400FV (By HAUSCHILD, Waterkamp 1, 509075 Hamm, Germany) and a four place weigh balance. 5 grams of calcium silicate (Hubersorb 600 supplied by Huber Engineered Materials, Havre de Grace, MD and reported by the supplier to have an oil absorption of 475 cc/100g, an average particle size of 6 microns, a BET surface area of 300 m<sup>2</sup>/g and a bulk density of 8 lbs/CFT) is weighed into a Flacktek Speedmixer 60 max jar. 5 grams of the secondary fragrance oil 2c is then weighed into the same 60 max jar with the use of a pipette. The jar is then sealed shut with the corresponding lid and speedmixed for approximately 60 seconds at 2750 rpm. The high impact perfume accord 2c is accordingly complexed at approximately 50% by weight of the complex and with the resulting complex in the form of a free flowing fine powder.

The calcium silicate complex of secondary perfume accord 2c and matrix the microspheres comprising maltodextrin, a secondary perfume accord 2c and cationic surfactant conditioner from Example 6 are blended together with the use of the Flacktek Speemixer™ DAC400FV at a weight ratio of 15 to 85 of the former in relation to the latter. Approximately 2 grams of the combined powders are weighed into a Flacktek Speedmixer 60 max jar. The jar is then sealed shut with the corresponding lid and speedmixed for approximately 35 seconds at 2750 rpm. The weight percentage of the perfume accord 2c in the resulting blended powder is approximately 33% by weight of the combined powders and with the resulting powder blend being in the form of a free flowing fine powder.

Porous dissolvable solid substrates with surface resident coatings are prepared according to the identical formulation and procedures as described in Example 7, but with the replacement of the surface coated microspheres comprising a cationic surfactant conditioner and a secondary perfume accord 2c with a surface coating of the above powder blend comprising 15% of a calcium silicate complex of a secondary perfume accord 2c and 85% of microspheres comprising a cationic surfactant conditioner and a secondary perfume accord 2c. Measured averages of approximately 0.066 +/- 0.003 grams of primary fragrance 1a and 0.125 +/- 0.023 grams of the powder blend are coated onto the substrates.



**Example 9: Porous dissolvable solid substrates shampoos with a surface coating of aminosilicone, a surface coating of primary fragrance 1a, and a surface coated powder blend comprising 35% of a calcium silicate complex of a secondary perfume accord 2c and 65% of microspheres comprising a cationic surfactant conditioner and a secondary perfume accord 2c**

Porous dissolvable solid substrate shampoos with surface resident coatings are prepared according to the identical formulation and procedures as described in Example 8, but with the replacement of the surface coated powder blend comprising 15% of a calcium silicate complex of a secondary perfume accord 2c and 85% of microspheres comprising a cationic surfactant conditioner and a secondary perfume accord 2c with a surface coating of a powder blend comprising 35% of a calcium silicate complex of a secondary perfume accord 2c and 65% of microspheres comprising a cationic surfactant conditioner and a secondary perfume accord 2c. Measured averages of approximately 0.067 +/- 0.001 grams of primary fragrance 1a and 0.128 +/- 0.009 grams of the powder blend are coated onto the substrates.

**Example 10: Porous dissolvable solid substrate shampoos with a surface coating of aminosilicone, a surface coating of primary fragrance 1a, and a surface coated powder blend comprising 50% of a calcium silicate complex of a secondary perfume accord 2c and 50% of microspheres comprising a cationic surfactant conditioner and a secondary perfume accord 2c**

Porous dissolvable solid substrate shampoos with surface resident coatings are prepared according to the identical formulation and procedures as described in Example 8, but with the replacement of the surface coated powder blend comprising 15% of a calcium silicate complex of a secondary perfume accord 2c and 85% of microspheres comprising a cationic surfactant conditioner and a secondary perfume accord 2c with a surface coating of a powder blend comprising 50% of a calcium silicate complex of a secondary perfume accord 2c and 50% of microspheres comprising a cationic surfactant conditioner and a secondary perfume accord 2c. Measured averages of approximately 0.064 +/- 0.001 grams of primary fragrance 1a and 0.119 +/- 0.008 grams of the powder blend are coated onto the substrates.

**Example 11: Porous dissolvable solid substrate shampoos with a surface coating of aminosilicone, a surface coating of primary fragrance 1a, and surface coated microspheres comprising a cationic surfactant conditioner and a secondary perfume accord 2b**

Porous dissolvable solid substrate shampoos with surface resident coatings are prepared according to the identical formulation and procedures as described in Example 7, but with the replacement of the surface coated microspheres comprising a cationic surfactant conditioner and a secondary perfume accord 2c from Example 6 with a surface coating of microspheres comprising a cationic surfactant conditioner and a secondary perfume accord 2b from Example 5. Measured averages of approximately 0.065 +/- 0.001 grams of primary fragrance 1a and 0.11 +/- 0.01 grams of the microspheres are coated onto the substrates.

**Example 12: Porous dissolvable solid substrate shampoos with a surface coating of aminosilicone, a surface coating of primary fragrance 1b, and a surface coated powder blend comprising 50% of microspheres comprising a cationic surfactant conditioner and a secondary perfume accord 2a and 50% of microspheres comprising a cationic surfactant conditioner and a secondary perfume accord 2b.**

Porous dissolvable solid substrate shampoos with surface resident coatings are prepared according to the identical formulation and procedures as described in Example 8, but with the replacement of the surface coated powder blend comprising 15% of a calcium silicate complex of a secondary perfume accord 2c and 85% of microspheres comprising a cationic surfactant conditioner and a secondary perfume accord 2c with a surface coating of a powder blend comprising 50% of microspheres comprising a cationic surfactant conditioner and a secondary perfume accord 2a from Example 4 and 50% of microspheres comprising a cationic surfactant conditioner and a secondary perfume accord 2b from Example 5. Additionally, the primary fragrance 1a from Example 8 is replaced with approximately 1/2 the level of a primary fragrance 1b. Measured averages of approximately 0.032 +/- 0.003 grams of primary fragrance 1b and 0.114 +/- 0.031 grams of the powder blend are coated onto the substrates.

### Expert Perfume Sensory Panel Evaluations

The below table summarizes Expert Perfume Sensory Panel data comparing the dissolvable porous solid shampoos from examples 7, 8, 9, 10, 11 and 12 comprising differing combinations of surface resident coatings including the cationic surfactant conditioner microspheres of the present invention comprising differing secondary perfume accords and in combination with differing primary fragrances to the retail Herbal Essences Drama Clean liquid shampoo product control. The data was collected by the method as described herein.

#### Expert Perfume Sensory Panel Data

Table 7

##### INTENSITY SCALE 1-100 (No odor – most intense possible)

Products	Neat Product Odor	Bloom (In hand)	Lather (On switch)	Wet	4 Hr (damp)	24 hr	48 hr	48 hr (Re-wet/comb)
<b>Herbal Essences Drama Clean shampoo reference (0.8% Barcelona perfume)</b>	Peachy citrus	75/80	75/80	45/50	35	10	5	5
Example 7: Porous dissolvable solid substrate shampoo with a surface coating of aminosilicone, a surface coating of primary fragrance 1a, and surface coated microspheres comprising a cationic surfactant conditioner and a secondary perfume accord 2c	Green floral	75/80	75/80	65/70	65	25	5	25 Green floral
Example 8: Porous dissolvable solid substrate shampoo with a surface coating of aminosilicone, a surface coating of primary fragrance 1a, and a surface coated powder blend comprising 15% of a calcium silicate complex of a secondary perfume accord 2c and 85% of microspheres comprising a cationic surfactant conditioner and a secondary perfume accord 2c	Green floral cosmetic	75/80	75/80	60/65	60	20	5	20 Sl. green
Example 9: Porous dissolvable solid substrate shampoo with a surface coating of aminosilicone, a surface coating of primary fragrance 1a, and a surface coated powder blend comprising 35% of a calcium silicate complex of a secondary perfume accord 2c and 65% of microspheres comprising a cationic surfactant conditioner and a secondary perfume accord 2c	Green floral cosmetic	75/80	80	60/65	60	15/20	5	25 Green floral
Example 10: Porous dissolvable solid substrate shampoo with a surface coating of aminosilicone, a surface coating of primary fragrance 1a, and a surface coated powder blend comprising 50% of a calcium silicate	Green floral cosmetic	75/80	80	60	60	15/20	5	20

complex of a secondary perfume accord 2c and 50% of microspheres comprising a cationic surfactant conditioner and a secondary perfume accord 2c								
Example 11: Porous dissolvable solid substrate shampoo with a surface coating of aminosilicone, a surface coating of primary fragrance 1a, and surface coated microspheres comprising a cationic surfactant conditioner and a secondary perfume accord 2b	Cosmetic floral aldehydic	80	80 Greener	65	55	20	5	20
Example 12: Porous dissolvable solid substrate shampoo with a surface coating of aminosilicone, a surface coating of primary fragrance 1b, and a surface coated powder blend comprising 50% of microspheres comprising a cationic surfactant conditioner and a secondary perfume accord 2a and 50% of microspheres comprising a cationic surfactant conditioner and a secondary perfume accord 2b.	Green cosmetic floral fruity	80/85 Green cosmetic floral fruity	80 Green, cosmetic	65	60	20	15	15/20

The above data demonstrates that the dissolvable porous solid shampoos in accordance with the present invention to provide superior panel perceptible fragrance longevity on hair at the wet, 4 hour, 24 hour and 48 hour time points relative to the retail Herbal Essences Drama Clean liquid shampoo control product.

### Wet and Dry Combing Evaluations

The below table summarizes Wet and Dry Combing Panel data comparing the dissolvable porous solid shampoos from examples 7, 8, 9, 10, 11 and 12 comprising differing combinations of surface resident coatings including the cationic surfactant conditioner microspheres of the present invention to a one step retail Clarifying shampoo control application and a 2 step application of a retail Clarifying shampoo followed by separate retail hair conditioner as negative and positive controls, respectively. The data was collected by the method as described herein.

#### Wet & Dry Combing Data

Table 8

	Wet Combing	Dry Combing
Clarifying Shampoo Control	0%	0%
Clarifying Shampoo + Separate Conditioner Control	100%	100%
Example 7: Porous dissolvable solid substrate shampoo with a surface coating of aminosilicone, a surface coating of primary fragrance 1a, and surface coated microspheres comprising a cationic surfactant conditioner and a secondary perfume accord 2c	72%	81%

Example 8: Porous dissolvable solid substrate shampoo with a surface coating of aminosilicone, a surface coating of primary fragrance 1a, and a surface coated powder blend comprising 15% of a calcium silicate complex of a secondary perfume accord 2c and 85% of microspheres comprising a cationic surfactant conditioner and a secondary perfume accord 2c	75%	75%
Example 9: Porous dissolvable solid substrate shampoo with a surface coating of aminosilicone, a surface coating of primary fragrance 1a, and a surface coated powder blend comprising 35% of a calcium silicate complex of a secondary perfume accord 2c and 65% of microspheres comprising a cationic surfactant conditioner and a secondary perfume accord 2c	53%	52%
Example 10: Porous dissolvable solid substrate shampoo with a surface coating of aminosilicone, a surface coating of primary fragrance 1a, and a surface coated powder blend comprising 50% of a calcium silicate complex of a secondary perfume accord 2c and 50% of microspheres comprising a cationic surfactant conditioner and a secondary perfume accord 2c	44%	39%
Example 11: Porous dissolvable solid substrate shampoo with a surface coating of aminosilicone, a surface coating of primary fragrance 1a, and surface coated microspheres comprising a cationic surfactant conditioner and a secondary perfume accord 2b	67%	71%
Example 12: Porous dissolvable solid substrate shampoo with a surface coating of aminosilicone, a surface coating of primary fragrance 1b, and a surface coated powder blend comprising 50% of microspheres comprising a cationic surfactant conditioner and a secondary perfume accord 2a and 50% of microspheres comprising a cationic surfactant conditioner and a secondary perfume accord 2b.	51%	68%

The above data demonstrates that the dissolvable porous solid shampoos comprising surface resident coatings including the cationic surfactant conditioner microspheres to result in a significant improvement in both wet and dry conditioning relative to the single step retail Clarifying shampoo. The data also demonstrates that strong hair conditioning performance can be achieved with a single step shampoo application according to the present invention and the conditioning benefit can approach the performance of the 2 step retail shampoo plus separate retail conditioner control.

### Hair Switch Lather Evaluations

The below table summarizes Hair Switch Lather data comparing the dissolvable porous solid shampoos from examples 7, 8, 9, 10, 11 and 12 comprising differing combinations of surface resident coatings including the cationic surfactant conditioner microspheres of the present invention to a retail 2-in-1 conditioning shampoo (Pantene Pro-V Smooth and Sleek). The data was collected by the method as describe herein.

Hair Switch Lather Data

Table 9

	Switch Lather
Liquid 2-in-1 Conditioner Shampoo Control (Pantene Pro-V, Smooth & Sleek)	93 +/- 2 ml
Example 7: Porous dissolvable solid substrate shampoo with a surface coating of aminosilicone, a surface coating of primary fragrance 1a, and surface coated microspheres comprising a cationic surfactant conditioner and a secondary perfume accord 2c	94 +/- 7 ml
Example 8: Porous dissolvable solid substrate shampoo with a surface coating of aminosilicone, a surface coating of primary fragrance 1a, and a surface coated powder blend comprising 15% of a calcium silicate complex of a secondary perfume accord 2c and 85% of microspheres comprising a cationic surfactant conditioner and a secondary perfume accord 2c	99 +/- 7 ml
Example 9: Porous dissolvable solid substrate shampoo with a surface coating of aminosilicone, a surface coating of primary fragrance 1a, and a surface coated powder blend comprising 35% of a calcium silicate complex of a secondary perfume accord 2c and 65% of microspheres comprising a cationic surfactant conditioner and a secondary perfume accord 2c	105 +/- 4 ml
Example 10: Porous dissolvable solid substrate shampoo with a surface coating of aminosilicone, a surface coating of primary fragrance 1a, and a surface coated powder blend comprising 50% of a calcium silicate complex of a secondary perfume accord 2c and 50% of microspheres comprising a cationic surfactant conditioner and a secondary perfume accord 2c	99 +/- 4 ml
Example 11: Porous dissolvable solid substrate shampoo with a surface coating of aminosilicone, a surface coating of primary fragrance 1a, and surface coated microspheres comprising a cationic surfactant conditioner and a secondary perfume accord 2b	96 +/- 10 ml
Example 12: Porous dissolvable solid substrate shampoo with a surface coating of aminosilicone, a surface coating of primary fragrance 1b, and a surface coated powder blend comprising 50% of microspheres comprising a cationic surfactant conditioner and a	103 +/- 7 ml

secondary perfume accord 2a and 50% of microspheres comprising a cationic surfactant conditioner and a secondary perfume accord 2b.	
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The above data demonstrates single variably that the dissolvable porous shampoo solids comprising surface resident coatings of cationic surfactant conditioner microspheres of the present invention generate very good lather performance relative to a retail liquid conditioning shampoo product (Pantene Pro-V, Smooth & Sleek)

### Hand Dissolution Evaluations

The below table summarizes Hand Dissolution data on the dissolvable porous solid shampoos from examples 7, 8, 9, 10, 11 and 12 comprising differing combinations of surface resident coatings including the cationic surfactant conditioner microspheres of the present invention. The data was collected by the method as describe herein.

#### Hand Dissolution Data

Table 10

	Hand Dissolution
Liquid 2-in-1 Conditioner Shampoo Control (Pantene Pro-V, Smooth & Sleek)	10 to 12 strokes
Example 7: Porous dissolvable solid substrate shampoo with a surface coating of aminosilicone, a surface coating of primary fragrance 1a, and surface coated microspheres comprising a cationic surfactant conditioner and a secondary perfume accord 2c	10 to 12 strokes
Example 8: Porous dissolvable solid substrate shampoo with a surface coating of aminosilicone, a surface coating of primary fragrance 1a, and a surface coated powder blend comprising 15% of a calcium silicate complex of a secondary perfume accord 2c and 85% of microspheres comprising a cationic surfactant conditioner and a secondary perfume accord 2c	10 to 12 strokes
Example 9: Porous dissolvable solid substrate shampoo with a surface coating of aminosilicone, a surface coating of primary fragrance 1a, and a surface coated powder blend comprising 35% of a calcium silicate complex of a secondary perfume accord 2c and 65% of microspheres comprising a cationic surfactant conditioner and a secondary perfume accord 2c	10 strokes
Example 10: Porous dissolvable solid substrate shampoo with a surface coating of aminosilicone, a surface coating of primary fragrance 1a, and a surface coated powder blend comprising	10 strokes

50% of a calcium silicate complex of a secondary perfume accord 2c and 50% of microspheres comprising a cationic surfactant conditioner and a secondary perfume accord 2c	
Example 11: Porous dissolvable solid substrate shampoo with a surface coating of aminosilicone, a surface coating of primary fragrance 1a, and surface coated microspheres comprising a cationic surfactant conditioner and a secondary perfume accord 2b	8 to 10 strokes
Example 12: Porous dissolvable solid substrate shampoo with a surface coating of aminosilicone, a surface coating of primary fragrance 1b, and a surface coated powder blend comprising 50% of microspheres comprising a cationic surfactant conditioner and a secondary perfume accord 2a and 50% of microspheres comprising a cationic surfactant conditioner and a secondary perfume accord 2b.	8 to 12 strokes

The above data demonstrates that the porous dissolvable solid substrate shampoos comprising surface resident coatings of cationic surfactant conditioner microspheres of the present invention to dissolve rapidly within the hand, i.e., completely dissolved within 8 to 12 hand strokes (i.e., less than about 30 seconds).

Note that any actives and/or compositions disclosed herein can be used in and/or with the articles, and in particular the household care articles, disclosed in the following U.S. Patent Applications, including any publications claiming priority thereto: US 61/229981; US 61/229986; US 61/229990; US 61/229996; US 61/230000; and US 61/230004. Such articles may comprise one or more of the following: detergent surfactant; plasticizer; enzyme; suds suppressor; suds booster; bleach; bleach stabilizer; chelant; cleaning solvent; hydrotrope; divalent ion; fabric softener additive (e.g. quaternary ammonium compounds); nonionic surfactant; perfume; and/or a perfume delivery system. Such articles may be utilized in methods including, but not limited to: dosing into a washing machine to clean and/or treat fabric; dosing into a dishwasher to clean and/or treat cutlery; and dosing into water to clean and/or treat fabric and/or hard surfaces.

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



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

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

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

## CLAIMS

What is claimed is:

1. A personal care article comprising:
  - a.) a porous dissolvable solid substrate comprising:
    - i. From about 10% to about 75% of a surfactant;
    - ii. from about 10% to about 50% water-soluble polymer;
    - iii. from about 1% to about 30% plasticizer; and
  - b.) a surface resident coating comprising from about 10% to about 100% of matrix microspheres wherein the matrix microspheres comprise from about 25% to about 70% of a starch derived material, from about 5% to about 60% of a cationic surfactant conditioner, and from about 5% to about 60% of a perfume; and wherein the ratio of the porous dissolvable solid substrate to the surface resident coating is from 110:1 to about 0.5:1.
2. The personal care article of Claim 1, wherein the matrix microspheres comprise from about 30% to about 60% starch derived material, preferably from about 35% to about 50% starch derived material.
3. The personal care article of Claim 1, wherein the matrix microspheres comprise from about 15% to about 50% cationic surfactant conditioner, preferably from about 20% to about 40% cationic surfactant conditioner.
4. The personal care article of Claim 1, wherein the matrix microspheres comprise from about 15% to about 50% perfume, preferably from about 20% to about 40% perfume.
5. The personal care article of Claim 1, wherein the surfactant comprises at least one Group I surfactant, and wherein the Group I surfactant is an anionic surfactant selected from the group consisting of alkyl and alkyl ether sulfates, sulfated monoglycerides, sulfonated olefins, alkyl aryl sulfonates, primary or secondary alkane sulfonates, alkyl sulfosuccinates, acid taurates, acid isethionates, alkyl glycerylether sulfonate, sulfonated

methyl esters, sulfonated fatty acids, alkyl phosphates, acyl glutamates, acyl sarcosinates, alkyl lactylates, anionic fluorosurfactants, sodium lauroyl glutamate, and combinations thereof.

6. The personal care article of Claim 2, wherein the surfactant further comprises a Group II surfactant, wherein the Group II surfactant is selected from the group consisting of amphoteric, zwitterionic, and combinations thereof.

7. The personal care article of Claim 1, wherein the surfactant is selected from the group consisting of (i) 0% to about 10% of an anionic surfactant, (ii) a non-ionic surfactant, (iii) a polymeric surfactant and (iv) any combination thereof.

8. The personal care article of Claim 1, wherein the ratio of the porous dissolvable solid substrate to the surface resident coating is from about 20:1 to about 1:1, preferably wherein the ratio is from about 10:1 to about 1.5:1, further preferably wherein the ratio is about 7:1 to about 3:1.

9. The personal care article of Claim 1, wherein the surface resident coating is a powder.

10. The personal care article of Claim 1, wherein the surface resident coating is in the form of a layer, a coating, and combinations thereof, and wherein surface resident coating is attached to at least a portion of the solid/air interface of the porous dissolvable solid substrate.

11. The personal care article of Claim 1, wherein the dissolvable personal care article comprises two porous dissolvable solid substrates, and wherein the surface resident coating is a layer situated between the two porous dissolvable solid substrates.

12. The personal care article of Claim 1, the porous dissolvable solid substrate having a basis weight of from about 125 grams/m<sup>2</sup> to about 3,000 grams/m<sup>2</sup> and a thickness of from about 0.5 mm to about 10 mm.

13. The personal care article of Claim 1, wherein the porous dissolvable solid substrate comprises a specific surface area from about 0.03 m<sup>2</sup>/gram to about 0.25 m<sup>2</sup>/gram.

14. The personal care article of Claim 1, wherein the porous dissolvable solid substrate comprises a Percent open cell content from about 80% to about 100.0%.

15. The personal care article of Claim 1, wherein the porous dissolvable solid substrate comprises a cell wall thickness of from about 0.02 mm to about 0.15 mm.

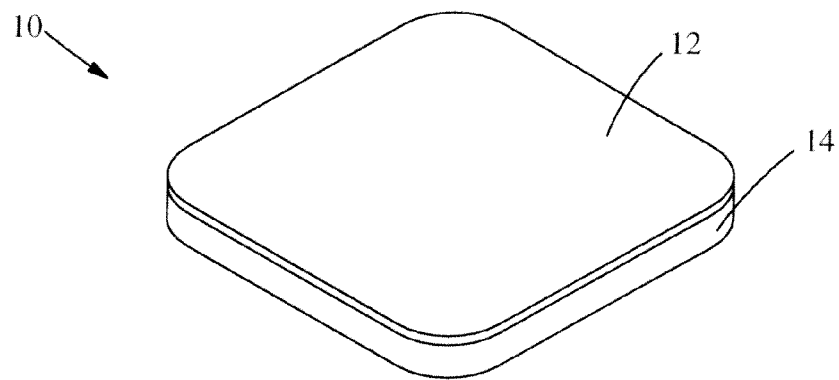


Fig. 1

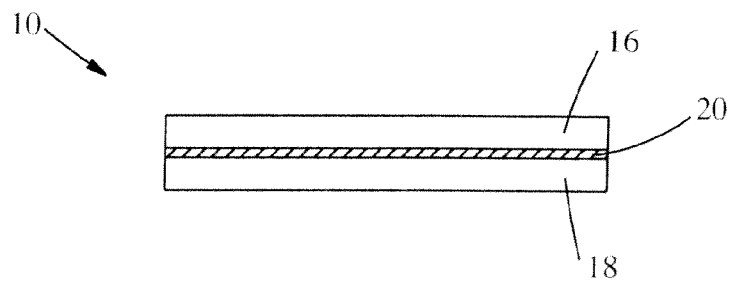


Fig. 2

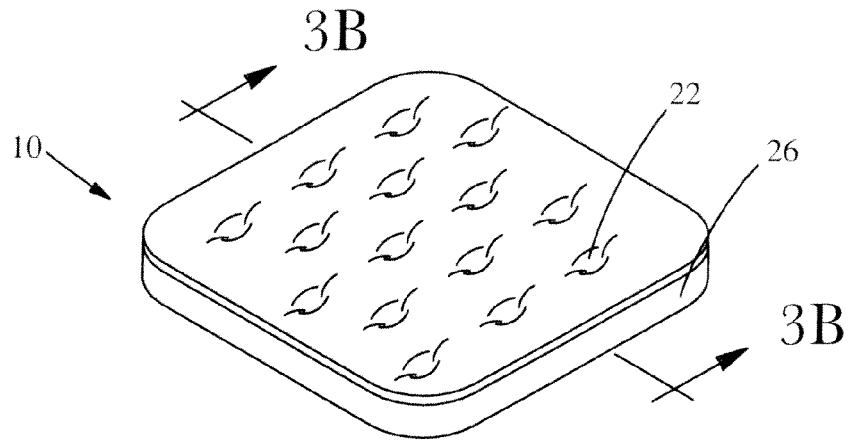


Fig. 3A

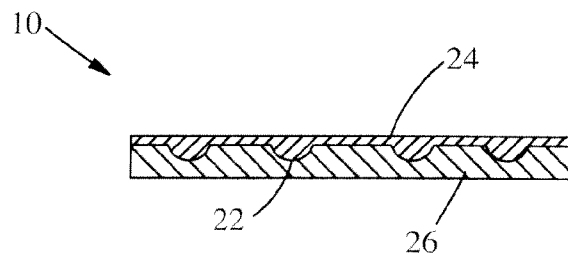


Fig. 3B

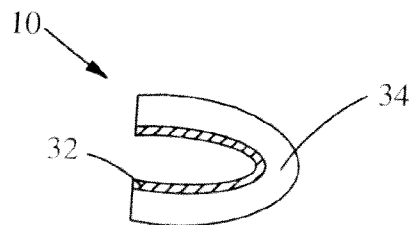
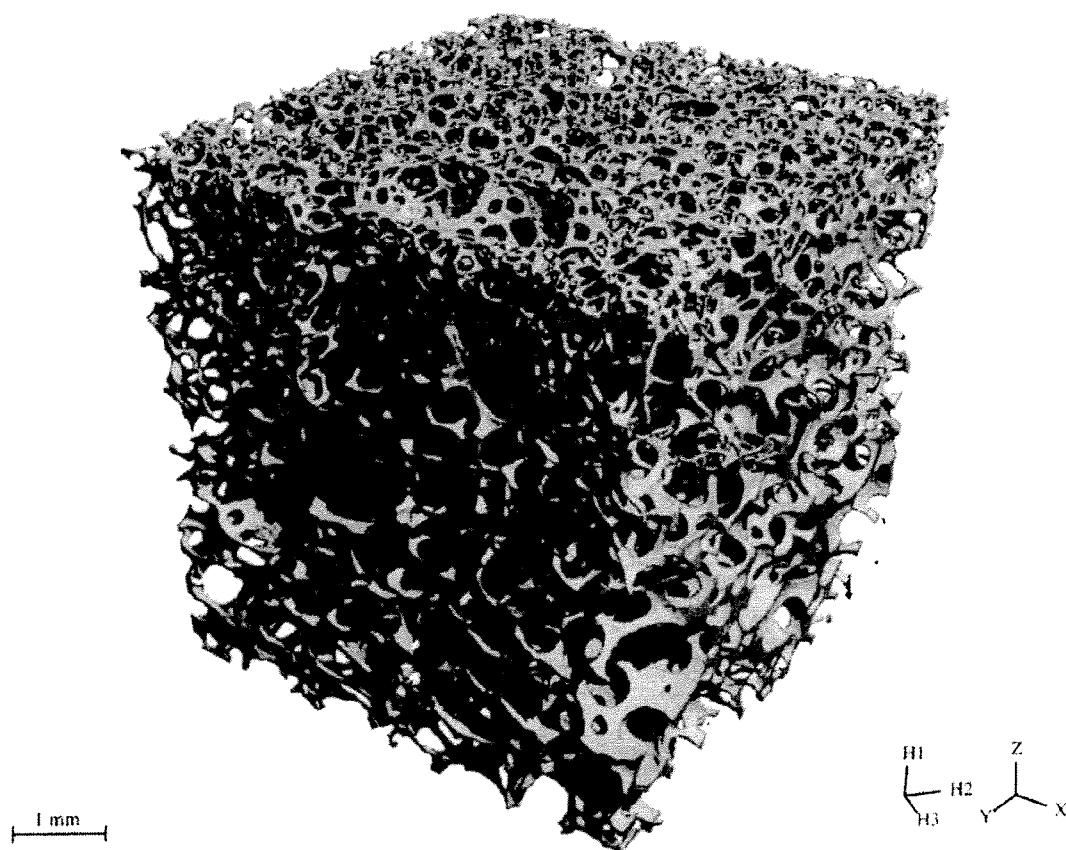
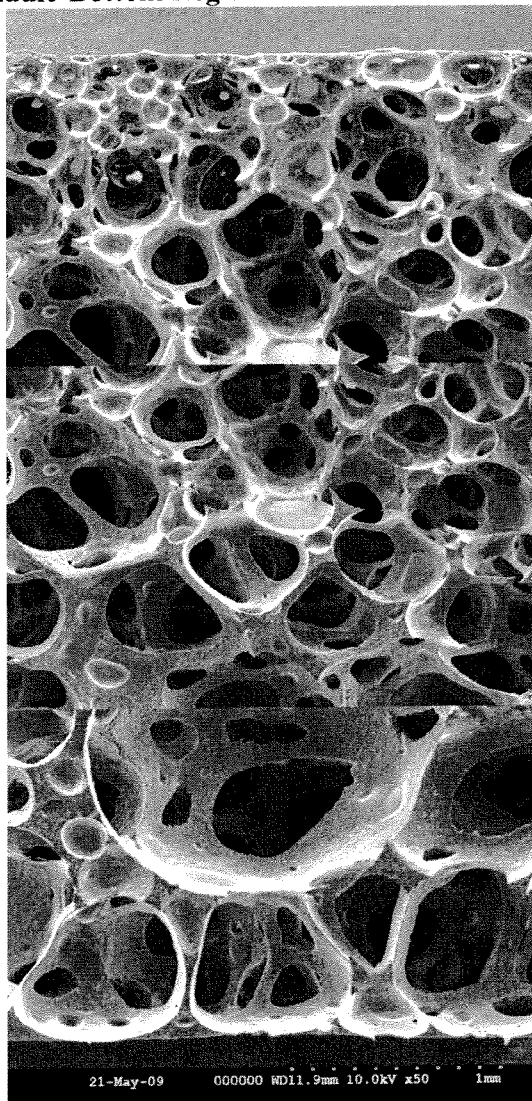


Fig. 4

**Figure 5**  
**Micro-CT 3-D Image**  
**of Dissolvable Porous Shampoo Solid**



**Figure 6**  
**Super-imposed Cross-Sectional SEM Images**  
**of Top-Middle-Bottom Regions of Dissolvable Porous Shampoo Solid**





## INTERNATIONAL SEARCH REPORT

International application No  
PCT/US2010/059455

A. CLASSIFICATION OF SUBJECT MATTER		
INV.	A61K8/02	A61K8/04
	A61K8/81	A61K8/49
	A61Q13/00	
	A61K8/34	A61K8/41
	A61Q5/02	A61Q5/12
		A61K8/46
		A61K8/73
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols)		
A61K A61Q		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practical, search terms used)		
EPO-Internal, WPI Data		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 03/037294 A2 (PROCTER & GAMBLE [US]) 8 May 2003 (2003-05-08) the whole document	1-15
A	US 6 106 849 A (MALKAN NISHA [US] ET AL) 22 August 2000 (2000-08-22) the whole document	1-15
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A	WO 2004/032859 A2 (DIAL CORP [US]) 22 April 2004 (2004-04-22) the whole document	1-15
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<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex.		
* Special categories of cited documents : "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art. "&" document member of the same patent family		
Date of the actual completion of the international search		Date of mailing of the international search report
11 April 2011		27/04/2011
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016		Authorized officer  Donovan-Beermann, T

## INTERNATIONAL SEARCH REPORT

International application No  
PCT/US2010/059455

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
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A	US 2003/232183 A1 (DUFTON DANIEL JAMES [GB]) 18 December 2003 (2003-12-18) the whole document -----	1-15
A	WO 2004/041991 A1 (SALVONA LLC [US]) 21 May 2004 (2004-05-21) the whole document -----	1-15
A	WO 03/088933 A1 (SALVONA L L C [US]) 30 October 2003 (2003-10-30) the whole document -----	1-15

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Information on patent family members

International application No

PCT/US2010/059455

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