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(54) Title: SURFACE-TREATED CALCIUM CARBONATE WITH IMPROVED STABILITY IN ENVIRONMENTS WITH A PH OF 4.5 TO 7

(57) Abstract: The present invention relates to a process for producing a surface-treated calcium carbonate with improved stability in environments with a pH of 4.5 to 7, wherein calcium carbonate, at least one acid having a pK_a value from 0 to 8, when measured at 20°C, and at least one conjugate base are brought into contact to form surface-treated calcium carbonate.

**Surface-treated calcium carbonate with improved stability in environments
with a pH of 4.5 to 7**

The present invention relates to a surface-treated calcium carbonate, dry or in a
5 suspension, with improved stability in environments with a pH of 4.5 to 7, a process
for producing the same, and its use, as well as products containing a calcium
carbonate with improved stability in environments with a pH of 4.5 to 7.

Abrasive cleaners are well-known in the art and are widely used for cleaning all
10 kinds of surfaces, especially surfaces which become soiled with difficult to remove
stains. For example, abrasive cleaners may be used for cleaning household surfaces
such as tables, sinks or dish surfaces. Abrasive materials can also be used in personal
care products such as toothpastes, as exfoliants in facial and body scrubs, or soaps.
Besides natural ingredients such as crushed apricot kernel, almond shells, sugar or
15 salt crystals, or pumice, polymer beads such as polyethylene microspheres are widely
used in personal care products as abrasive materials.

The use of polyethylene microspheres, also called microbeads, however, in cosmetic
compositions for abrasives and exfoliation has become a substantial environmental
20 concern due to the water pollution by microplastics such as microbeads. Microbeads
from cosmetics and personal care products can be washed down the drain after use,
entering the sewerage system before making their way into rivers and canals. From
there, they can easily end up in seas and oceans.

25 As a consequence, microbeads have already been banned in some states of the
United States and in the Netherlands. Illinois became the first U.S. state to enact
legislation banning the manufacture and sale of products containing microbeads: the
two-part ban goes into effect in 2018 and 2019. The New York State Assembly voted
in May 2014 to ban microbeads, and additional legislation is under consideration in
30 Ohio and California. The Netherlands is the first country in the world to announce its
intent to be virtually free of microbeads in cosmetics by the end of 2016. As a result,
cosmetic companies have pledged to phase out the use of microbeads over the next
years and search intensively for environmentally friendly substitutes.

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A liquid cleaning composition comprising calcium carbonate as abrasive material is, for example, described in WO 2013/078949. A dry blasting process for the cleaning of solid surfaces involving the use of natural alkaline earth carbonate particles is disclosed in WO 2009/133173. WO 03/061908, EP 1 666 203, and EP 1 738 872 also disclose a process for dry cleaning of solid surfaces involving the use of a precipitate or agglomerate of an insoluble alkali metal carbonate. US 5,827,114, US 5,531,634, and WO 94/07658 disclose the use of calcium carbonate for blast cleaning. A microdermabrasion procedure is described in US 2001/0023351. The rounded particles used in this procedure can be glass beads.

However, conventional calcium carbonate decomposes in acidic aqueous media, and thus, generally cannot be used in compositions having a pH of less than 7, which is often the case for cleaning compositions or personal care products. Cosmetic abrasive cleaning compositions such as body scrubs, for example, typically have a pH value of about 5 to 7 in order to preserve the protective layer of the skin.

In view of the foregoing, there is a continuous need for environmentally friendly abrasive materials.

The use of acid stabilized calcium carbonates or suspensions thereof is known in the paper making industry for the production of neutral to acidic acid. Such uses are, for example, described in US 6,228,161, and US 7,033,428 (both of Drummond), US 5,043,017, US 5,156,719 (both of Passaretti), WO 97/08247, WO 97/08248, and WO 97/14651 (all of ECC), as well as in US 6,540,878 (Leino).

The reaction of ground calcium carbonate or precipitated calcium carbonate in the presence of at least one acid and carbon dioxide is described in WO 00/39222, WO 2004/083316, WO 2005/121257, WO 2009/074492, EP 2 264 108, EP 2 264 109, US 2004/0020410, and EP 2 070 991. All products obtained by the

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reactions described in these documents are porous products showing a high BET surface area in the range of 20 to 120 or to even 200 m²/g.

Accordingly it is an object of the present invention to provide an abrasive material,
5 which avoids at least some of the foregoing disadvantages. In particular, it is desirable to provide an abrasive agent which is stable in environments with a pH of 4.5 to 7, and, therefore, can also be used in abrasive compositions that are stable under these conditions. Furthermore, it is desirable to provide an abrasive material which has gentle abrasive properties, and, therefore, can also be used for cleaning
10 delicate surfaces and in personal care products.

Furthermore, it is an object of the present invention to provide an abrasive material which is derivable from natural sources. It is also desirable to provide an abrasive agent which is easily biodegradable.

15

The foregoing and other objects are solved by the subject-matter as defined herein in the independent claims.

According to one aspect of the present invention, a process for producing a surface-treated calcium carbonate with improved stability in environments with a pH of 4.5
20 to 7 is provided, wherein the process comprises the steps of:

- i) providing calcium carbonate,
- ii) providing at least one acid having a pK_a value from 0 to 8, when measured at 20°C,
- 25 iii) providing at least one conjugate base,
- iv) contacting the calcium carbonate of step i), the at least one acid of step ii), and the at least one conjugate base of step iii) to form surface-treated calcium carbonate,

wherein the at least one acid of step ii) and/or the at least one conjugate base of
30 step iii) are provided in form of an aqueous solution.

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According to a further aspect, a suspension of a surface-treated calcium carbonate with improved stability in environments with a pH of 4.5 to 7, and obtainable by a process according to the present invention is provided.

5

According to yet a further aspect, a dried surface-treated calcium carbonate with improved stability in environments with a pH of 4.5 to 7, and obtainable by a process according to the present invention is provided.

10 According to still a further aspect an abrasive cleaning composition comprising a suspension of a surface-treated calcium carbonate or a dried surface-treated calcium carbonate according to the present invention is provided.

15 According to still a further aspect, use of a suspension of a surface-treated calcium carbonate according to the present invention as abrasive material is provided, preferably as abrasive material for cleaning application.

20 According to yet a further aspect, use of a dried surface-treated calcium carbonate according to the present invention as abrasive material is provided, preferably as abrasive material for cosmetic application and/or cleaning application, more preferably as abrasive material for cosmetic application, and most preferably as abrasive material for topical skin application.

25 According to still a further aspect, use of an abrasive cleaning composition according to the present invention for cleaning a surface is provided, preferably for cleaning an animate surface, and more preferably for cleaning an animate surface selected from the group consisting of human skin, animal skin, human hair, animal hair, and tissues of the oral cavity such as teeth, gums, tongue or buccal surfaces.

Advantageous embodiments of the present invention are defined in the corresponding sub-claims.

5 According to one embodiment step iv) comprises the steps of: (a1) contacting the calcium carbonate of step i) and the at least one acid of step ii) to form a pre-treated calcium carbonate, and (a2) contacting the pre-treated calcium carbonate of step a1) with the at least one conjugate base of step iii) to form surface-treated calcium carbonate, wherein at least the at least one acid of step ii) is provided in form of an aqueous solution.

10

According to another embodiment step iv) comprises the steps of: (b1) contacting the calcium carbonate of step i) and the at least one conjugate base of step iii) to form a pre-treated calcium carbonate, and (b2) contacting the pre-treated calcium carbonate of step b1) with the at least one acid of step ii) to form surface-treated calcium carbonate, wherein at least the at least one conjugate base of step iii) is provided in form of an aqueous solution.

15

20 According to one embodiment the at least one acid of step ii) and the at least one conjugate base of step iii) are provided together in form of an aqueous buffer solution, and in step iv) the calcium carbonate of step i) is contacted with the aqueous buffer solution to form surface-treated calcium carbonate. According to another embodiment step iv) comprises the steps of: (c1) mixing the calcium carbonate of step i), the aqueous buffer solution, and optionally water, to form an aqueous suspension of surface-treated calcium carbonate, and (c2) separating the surface-treated calcium carbonate from the aqueous suspension obtained from step c1).

25

30 According to one embodiment the calcium carbonate of step i) is natural ground calcium carbonate, precipitated calcium carbonate, dolomite, agglomerates or aggregates thereof, or a mixture of the aforementioned materials, and preferably

natural ground calcium carbonate. According to another embodiment the calcium carbonate of step i) is in form of particles having a volume determined median particle size d_{50} from 1 to 1500 μm , preferably from 25 to 1 400 μm , more preferably from 100 to 1 200 μm , even more preferably from 200 to 1 000 μm , and most preferably from 300 to 800 μm .

According to one embodiment the at least one acid of step ii) is selected from the group consisting of phosphoric acid, citric acid, sulphurous acid, boric acid, acetic acid, tartaric acid, formic acid, propanoic acid, oxalic acid, phosphonic acid, acidic salt, and mixtures thereof. According to a preferred embodiment the at least one acid of step ii) is selected from the group consisting of phosphoric acid, citric acid, tartaric acid, oxalic acid, their acidic salts, and mixtures thereof. According to the most preferred embodiment the at least one acid of step ii) is selected from the group consisting of phosphoric acid, citric acid, their acidic salts, and mixtures thereof.

According to another embodiment the at least one conjugate base of step iii) is an alkali metal salt and/or alkaline earth metal salt of an acid having a pK_a value from 0 to 8, when measured at 20°C, preferably the at least one conjugate base of step iii) is an alkali metal salt and/or alkaline earth metal salt of an acid selected from the group consisting of phosphoric acid, citric acid, sulphurous acid, boric acid, acetic acid, tartaric acid, formic acid, propanoic acid, oxalic acid, phosphonic acid, and mixtures thereof, more preferably the at least one conjugate base of step iii) is a sodium and/or potassium salt of an acid selected from the group consisting of phosphoric acid, citric acid, sulphurous acid, boric acid, acetic acid, tartaric acid, formic acid, propanoic acid, oxalic acid, phosphonic acid, and mixtures thereof, and most preferably the at least one conjugate base of step iii) is a sodium and/or potassium salt of an acid selected from the group consisting of phosphoric acid, citric acid, and mixtures thereof. The alkali metal of the above alkali metal salt can be selected from the group consisting of Li^+ , Na^+ , K^+ , and is preferably selected from the group consisting of Na^+ and K^+ . The metal of the above alkaline earth metal salt is Mg^{2+} .

According to one embodiment the aqueous buffer solution has a pH value from 4.0 to 7.5, preferably from 4.5 to 6.0, and most preferably of 4.8 to 5.5. According to another embodiment the aqueous buffer solution has a concentration from 0.01
5 mol/kg to 2 mol/kg, preferably from 0.04 to 1.0 mol/kg, more preferably from 0.06 to 0.5 mol/kg, even more preferably from 0.07 to 0.4 mol/kg, and most preferably from 0.08 to 0.2 mol/kg.

It should be understood that for the purpose of the present invention, the following
10 terms have the following meaning.

The term “abrasive material” in the meaning of the present invention refers to a particulate substance that is capable of polishing or cleaning surfaces by rubbing or exfoliating.
15

For the purpose of the present invention, an “acid” is defined as Brønsted-Lowry acid, that is to say, it is an H_3O^+ ion provider. According to the present invention, the acid can also be an acid salt, generating H_3O^+ ions under the preparation conditions. An “acid salt” is defined as an H_3O^+ ion-provider that is partially neutralized by an
20 electropositive element. A “salt” is defined as an electrically neutral ionic compound formed from anions and cations. A “partially crystalline salt” is defined as a salt that, on XRD analysis, presents an essentially discrete diffraction pattern.

In accordance with the present invention, pK_a , is the symbol representing the acid
25 dissociation constant associated with a given ionisable hydrogen in a given acid, and is indicative of the natural degree of dissociation of this hydrogen from this acid at equilibrium in water at a given temperature. Such pK_a values may be found in reference textbooks such as Harris, D. C. “Quantitative Chemical Analysis: 3rd Edition”, 1991, W.H. Freeman & Co. (USA), ISBN 0-7167-2170-8, or CRC

Handbook of Chemistry and Physics, 1994-1995 75th edition, 8-43 to 8-55, CRC Press Inc., 1995.

5 The term “conjugate base” refers to a substance that is formed by removal of a proton from an acid. By gaining a proton the conjugate base is reformed into the acid.

10 “Natural ground calcium carbonate” (GCC) in the meaning of the present invention is a calcium carbonate obtained from natural sources, such as limestone, marble, or chalk, and processed through a wet and/or dry treatment such as grinding, screening and/or fractionation, for example, by a cyclone or classifier.

15 “Precipitated calcium carbonate” (PCC) in the meaning of the present invention is a synthesized material, generally obtained by precipitation following a reaction of carbon dioxide and calcium hydroxide (hydrated lime) in an aqueous environment or by precipitation of a calcium- and a carbonate source in water. Additionally, precipitated calcium carbonate can also be the product of introducing calcium and carbonate salts, calcium chloride and sodium carbonate for example, in an aqueous environment. PCC may have a vateritic, calcitic or aragonitic crystalline form. PCCs
20 are described, for example, in EP 2 447 213 A1, EP 2 524 898 A1, EP 2 371 766 A1, or WO 2013/142473 A1.

For the purpose of the present invention, the terms “agglomerate” and “aggregate” shall have the definition as set out in ISO 14887:2000(E). There, an “agglomerate” is
25 defined as an assemblage of particles which are loosely coherent, and an “aggregate” is defined as an assemblage of particles rigidly joined together.

Throughout the present document, the “particle size” of a filler material or other particulate material is described by its distribution of particle sizes. The value d_x
30 represents the diameter relative to which x % by volume of the particles have

diameters less than d_x . The d_{50} value is thus the volume determined median particle size, i.e. 50 % of the total volume of all particles results from particles bigger and 50 % of the total volume of all particles results from particles smaller than this particle size. For the purpose of the present invention the particle size is specified as

5 volume determined median particle size d_{50} unless indicated otherwise. For determining the volume determined median particle size d_{50} a Mastersizer 2000 or Mastersizer 3000 from the company Malvern Instruments Ltd., Great Britain, using the Fraunhofer light scattering model, may be used. The weight determined particle size distribution may correspond to the volume determined particle size if the density

10 of all the particles is equal. The method and the instrument are known to the skilled person and are commonly used to determine grain size of fillers and pigments. The samples are dispersed using a high speed stirrer and supersonics.

For the purpose of the present invention, the “solids content” of a liquid composition

15 is a measure of the amount of material remaining after all the solvent or water has been evaporated.

A “specific surface area (SSA)” of a calcium carbonate in the meaning of the present invention is defined as the surface area of the mineral pigment divided by the mass of

20 the calcium carbonate. As used herein, the specific surface area is measured by nitrogen gas adsorption using the BET isotherm (ISO 9277:2010) and is specified in m^2/g .

The term “surface-treated calcium carbonate” in the meaning of the present invention

25 refers to a calcium carbonate which has been contacted with at least one acid and at least one conjugate base as defined in claim 1, such as to obtain a surface-treatment on at least a part of the surface of the calcium carbonate.

In the meaning of the present invention, the term “surfactant” refers to a compound

30 that lowers the surface tension or interfacial tension between two liquids or between

a liquid and a solid, and may act as detergent, wetting agent, emulsifier, foaming agent, or dispersant.

For the purpose of the present invention, the term “viscosity” or “Brookfield
5 viscosity” refers to Brookfield viscosity. The Brookfield viscosity is for this purpose measured by a Brookfield DV-II+ Pro viscometer at $25^{\circ}\text{C} \pm 1^{\circ}\text{C}$ at 100 rpm using an appropriate spindle of the Brookfield RV-spindle set and is specified in mPa·s. Based on his technical knowledge, the skilled person will select a spindle from the Brookfield RV-spindle set which is suitable for the viscosity range to be measured.
10 For example, for a viscosity range between 200 and 800 mPa·s the spindle number 3 may be used, for a viscosity range between 400 and 1 600 mPa·s the spindle number 4 may be used, for a viscosity range between 800 and 3 200 mPa·s the spindle number 5 may be used, for a viscosity range between 1 000 and 2 000 000 mPa·s the spindle number 6 may be used, and for a viscosity range between 4 000 and
15 8 000 000 mPa·s the spindle number 7 may be used.

A “suspension” or “slurry” in the meaning of the present invention comprises insoluble solids and a solvent or liquid, preferably water, and optionally further additives, and usually contains large amounts of solids and, thus, is more viscous and
20 can be of higher density than the liquid from which it is formed.

Where the term “comprising” is used in the present description and claims, it does not exclude other non-specified elements of major or minor functional importance. For the purposes of the present invention, the term “consisting of” is considered to be
25 a preferred embodiment of the term “comprising of”. If hereinafter a group is defined to comprise at least a certain number of embodiments, this is also to be understood to disclose a group, which preferably consists only of these embodiments.

Whenever the terms “including” or “having” are used, these terms are meant to be
30 equivalent to “comprising” as defined above.

Where an indefinite or definite article is used when referring to a singular noun, e.g. “a”, “an” or “the”, this includes a plural of that noun unless something else is specifically stated.

5

Terms like “obtainable” or “definable” and “obtained” or “defined” are used interchangeably. This e.g. means that, unless the context clearly dictates otherwise, the term “obtained” does not mean to indicate that e.g. an embodiment must be obtained by e.g. the sequence of steps following the term “obtained” even though
10 such a limited understanding is always included by the terms “obtained” or “defined” as a preferred embodiment.

The inventive process for producing a surface-treated calcium carbonate with improved stability in environments with a pH of 4.5 to 7 comprises the steps of: (i)
15 providing calcium carbonate, (ii) providing at least one acid having a pKa value from 0 to 8, when measured at 20°C, (iii) providing at least one conjugate base, (iv) contacting the calcium carbonate of step (i), the at least one acid of step (ii), and the at least one conjugate base of step (iii) to form surface-treated calcium carbonate. The at least one acid of step (ii) and/or the at least one conjugate base of step (iii) are
20 provided in form of an aqueous solution.

In the following details and preferred embodiments of the inventive process will be set out in more detail. It is to be understood that these technical details and embodiments also apply to the inventive surface-treated calcium carbonate obtained
25 from said process, the inventive use of said inventive surface-treated calcium carbonate and compositions comprising said inventive compacted material.

The calcium carbonate

In step i) of the process of the present invention, calcium carbonate is provided. According to one embodiment, the calcium carbonate of step i) is natural ground
5 calcium carbonate, precipitated calcium carbonate, dolomite, agglomerates or aggregates thereof, or a mixture of the aforementioned materials. Preferably, the calcium carbonate of step i) is natural ground calcium carbonate.

Natural ground calcium carbonate (GCC) is understood to be manufactured from a
10 naturally occurring form of calcium carbonate, mined from sedimentary rocks such as limestone or chalk, or from metamorphic marble rocks, eggshells or seashells. Calcium carbonate is known to exist as three types of crystal polymorphs: calcite, aragonite and vaterite. Calcite, the most common crystal polymorph, is considered to be the most stable crystal form of calcium carbonate. Less common is aragonite,
15 which has a discrete or clustered needle orthorhombic crystal structure. Vaterite is the rarest calcium carbonate polymorph and is generally unstable. Ground calcium carbonate is almost exclusively of the calcitic polymorph, which is said to be trigonal-rhombohedral and represents the most stable of the calcium carbonate polymorphs. The term "source" of the calcium carbonate in the meaning of the
20 present application refers to the naturally occurring mineral material from which the calcium carbonate is obtained. The source of the calcium carbonate may comprise further naturally occurring components such as magnesium carbonate, alumino silicate etc.

25 According to one embodiment of the present invention the source of natural ground calcium carbonate (GCC) is selected from marble, chalk, limestone, or mixtures thereof. Preferably, the source of natural ground calcium carbonate is marble. According to one embodiment of the present invention the GCC is obtained by dry grinding. According to another embodiment of the present invention the GCC is
30 obtained by wet grinding and subsequent drying.

“Dolomite” in the meaning of the present invention is a calcium carbonate containing mineral, namely a carbonic calcium-magnesium-mineral, having the chemical composition of $\text{CaMg}(\text{CO}_3)_2$ (“ $\text{CaCO}_3 \cdot \text{MgCO}_3$ ”). A dolomite mineral may contain
5 at least 30.0 wt.-% MgCO_3 , based on the total weight of dolomite, preferably more than 35.0 wt.-%, and more preferably more than 40.0 wt.-% MgCO_3 .

According to one embodiment of the present invention, the calcium carbonate comprises one type of natural ground calcium carbonate. According to another
10 embodiment of the present invention, the calcium carbonate comprises a mixture of two or more types of natural ground calcium carbonates selected from different sources.

“Precipitated calcium carbonate” (PCC) in the meaning of the present invention is a
15 synthesized material, generally obtained by precipitation following reaction of carbon dioxide and lime in an aqueous environment or by precipitation of a calcium and carbonate ion source in water or by precipitation by combining calcium and carbonate ions, for example CaCl_2 and Na_2CO_3 , out of solution. Further possible ways of producing PCC are the lime soda process, or the Solvay process in which
20 PCC is a by-product of ammonia production. Precipitated calcium carbonate exists in three primary crystalline forms: calcite, aragonite and vaterite, and there are many different polymorphs (crystal habits) for each of these crystalline forms. Calcite has a trigonal structure with typical crystal habits such as scalenohedral (S-PCC), rhombohedral (R-PCC), hexagonal prismatic, pinacoidal, colloidal (C-PCC), cubic,
25 and prismatic (P-PCC). Aragonite is an orthorhombic structure with typical crystal habits of twinned hexagonal prismatic crystals, as well as a diverse assortment of thin elongated prismatic, curved bladed, steep pyramidal, chisel shaped crystals, branching tree, and coral or worm-like form. Vaterite belongs to the hexagonal crystal system. The obtained PCC slurry can be mechanically dewatered and dried.

According to one embodiment of the present invention, the calcium carbonate comprises one type of precipitated calcium carbonate. According to another embodiment of the present invention, the calcium carbonate comprises a mixture of two or more precipitated calcium carbonates selected from different crystalline forms and different polymorphs of precipitated calcium carbonate. For example, the at least one precipitated calcium carbonate may comprise one PCC selected from S-PCC and one PCC selected from R-PCC. According to still another embodiment of the present invention, the calcium carbonate comprises agglomerates or aggregates of precipitated calcium carbonate having a volume determined median particle size d_{50} from 25 to 1 500 μm .

According to one embodiment of the present invention, the calcium carbonate is a natural ground calcium carbonate. According to another embodiment of the present invention, the calcium carbonate is a precipitated calcium carbonate. According to still another embodiment of the present invention, the calcium carbonate is a mixture of natural ground calcium carbonate and precipitated calcium carbonate. According to still another embodiment of the present invention, the calcium carbonate is dolomite, optionally in mixture with natural ground calcium carbonate and/or precipitated calcium carbonate.

According to one embodiment, the calcium carbonate of step i) is in form of particles having a volume determined median particle size d_{50} from 1 to 1 500 μm , preferably from 25 to 1 400 μm , more preferably from 100 to 1 200 μm , even more preferably from 200 to 1 000 μm , and most preferably from 300 to 800 μm .

According to one embodiment the calcium carbonate of step i) is selected from the group consisting of natural ground calcium carbonate, dolomite, aggregates or agglomerates of PCC, or mixtures of the aforementioned, and is in form of particles having a volume determined median particle size d_{50} from 25 to 1 500 μm , preferably from 25 to 1 400 μm , more preferably from 100 to 1 200 μm , even more preferably

from 150 to 1 100 μm , still more preferably from 200 to 1 000 μm , and most preferably from 300 to 800 μm .

According to one embodiment, the calcium carbonate of step i) is in form of particles
5 having a volume determined top cut particle size (d_{98}) from 40 to 2 000 μm , preferably from 200 to 1 800 μm , more preferably from 300 to 1 500 μm , even more preferably from 400 to 1 200 μm , and most preferably from 500 to 1 000 μm .

According to another embodiment, the calcium carbonate of step i) is in form of
10 particles having a specific BET surface area in the range of > 0 to 5 m^2/g , preferably in the range of > 0 to 2 m^2/g , and more preferably in the range of > 0 to 1.6 m^2/g .

The calcium carbonate may be used in any suitable liquid or dry form. For example,
the calcium carbonate may be in form of a powder and/or a suspension. The
15 suspension can be obtained by mixing particles of calcium carbonate with a solvent, preferably water. The calcium carbonate to be mixed with a solvent, and preferably water, may be provided in any form, for example, as suspension, slurry, dispersion, paste, powder, a moist filter cake or in pressed or granulated form.

20 The suspension can be undispersed or dispersed, i.e. the suspension includes a dispersant, and thus, forms an aqueous dispersion.

According to one embodiment of the present invention, the calcium carbonate is used
in form of an aqueous suspension, which does not contain a dispersant. According to
25 another embodiment of the present invention, calcium carbonate is used in form of an aqueous suspension, which contains a dispersant. A suitable dispersant may be selected from polyphosphates, and is in particular a triphosphosphate. Another suitable dispersant may be selected from the group comprising homopolymers or copolymers of polycarboxylic acid salts based on, for example, acrylic acid,
30 methacrylic acid, maleic acid, fumaric acid or itaconic acid and acrylamide or

mixtures thereof. Homopolymers or copolymers of acrylic acid are especially preferred. The weight average molecular weight M_w of such products is preferably in the range from 2 000 to 15 000 g/mol, with a weight average molecular weight M_w from 3 000 to 7 000 g/mol or 3 500 to 6 000 g/mol being especially preferred.

- 5 According to an exemplary embodiment, the dispersant is sodium polyacrylate having a weight average molecular weight M_w from 2 000 to 15 000 g/mol, preferably from 3 000 to 7 000 g/mol, and most preferably from 3 500 to 6 000 g/mol.
- 10 The solids content of the suspension of calcium carbonate can be adjusted by the methods known to the skilled person. To adjust the solids content of an aqueous suspension, for example, the aqueous suspension may be partially dewatered by a settling, filtration, centrifugation or thermal separation process. According to one embodiment of the present invention, the solids content of the aqueous suspension of
- 15 calcium carbonate is from 1 to 85 wt.-%, more preferably from 5 to 75 wt.-%, and most preferably from 10 to 65 wt.-%, based on the total weight of the aqueous suspension.
- 20 The at least one acid and the at least one conjugate base

In process step ii) at least one acid is provided having a pK_a value from 0 to 8, when measured at 20°C.

- 25 The at least one acid of step ii) can be any medium-strong acid, or weak acid, or mixtures thereof, generating H_3O^+ ions under the preparation conditions. According to the present invention, the at least one acid can also be an acidic salt, generating H_3O^+ ions under the preparation conditions.

The at least one acid of step ii) and the at least one conjugate base of step iii), when available in dry form, may include crystalline water.

According to one embodiment, the at least one acid of step ii) is a medium-strong acid having a pK_a value from 0 to 2.5, when measured at 20°C. If the pK_a at 20°C is from 0 to 2.5, the acid is preferably selected from sulphurous acid, phosphoric acid, oxalic acid, or mixtures thereof, more preferably from phosphoric acid, oxalic acid, or mixtures thereof, and most preferably from phosphoric acid. The at least one acid can also be an acidic salt, for example, $H_2PO_4^-$, being at least partially neutralised by a corresponding cation such as Li^+ , Na^+ or K^+ , or HPO_4^{2-} , being at least partially neutralised by a corresponding cation such as Li^+ , Na^+ , K^+ , Mg^{2+} or Ca^{2+} . The at least one acid can also be a mixture of one or more acids and one or more acidic salts.

According to still another embodiment, the at least one acid is a weak acid having a pK_a value of greater than 2.5 and less than or equal to 7, when measured at 20°C. According to the preferred embodiment, the weak acid has a pK_a value from 2.6 to 5 at 20°C, and more preferably the weak acid is selected from the group consisting of acetic acid, formic acid, propanoic acid, citric acid, boric acid, tartaric acid, phosphonic acid, and mixtures thereof, preferably from the group consisting of citric acid, tartaric acid, and mixtures thereof, and is most preferably citric acid.

According to one embodiment of the present invention, the at least one acid of step ii) is selected from the group consisting of phosphoric acid, citric acid, sulphurous acid, boric acid, acetic acid, tartaric acid, formic acid, propanoic acid, oxalic acid, phosphonic acid, acidic salt, and mixtures thereof, preferably selected from the group consisting of phosphoric acid, citric acid, tartaric acid, oxalic acid, their acidic salts, and mixtures thereof, and most preferably selected from the group consisting of phosphoric acid, citric acid, their acidic salts, and mixtures thereof.

Preferably the at least one acid of step ii) may be a phosphoric acid or acidic salt thereof, a citric acid or acidic salt thereof, or a mixture thereof. According to a preferred embodiment, the at least one acid is selected from the group consisting of phosphoric acid, citric acid, sodium dihydrogen phosphate, potassium dihydrogen phosphate, potassium dihydrogen citrate, sodium dihydrogen citrate, disodium hydrogen citrate, dipotassium hydrogen citrate and mixtures thereof.

It is preferred that when the used acid(s) is an organic acid, then it is preferably not an aliphatic monocarboxylic acid derived from an animal or vegetable fat, oil or wax, and having a chain of 4 to 28 carbons (usually branched and even-numbered), which may be saturated or unsaturated. It has to be noted that this is the IUPAC definition of fatty acids. In other words, if an organic acid is used in the process of the present invention, then it is preferably not a fatty acid. The aforementioned also applies to the conjugate base.

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The at least one acid of step ii) can be provided in liquid or dry form. For example, the at least one acid may be in form of a solid such as granules or a powder and/or a solution. According to one embodiment, the at least one acid of step ii) is provided in form of an aqueous solution. When the at least one acid is in form of a solid such as granules or a powder, the acid may include crystalline water.

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The at least one acid of step ii) can be provided as a concentrated solution or a more diluted solution. Preferably, the molar ratio of the at least one acid to the calcium carbonate is from 1:10 to 1:100, preferably from 1:20 to 1:80, and more preferably from 1:50 to 1:60.

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According to one embodiment of the present invention, the aqueous solution of the at least one acid of step ii) has a concentration from 0.01 mol/kg to 2 mol/kg, preferably from 0.04 to 1.0 mol/kg, more preferably from 0.06 to 0.5 mol/kg, even more preferably from 0.07 to 0.4 mol/kg, and most preferably from 0.08 to 0.2 mol/kg.

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In process step iii) at least one conjugate base is provided. A conjugate base according to the present invention is a substance that is formed by removal of a proton from an acid. By gaining a proton the conjugate base is reformed into the corresponding acid.

The at least one conjugate base of step iii) can be an alkali metal salt and/or alkaline earth metal salt of an acid. According to one embodiment of the present invention, the at least one conjugate base is an alkali metal salt and/or alkaline earth metal salt of an acid being selected from the group consisting of phosphoric acid, citric acid, sulphurous acid, boric acid, acetic acid, tartaric acid, formic acid, propanoic acid, oxalic acid, phosphonic acid, and mixtures thereof. The alkali metal may be selected from lithium, sodium, or potassium. The alkaline earth metal may be magnesium.

Preferably the at least one conjugate base of step iii) may be an alkali metal salt and/or alkaline earth metal salt of an acid being selected from a phosphoric acid or acidic salt thereof, a citric acid or acidic salt thereof, or a mixture thereof. According to a preferred embodiment, the at least one conjugate base of step iii) is disodium hydrogen phosphate, dipotassium hydrogen phosphate, tripotassium citrate and/or trisodium citrate.

According to one embodiment, the at least one conjugate base of step iii) is a conjugate base of the at least one acid of step ii). For example, if the at least one acid of step ii) is phosphoric acid, the at least one conjugate base of step iii) is an alkali metal phosphate and/or alkaline earth metal phosphate. According to another exemplary embodiment, if the at least one acid of step ii) is citric acid, the at least one conjugate base of step iii) is an alkali metal citrate and/or alkaline earth metal citrate. However, the at least one conjugate base of step iii) can also be a conjugate base of an acid different from the at least one acid of step ii). For example, the at

least one acid of step ii) can be citric acid and the at least one conjugate base of step iii) can be an alkali metal phosphate and/or alkaline earth metal phosphate.

The at least one conjugate base of step iii) can be provided in liquid or dry form. For example, the at least one conjugate base may be in form of a solid such as granules or a powder and/or a solution. According to one embodiment, the at least one conjugate base of step iii) is provided in form of an aqueous solution.

The at least one conjugate base of step iii) can be provided as a concentrated solution or a more diluted solution. Preferably, the molar ratio of the at least one conjugate base to the calcium carbonate is from 1:10 to 1:100, preferably from 1:20 to 1:80, and more preferably from 1:50 to 1:60.

According to one embodiment of the present invention, the aqueous solution of the at least one conjugate base of step iii) has a concentration from 0.01 mol/kg to 2 mol/kg, preferably from 0.04 to 1.0 mol/kg, more preferably from 0.06 to 0.5 mol/kg, even more preferably from 0.07 to 0.4 mol/kg, and most preferably from 0.08 to 0.2 mol/kg.

The at least one acid of process step ii) and the at least one conjugate base of process step iii) can be provided separately or in combination.

According to the present invention, the at least one acid of step ii) and/or the at least one conjugate base of step iii) are provided in form of an aqueous solution.

According to one embodiment, the at least one acid of step ii) as well as the at least one conjugate base of step iii) are provided as separate aqueous solutions.

According to one embodiment, the at least one acid of step ii) and the at least one conjugate base of step iii) are provided together in form of an aqueous buffer solution. According to one embodiment of the present invention the aqueous buffer

solution is selected from the group consisting of phosphate buffer, phosphate-citrate buffer, citrate buffer, tartrate buffer, borate buffer, preferably the aqueous buffer solution is a phosphate buffer, a phosphate-citrate buffer, or a citrate buffer, and more preferably a phosphate-citrate buffer, or a citrate buffer.

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According to a preferred embodiment, the at least one acid of step ii) and the at least one conjugate base of step iii) are provided together in form of an aqueous buffer solution, wherein the at least one acid of step ii) is selected from sodium dihydrogen phosphate, potassium dihydrogen phosphate, citric acid, sodium dihydrogen citrate, potassium dihydrogen citrate, disodium hydrogen citrate, dipotassium hydrogen citrate, or mixtures thereof, and the at least one conjugate base of step iii) is disodium hydrogen phosphate, dipotassium hydrogen phosphate, tripotassium citrate and/or trisodium citrate. More preferably, the at least one acid of step ii) may be selected from sodium dihydrogen phosphate, sodium dihydrogen citrate, or mixtures thereof, and the at least one conjugate base of step iii) may be disodium hydrogen phosphate, dipotassium hydrogen phosphate, tripotassium citrate and/or trisodium citrate.

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According to one embodiment the aqueous buffer solution has a pH value from 4.0 to 7.5, preferably from 4.5 to 6.0, and most preferably from 4.8 to 5.5. According to another embodiment the aqueous buffer solution of step has a concentration from 0.01 mol/kg to 2 mol/kg, preferably from 0.04 to 1.0 mol/kg, more preferably from 0.06 to 0.5 mol/kg, even more preferably from 0.07 to 0.4 mol/kg, and most preferably from 0.08 to 0.2 mol/kg.

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According to one embodiment the aqueous buffer solution is provided in an amount from 0.1 to 99 wt.-%, based on the total amount of the aqueous suspension of calcium carbonate, preferably in an amount from 1 to 90 wt.-%, more preferably in an amount from 10 to 80 wt.-%, and most preferably from 60 to 70 wt.-%.

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The process for producing a surface-treated calcium carbonate

According to one aspect of the present invention, a process for producing a surface-treated calcium carbonate with improved stability in environments with a pH of 4.5
5 to 7 is provided, wherein the process comprises the steps of:

- i) providing calcium carbonate,
- ii) providing at least one acid having a pK_a value from 0 to 8, when measured at 20°C
- iii) providing at least one conjugate base,
- 10 iv) contacting the calcium carbonate of step i), the at least one acid of step ii), and the at least one conjugate base of step iii) to form surface-treated calcium carbonate,

wherein the at least one acid of step ii) and/or the at least one conjugate base of step iii) are provided in form of an aqueous solution.

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According to step iv) of the inventive process, the calcium carbonate of step i), the at least one acid of step ii), and the at least one conjugate base of step iii) are contacted. The calcium carbonate of step i) may be contacted with the at least one acid of step ii) and the at least one conjugate base of step iii) in one step or in several steps.

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According to one embodiment of the present invention, step iv) comprises the steps of:

- a1) contacting the calcium carbonate of step i) and the at least one acid of step ii) to form a pre-treated calcium carbonate, and
 - 25 a2) contacting the pre-treated calcium carbonate of step a1) with the at least one conjugate base of step iii) to form surface-treated calcium carbonate,
- wherein at least the at least one acid of step ii) is provided in form of an aqueous solution.

According to another embodiment of the present invention, step iv) comprises the steps of:

b1) contacting the calcium carbonate of step i) and the at least one conjugate base of step iii) to form a pre-treated calcium carbonate, and

5 b2) contacting the pre-treated calcium carbonate of step b1) with the at least one acid of step ii) to form surface-treated calcium carbonate, wherein at least the at least one conjugate base of step iii) is provided in form of an aqueous solution.

10 Alternatively, the calcium carbonate of step i), the at least one acid of step ii) and the at least one conjugate base of step iii) are contacted simultaneously. In this case, the at least one acid of step ii) and the at least one conjugate base of step iii) may be provided separately or as a mixture. Preferably, the at least one acid of step ii) and the at least one conjugate base of step iii) may be provided as a mixture, for example,
15 in form of an aqueous buffer solution comprising the at least acid of step ii) and the at least one conjugate base of step iii).

According to one embodiment of the present invention, the at least one acid of step ii) and the at least one conjugate base of step iii) are provided together in form
20 of an aqueous buffer solution, and in step iv) the calcium carbonate of step i) is contacted with the aqueous buffer solution to form surface-treated calcium carbonate.

The contacting step iv) can be carried out by any means known in the art. For example, the calcium carbonate of step i), the at least one acid of step ii), and the at
25 least one conjugate base of step iii) can be brought into contact by spraying and/or mixing. Suitable process equipment for spraying or mixing is known to the skilled person.

According to one embodiment of the present invention, process step iv) is carried out
30 by spraying. According to another embodiment of the present invention, process

step iv) is carried out by mixing. The skilled person will adapt the mixing conditions such as the mixing speed and temperature according to his process equipment. For example, the mixing may take place by means of a ploughshare mixer. Ploughshare mixers function by the principle of a fluidized bed produced mechanically.

- 5 Ploughshare blades rotate close to the inside wall of a horizontal cylindrical drum and convey the components of the mixture out of the product bed and into the open mixing space. The fluidized bed produced mechanically ensures intense mixing of even large batches in a very short time. Choppers and/or dispersers are used to disperse lumps in a dry operation. Equipment that may be used in the inventive
10 process is available, for example, from Gebrüder Lödige Maschinenbau GmbH, Germany. Furthermore, a tubular mixing apparatus, for example, from Ystral GmbH, Ballrechten-Dottingen, Germany may be used.

- Process step iv) may be carried out at room temperature, i.e. at a temperature of 20°C
15 ± 2°C, or at other temperatures. According to one embodiment of the present invention, process step iv) is carried out for at least 1 s, preferably for at least one min, e.g. for at least 2 min. According to one embodiment, process step iv) is carried out by mixing for at least 1 min, preferably at least 5 min, more preferably at least
20 10 min, and most preferably at least 20 min.

- 20 According to the present invention the at least one acid of step ii) and/or the at least one conjugate base of step iii) are provided in form of an aqueous solution. Depending on the amount of water that is introduced during step iv) by contacting the aforementioned compounds, the surface-treated calcium carbonate is obtained in
25 form of a wet or moist surface-treated calcium carbonate or in form of an aqueous suspension of surface-treated calcium carbonate. It is also within the confines of the present invention that additional water may be introduced during process step iv), for example, in order to control and/or maintain and/or achieve the desired solids content or Brookfield viscosity of the obtained wet or moist surface-treated calcium
30 carbonate or aqueous suspension of surface-treated calcium carbonate.

- 25 -

By means of step iv), a suspension of surface-treated calcium carbonate is obtained, the suspension having a solid content in the range from 1 to 80 wt.-%, more preferably in the range from 10 to 60 wt.-%, and most preferably in the range from
5 20 to 50 wt.-%, based on the weight of the surface-treated calcium carbonate in the suspension.

According to the present invention, the process can further comprise a step v) of drying the surface-treated calcium carbonate.

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In general, the drying step v) may take place using any suitable drying equipment and can, for example, include thermal drying and/or drying at reduced pressure using equipment such as an evaporator, a flash drier, an oven, a spray drier and/or drying in a vacuum chamber.

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According to one embodiment, drying step v) is a spray drying step, preferably said spray drying step is carried out with an inlet temperature of 100°C – 1000°C and preferably from 200°C to 600°C. Spray drying may be preferred in case of small particle sizes, e.g., at a volume determined median particle size d_{50} from 1 to 20 μm .

20 In case of a volume determined median particle size d_{50} of more than 20 μm other drying methods, e.g., drying in an oven, fluid bed dryer or flash drying may be preferred.

By means of drying step v), a dried surface-treated calcium carbonate is obtained,
25 preferably having a low total moisture content. According to one embodiment, the surface-treated calcium carbonate obtained by step v) has a total moisture content which is less than or equal to 1.0 wt.-%, based on the total weight of the dried surface-treated calcium carbonate.

According to another embodiment, the dried surface-treated calcium carbonate obtained by step v) has a total moisture content of less than or equal to 0.5 wt.-%, and preferably less than or equal to 0.2 wt.-%, based on the total weight of the dried surface-treated calcium carbonate. According to still another embodiment, the dried surface-treated calcium carbonate obtained by step v) has a total moisture content of
5 between 0.01 and 0.15 wt.-%, preferably between 0.02 and 0.10 wt.-%, and more preferably between 0.03 and 0.07 wt.-%, based on the total weight of the dried surface-treated calcium carbonate.

10 According to one optional embodiment of the present invention, after step iv) and before step v), the surface-treated calcium carbonate is left to stand for at least 6 h, preferably at least 12 h, more preferably at least 24 h, and most preferably at least 48 h. This prolonged contacting time may improve the efficiency of the surface treatment and may lead to the formation of a more homogeneous surface-treatment
15 layer.

In case an aqueous suspension of surface-treated calcium carbonate is obtained after step iv), it may be necessary to separate the surface-treated calcium carbonate from the aqueous suspension. According to an optional embodiment, in process step iv)
20 the calcium carbonate of step i), the at least one acid of step ii), the at least one conjugate base of step iii), and optionally water, are contacted to form an aqueous suspension of surface-treated calcium carbonate, and after step iv) and before step v) the surface-treated calcium carbonate is separated from the aqueous suspension obtained from step iv).

25 According to one embodiment, the calcium carbonate of step i) is provided in an amount from 10 to 99 wt.-%, based on the total amount of the aqueous suspension of surface-treated calcium carbonate, preferably in an amount from 10 to 95 wt.-%, more preferably in an amount from 20 to 90 wt.-%, and most preferably in an amount
30 from 30 to 40 wt.-%.

According to one embodiment of the present invention, the at least one acid of step ii) and the at least one conjugate base of step iii) are provided together in form of an aqueous buffer solution, and step iv) comprises the steps of:

5 c1) mixing the calcium carbonate of step i), the aqueous buffer solution, and optionally water, to form an aqueous suspension of surface-treated calcium carbonate, and

 c2) separating the surface-treated calcium carbonate from the aqueous suspension obtained from step c1).

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For the purpose of the present invention, the expression “separating” means that the surface-treated calcium carbonate is removed or isolated from the aqueous suspension obtained from step c1) of the inventive process. The surface-treated calcium carbonate obtained from step c1) may be separated from the aqueous suspension by any conventional means of separation known to the skilled person.

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According to one embodiment of the present invention, in process step c2) the surface-treated calcium carbonate is separated mechanically and/or thermally.

Examples for mechanical separation processes are filtration, e.g. by means of a drum filter or filter press, nanofiltration, or centrifugation. An example for a thermal

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separation process is a concentrating process by the application of heat, for example, in an evaporator. According to a preferred embodiment, in process step c2) the surface-treated calcium carbonate is separated mechanically, preferably by filtration and/or centrifugation.

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According to one embodiment, after step iv) and before step v), the surface-treated calcium carbonate is washed with a washing solution, preferably water. For example, the surface-treated calcium carbonate can be washed one time, two times or three times with a washing solution, preferably water. Suitable washing solutions may be selected from water, ethanol, or mixtures thereof.

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According to a preferred embodiment of the present invention, a process for producing a surface-treated calcium carbonate with improved stability in environments with a pH of 4.5 to 7 is provided, wherein the process comprises the steps of:

- 5 I) providing calcium carbonate,
- II) providing an aqueous buffer solution comprising at least one acid having a pK_a value from 0 to 8, when measured at 20°C, and at least one conjugate base,
- 10 III) contacting the calcium carbonate of step I), the buffer solution of step II), and optionally water, to form surface-treated calcium carbonate.

According to one embodiment the aqueous buffer solution is selected from the group consisting of phosphate buffer, phosphate-citrate buffer, citrate buffer, tartrate buffer, borate buffer, preferably the aqueous buffer solution is a phosphate buffer, a
15 phosphate-citrate buffer, or a citrate buffer, and more preferably a phosphate-citrate buffer, or a citrate buffer. According to a preferred embodiment, the at least one acid is selected from sodium dihydrogen phosphate, potassium dihydrogen phosphate, citric acid, sodium dihydrogen citrate, potassium dihydrogen citrate, disodium
20 hydrogen citrate, dipotassium hydrogen citrate, or mixtures thereof, and the at least one conjugate base is disodium hydrogen phosphate, dipotassium hydrogen phosphate, tripotassium citrate and/or trisodium citrate. More preferably, the at least one acid may be selected from sodium dihydrogen phosphate, potassium dihydrogen phosphate, sodium dihydrogen citrate, potassium dihydrogen citrate, or mixtures
25 thereof, and the at least one conjugate base may be disodium hydrogen phosphate, dipotassium hydrogen phosphate, tripotassium citrate and/or trisodium citrate.

According to the present invention, this process can further comprise a step IV) of drying the surface-treated calcium carbonate as described above with respect to
30 drying step v).

The surface-treated calcium carbonate

5 According to a further aspect of the present invention, a suspension of a surface-treated calcium carbonate with improved stability in environments with a pH of 4.5 to 7 is provided, which is obtainable by a process comprising the steps of:

- i) providing calcium carbonate,
- 10 ii) providing at least one acid having a pK_a value from 0 to 8, when measured at 20°C,
- iii) providing at least one conjugate base,
- iv) contacting the calcium carbonate of step i), the at least one acid of step ii), and the at least one conjugate base of step iii) to form surface-treated calcium carbonate,
- 15 wherein the at least one acid of step ii) and/or the at least one conjugate base of step iii) are provided in form of an aqueous solution.

According to a further aspect of the present invention, a dried surface-treated calcium carbonate with improved stability in environments with a pH of 4.5 to 7 is provided, 20 which is obtainable by a process comprising the steps of:

- i) providing calcium carbonate,
- ii) providing at least one acid having a pK_a value from 0 to 8, when measured at 20°C,
- iii) providing at least one conjugate base,
- 25 iv) contacting the calcium carbonate of step i), the at least one acid of step ii), and the at least one conjugate base of step iii) to form surface-treated calcium carbonate, and
- v) drying the surface-treated calcium carbonate,

wherein the at least one acid of step ii) and/or the at least one conjugate base of 30 step iii) are provided in form of an aqueous solution.

- 30 -

The inventors have surprisingly found that by implementing the process according to the present invention, a surface-treated calcium carbonate can be prepared that shows a similar BET surface area like the calcium carbonate that has been used for its
5 preparation. In other words, the inventors have surprisingly found that the treatment of the present invention does not lead to or only leads to a minor increase of the BET surface of the treated product.

The following paragraphs are intended to refer to both the suspension of a surface-
10 treated calcium carbonate with improved stability in environments with a pH of 4.5 to 7 and the dried surface-treated calcium carbonate with improved stability in environments with a pH of 4.5 to 7, unless otherwise stated.

According to one embodiment the surface-treated calcium carbonate is in form of
15 particles having a volume determined median particle size d_{50} from 1 to 1 500 μm , preferably from 25 to 1 400 μm , more preferably from 100 to 1 200 μm , even more preferably from 200 to 1 000 μm , and most preferably from 300 to 800 μm .

Additionally or alternatively, the surface-treated calcium carbonate may be in form
of particles having a volume determined top cut particle size d_{98} from 40 to 2 000
20 μm , preferably from 200 to 1 800 μm , more preferably from 300 to 1 500 μm , even more preferably from 400 to 1 200 μm , and most preferably from 500 to 1 000 μm .

According to one embodiment the surface-treated calcium carbonate has a reduced
acid consumption per hour at pH 5 and pH 6 when treated with acetic acid, the
25 reduction being at least 25 %, more preferably at least 50 %, and most preferably at least 70 %.

According to another embodiment the surface-treated calcium carbonate is in form of
particles having a specific BET surface area in the range of > 0 to 5 m^2/g , preferably
30 in the range of > 0 to 2 m^2/g , and more preferably in the range of > 0 to 1.6 m^2/g .

The surface-treated calcium carbonate obtainable by the process of the present invention may be used for various applications. According to one aspect of the present invention, the surface-treated calcium carbonate is used as abrasive material.

5 The inventors of the present invention found that the surface-treated calcium carbonate obtained by the process of the present invention may provide a very gentle abrasiveness, which makes it suitable for delicate surfaces and especially cosmetic applications. According to a preferred embodiment, the dried surface-treated calcium carbonate obtainable by the process of the present invention is used as abrasive
10 material for cosmetic application and/or cleaning application, more preferably as abrasive material for cosmetic application, and most preferably as abrasive material for topical skin application. According to another preferred embodiment, the suspension of the surface-treated calcium carbonate obtainable by the process of the present invention is used as abrasive material for cleaning application.

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The inventors of the present invention surprisingly found that the surface-treated calcium carbonate obtainable by the inventive process exhibits an improved stability at environments with a pH of 4.5 to 7. Therefore, the surface-treated calcium carbonate is especially suitable for applications in such environments. However, the
20 inventive surface-treated calcium carbonate, in suspension or in dry form, can also be used in applications requiring pH values of > 7 , for example pH values in the range from > 7 to 10 or 11. Furthermore, it was found that the surface-treated calcium carbonate obtained by the inventive process can replace conventional abrasive materials such as microbeads in abrasive cleaning compositions without affecting the
25 sensory properties of the composition. Moreover, the dried surface-treated calcium carbonate is a non-toxic material and biologically degradable, which makes it, for example, most suitable for cosmetic applications and eco-friendly household cleaners.

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The abrasive cleaning composition

According to a further aspect of the present invention, an abrasive cleaning composition comprising a surface-treated calcium carbonate obtainable by a process according to the present invention is provided.

According to one embodiment, the abrasive cleaning composition comprises at least 1 wt.-%, based on the total weight of the composition, of the surface-treated calcium carbonate as an abrasive material. For example, the abrasive cleaning composition can comprise at least 2 wt.-%, at least 5 wt.-%, or at least 8 wt.-%, based on the total weight of the composition, of the surface-treated calcium carbonate as an abrasive material. According to one embodiment of the present invention, the composition comprises from 10 to 80 wt.-%, preferably from 15 to 70 wt.-%, more preferably from 17 to 60 wt.-%, even more preferably from 19 to 50 wt.-%, and most preferably about 20 wt.-% of the surface-treated calcium carbonate, based on the total weight of the composition.

The surface-treated calcium carbonate can consist of only one type of surface-treated calcium carbonate or can be a mixture of two or more types of surface-treated calcium carbonate. The abrasive cleaning composition of the present invention may contain the surface-treated calcium carbonate as the only abrasive material. Alternatively, the abrasive cleaning composition of the present invention may contain the surface-reacted calcium carbonate in combination with at least one additional abrasive material. The further abrasive material can be made from plastic, hard waxes, inorganic and organic abrasives, or natural materials.

According to one embodiment, the abrasive cleaning composition further comprises at least one additional abrasive material, preferably selected from the group consisting of silica, precipitated silica, alumina, aluminosilicate, metaphosphate, tricalcium phosphate, calcium pyrophosphate, natural ground calcium carbonate,

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precipitated calcium carbonate, sodium bicarbonate, bentonite, kaolin, aluminium hydroxide, calcium hydrogen phosphate, hydroxylapatite, apricot kernels, plum kernels, salt, sugar, polyethylene beads, luffa, rice, bamboo, microcrystalline cellulose, basalt, waxes, coffee, polylactic acid, cocoa exfoliator and mixtures thereof.

According to one embodiment, the additional abrasive material can have the same volume determined median particle size d_{50} as the surface-treated calcium carbonate, namely a d_{50} from 1 to 1 500 μm , preferably from 25 to 1 400 μm , more preferably from 100 to 1 200 μm , even more preferably from 200 to 1 000 μm , and most preferably from 300 to 800 μm . This abrasive material is suitable for topical applications.

Alternatively, the additional abrasive material has volume determined median particle size d_{50} from 0.1 to 100 μm , preferably from 0.5 to 50 μm , more preferably from 1 to 20 μm , and most preferably from 2 to 10 μm . Such an abrasive material is suitable for oral applications.

The at least one additional abrasive material can be present in the abrasive cleaning composition in an amount from 1 to 80 wt.-%, based on the total weight of the composition, preferably from 5 to 70 wt.-%, more preferably from 10 to 60 wt.-%, and most preferably from 20 to 50 wt.-%.

The abrasive cleaning composition of the present invention may be in form of a solid or in form of a liquid. According to one embodiment, the abrasive cleaning composition is in form of a solid, preferably a powder, a granulate, a tablet, a stick, a chunk, a block, a sponge or a brick. According to another embodiment, the abrasive cleaning composition is in form of a liquid, preferably a solution, a suspension, a paste, an emulsion, a cream, an oil, or a gel.

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According to one embodiment of the present invention, the abrasive cleaning composition is a liquid, aqueous composition. According to one embodiment the aqueous composition comprises from 1 to 90 wt.-% water, based on the total weight of the composition, preferably from 5 to 80 wt.-%, more preferably from 10 to 70,
5 and most preferably from 20 to 60 wt.-%.

According to another embodiment of the present invention, the abrasive cleaning composition is a liquid, non-aqueous composition. According to one embodiment the aqueous composition comprises from 1 to 90 wt.-% of a solvent, based on the total
10 weight of the composition, preferably from 5 to 80 wt.-%, more preferably from 10 to 70, and most preferably from 20 to 60 wt.-%. Suitable solvents are known to the skilled person and are, for example, aliphatic alcohols, ethers and diethers having from 4 to 14 carbon atoms, glycols, alkoxyated glycols, glycol ethers, alkoxyated aromatic alcohols, aromatic alcohols, terpenes, natural oils, or mixtures thereof.

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According to one embodiment the abrasive cleaning composition has a pH from 5.0 to 7.0, measured at 20°C, preferably from 5.5 to 6.5, and most preferably of about 6. According to an alternative embodiment, the abrasive cleaning composition has a pH above 5, measured at 20°C. According to another alternative embodiment, the
20 composition has a pH above 7.0, measured at 20°C. For example, the abrasive cleaning composition may have a pH from 7.5 to 11 or from 7.5 to 10. Means for adjusting the pH are known to the skilled person.

In case the abrasive cleaning composition is in liquid form, it may be a thickened
25 composition having a Brookfield viscosity from 4 000 to 50 000 mPa·s at 20°C.

The abrasive cleaning composition may further comprise a surfactant. According to one embodiment of the present invention, the abrasive cleaning composition comprises from 0.1 to 30 wt.-% of a surfactant, preferably from 0.5 to 25 wt.-%, and
30 most preferably from 2 to 20 wt.-%, based on the total amount of the composition.

Suitable surfactants are known to the skilled person and may be selected from non-ionic, anionic, zwitterionic, amphoteric, cationic surfactants, and mixtures thereof.

- 5 Examples of suitable nonionic surfactants are compounds produced by the condensation of simple alkylene oxides, which are hydrophilic in nature, with an aliphatic or alkyl-aromatic hydrophobic compound having a reactive hydrogen atom. Suitable anionic surfactants are, for example, water-soluble salts of organic sulphuric acid mono-esters and sulphonic acids which have in the molecular structure a
- 10 branched or straight chain alkyl group containing from 6 to 22 carbon atoms in the alkyl part. Examples of suitable zwitterionic surfactants are of aliphatic quaternary ammonium, sulphonium and phosphonium compounds having an aliphatic group of from 8 to 18 carbon atoms and an aliphatic group substituted by an anionic water-solubilising group, for instance betaine and betaine derivatives such as alkyl betaine,
- 15 in particular C₁₂-C₁₆ alkyl betaine, 3-(N,N-dimethyl-N-hexadecylammonium)-propane-1-sulphonate betaine, 3-(dodecylmethyl-sulphonium)-propane-1-sulphonate betaine, 3-(cetylmethyl-phosphonium)-propane-1-sulphonate betaine and N,N-dimethyl-N-dodecyl-glycine. Suitable amphoteric surfactants are, for example, derivatives of aliphatic secondary and tertiary amines containing an alkyl group of
- 20 8 to 20 carbon atoms and an aliphatic group substituted by an anionic water-solubilising group, for instance sodium 3-dodecylamino-propionate, sodium 3-dodecylaminopropane-sulphonate and sodium N-2-hydroxy-dodecyl-N-methyltaurate. Examples of suitable cationic surfactants are quaternary ammonium salts having one or two alkyl or aralkyl groups of from 8 to 20 carbon atoms and two
- 25 or three small aliphatic (e.g. methyl) groups, for instance, cetyltrimethylammonium chloride. Further examples are given in well-known text books such as "Household Cleaning, Care and Maintenance Products", Edts. Herrmann G. Hauthal, G. Wagner, 1st Edition, Verlag für Chem. Industrie H. Ziolkowsky 2004, or "Kosmetische Emulsionen und Cremes", Gerd Kutz, Verlag für Chem. Industrie H. Ziolkowsky
- 30 2001.

The abrasive composition of the present invention may further comprise ingredients which aid in its cleaning performance. For example, the composition may contain detergent builders and mixtures of such builders in an amount of up to 25 wt.-%, based on the total amount of the composition. Suitable inorganic or organic detergent builders are known to the skilled person and may be selected, for example, from sodium tripolyphosphate or sodium aluminium silicate.

According to one embodiment, in addition to the components already mentioned, the abrasive cleaning composition further comprises dispersing agents, thickeners, preservatives, humectants, foaming agents, fluoride sources (e.g., in case the abrasive cleaning composition is an oral care product), flavouring agents, fragrances, colorants, active agents, and/or buffering systems. Examples of active agents are pharmaceutically, biologically or cosmetically active agents, biocides, or disinfecting agents. The abrasive cleaning composition of the present invention may also comprise further optional ingredients which are not mentioned here but known to skilled person.

According to one embodiment of the present invention, the abrasive cleaning composition is a cosmetic composition, preferably a cosmetic composition for topical application, and more preferably a facial cleanser, a body wash, a body scrub, a scrub shampoo, a massage cream, a body polisher, an exfoliator, a peeling cream, a food scrub, a microderm abrasion product, or an oral care composition. Examples of an oral care composition are a toothpaste, a toothpowder, a powder for dental powder blasting, or a chewable gum. According to one embodiment, the abrasive cleaning composition is a cosmetic composition having a pH value from 5.0 to 7.0, preferably from 5.5 to 6.5, and most preferably of about 6.

According to one embodiment, a cosmetic composition is provided comprising a surface-treated calcium carbonate with improved stability in environments with a pH

of 4.5 to 7 is provided, wherein the cosmetic composition has a pH value from 5.0 to 7.0 and the surface-treated calcium carbonate is obtainable by a process comprising the steps of:

- 5 i) providing calcium carbonate,
- ii) providing at least one acid having a pK_a value from 0 to 8, when measured at 20°C,
- iii) providing at least one conjugate base,
- iv) contacting the calcium carbonate of step i), the at least one acid of step ii), and the at least one conjugate base of step iii) to form surface-treated calcium carbonate, and
- 10 v) drying the surface-treated calcium carbonate,

wherein the at least one acid of step ii) and/or the at least one conjugate base of step iii) are provided in form of an aqueous solution.

- 15 According to a further aspect of the present invention, the abrasive cleaning composition of the present invention is used for cleaning a surface.

According to a further aspect of the present invention, a method for cleaning a surface is provided, wherein the surface is contacted with an abrasive cleaning composition according to the present invention. The surface may be contacted with the inventive composition by applying the composition to the surface, for example, by spraying, pouring or squeezing. The abrasive cleaning composition may be applied to the surface by using an appropriate means such as a mop, a paper towel, a brush, or a cloth, soaked in the composition, which can be in neat or in diluted form.

- 25
- According to one embodiment of the present invention, the surface is an inanimate surface, preferably selected from the group consisting of household hard surfaces, dish surfaces, leather surfaces, and automotive vehicle surfaces. Examples of household hard surfaces are working surfaces, ceramic surfaces, refrigerators, freezers, washing machines, automatic dryers, ovens, microwave ovens, ceramic
- 30

- 38 -

cook tops, bathroom fittings or dishwashers. Examples of dish surfaces are dishes, cutlery, cutting boards, or pans.

5 According to another embodiment of the present invention, the surface is an animate surface, preferably selected from the group consisting of human skin, animal skin, human hair, animal hair, and tissues of the oral cavity such as teeth, gums, tongue or buccal surfaces.

10 According to one embodiment of the present invention, the method of the present invention further comprises a step of rinsing the composition.

15 According to a preferred embodiment, the abrasive cleaning composition of the present invention is used for cleaning an animate surface, and more preferably for cleaning an animate surface selected from the group consisting of human skin, animal skin, human hair, animal hair, and tissues of the oral cavity such as teeth, gums, tongue or buccal surfaces.

20 According to one embodiment, the surface to be cleaned is an inanimate surface, preferably selected from the group consisting of household hard surfaces, dish surfaces, leather surfaces, and automotive vehicle surfaces.

The scope and interest of the invention will be better understood based on the following examples which are intended to illustrate certain embodiments of the present invention and are non-limitative.

25

Examples

1. Measurement Methods

5 In the following, measurement methods implemented in the examples are described.

pH value

a) Normal pH measurement

The pH of a suspension or solution was measured at 25°C using a Mettler Toledo
10 Seven Easy pH meter and a Mettler Toledo InLab® Expert Pro pH electrode. A three
point calibration (according to the segment method) of the instrument was first made
using commercially available buffer solutions having pH values of 4, 7 and 10 at
20°C (from Sigma-Aldrich Corp., USA). The reported pH values are the endpoint
values detected by the instrument (the endpoint was when the measured signal
15 differed by less than 0.1 mV from the average over the last 6 seconds).

b) pH measurement with regard to stability at pH 5 and 6

The pH of a suspension or solution was measured at 25°C using a Mettler Toledo
DL58 Titrator and a Mettler Toledo DG 115-SC electrode. A three point calibration
20 (according to the segment method) of the instrument was first made using
commercially available buffer solutions having pH values of 4.01, 7.00 and 9.21 at
20°C (Duracal Buffers from Hamilton, Switzerland). The reported pH values are the
endpoint values detected by the instrument (the endpoint was when the measured
signal differed by less than 0.1 mV from the average over the last 2.5 seconds).

25

BET specific surface area (SSA)

The BET specific surface area is measured via the BET process according to
ISO 9277 using nitrogen, following conditioning of the sample by heating at 250°C
30 for a period of 30 minutes. Prior to such measurements, the sample is filtered within

a Büchner funnel, rinsed with deionised water and dried at 110°C in an oven for at least 12 hours.

Particle size distribution

5

The weight median particle size of all particulate materials, e.g. natural ground or precipitated calcium carbonate, was determined by the sedimentation method, which is an analysis of sedimentation behaviour in a gravimetric field. The measurement was made with a Sedigraph™ 5100, Micromeritics Instrument Corporation. The method and the instrument are known to the skilled person and are commonly used to determine grain size of fillers and pigments in the range from 0.1 to 5 µm. The measurement was carried out in an aqueous solution of 0.1 wt.-% Na₄P₂O₇. The samples are dispersed using a high speed stirrer and supersonicated.

10

15

The volume determined median particle size d_{50} of calcium carbonate and surface-treated calcium carbonate was evaluated using a Malvern Mastersizer 2000 Laser Diffraction System (Malvern Instruments Plc., Great Britain), using the Fraunhofer light scattering approximation. The method and instrument are known to the skilled person and are commonly used to determine particle sizes of fillers and other particulate materials of > 5 µm. Although it is preferable to use the Sedigraph method for particle sizes of less than 5 µm it is also possible to do volume based particles size determination using the Malvern Mastersizer for particle sizes as low as 1 µm. The samples were dispersed using a high speed stirrer and in the presence of supersonics.

20

25

2. Materials

For the present invention the following buffer solutions were tested:

30

It has to be noted that for the preparation of each buffer solution deionized water was

used.

Buffers used in lab-scale trials

A: Phosphate buffer

5

999.2 g of a NaH_2PO_4 solution (0.1 mol/kg) and 20.8 g Na_2HPO_4 solution (0.1 mol/kg) were mixed. The final pH of this buffer was 5.0 and the total phosphate ionic concentration was 0.1 mol/kg.

10 B: Phosphate citrate buffer

257.3 g Na_2HPO_4 solution (0.2 mol/kg), 269.1 g citric acid solution (0.1 mol/kg) and 492.7 g deionized water were mixed. The final pH of this buffer was 5.0, the total phosphate ionic concentration was 0.05 mol/kg, and the total citrate ionic
15 concentration was 0.026 mol/kg.

C: Citrate buffer

A first solution was prepared by placing 1 000 g sodium dihydrogen citrate solution
20 (0.1 mol/kg) in a beaker, and adding 48.2 g trisodium citrate to the beaker while stirring with a magnetic stirring bar. The total citrate concentration of said first solution was 0.27 mol/kg.

365 g of said first solution and 635 g deionized water were combined and mixed.
25 Then a 0.1 mol/kg citric acid solution was added until a final pH of 5.0 was reached. The final buffer solution had a total citrate ion concentration of 0.1 mol/kg.

The following chemicals were used to prepare the above solutions: Sodium di-
hydrogen phosphate monohydrate ($\text{NaH}_2\text{PO}_4 \cdot \text{H}_2\text{O}$, Merck KGaG), di-sodium
30 hydrogen phosphate di-hydrate ($\text{Na}_2\text{HPO}_4 \cdot 2\text{H}_2\text{O}$, Merck KGaA), citric acid

anhydrous ($\text{H}_3\text{C}_6\text{H}_5\text{O}_7$, Sigma Aldrich), sodium di-hydrogen citrate anhydrous ($\text{NaH}_2\text{C}_6\text{H}_5\text{O}_7$, Sigma Aldrich) and tri-sodium citrate di-hydrate ($\text{Na}_3\text{C}_6\text{H}_5\text{O}_7 \cdot 2\text{H}_2\text{O}$, Sigma Aldrich).

5 Buffers used in pilot-scale trials

The following buffer solutions were tested in pilot-scale trials. Table 1 lists the amounts of the used compounds as well as the resulting ionic concentrations. All compounds were purchased from Sigma Aldrich.

10

			Phosphate citrate buffer D	Phosphate citrate buffer E	Phosphate citrate buffer F	Phosphate buffer G	Citrate buffer H
Additive Masses	$\text{C}_6\text{H}_5\text{Na}_3\text{O}_7 \cdot 2\text{H}_2\text{O}$	g	468	468	780	0	357
	KH_2PO_4	g	233	233	388	2645	0
	H_3PO_4 (30%)	g	431	431	718	0	0
	NaOH	g	0	0	0	45,3	0
	$\text{C}_6\text{H}_8\text{O}_7$	g	0	0	0	0	82.5
Solution Conditions at treatment	Water - total	kg	29.2	17.2	10.5	15.6	19.6
	Solids CaCO_3	%	34.0%	46.6%	70.4%	61.6%	56.1%
	Dose $\text{C}_6\text{H}_5\text{O}_7^{-3}$	%	2.0%	2.0%	2.0%	0.0%	1.2%
	Dose PO_4^{-3}	%	1.9%	1.9%	1.9%	7.4%	0.0%
	$[\text{C}_6\text{H}_5\text{O}_7^{-3}]$	mmol/kg	55	112	482	0	113
	$[\text{PO}_4^{-3}]$	mmol/kg	104	214	918	1837	0
	pH	-	5.6	5.1	4.8	4.9	5.3

Table 1: Compounds used for preparation of different buffers and resulting ionic concentrations and pH.

Calcium carbonate

15

The calcium carbonate used was a natural ground calcium carbonate from Karabiga, Turkey, having a d_{10} (volume determined) of 200 μm , a d_{20} (volume determined) of 243 μm , a d_{50} (volume determined) of 362 μm , a d_{90} (volume determined) of 640 μm , and a d_{98} (volume determined) of 811 μm , and a BET specific surface area less than 1.0.

20

3. Examples

Example 1A – Preparation of surface-treated calcium carbonate – lab-scale

- 5 Three samples of surface-treated calcium carbonate were prepared by treating the calcium carbonate with any one of the three prepared buffer solutions as follows:

1 000 g buffer solution was added to a beaker. Under stirring 550 g calcium carbonate was added and the mixture was stirred for 5 minutes.

10

After letting the mixture sit for 20 to 24 hours, the pH of the mixture was measured. The measured pH values are given in Table 2 below. Then, the mixture was filtered through a 100 μm sieve. The obtained residue on the sieve was washed with approximately 500 g of tap water in a beaker for about half a minute and the mixture
 15 was filtered again. Then the residue obtained on the sieve was dried in an oven at 90°C over night.

Sample	Buffer solution	pH value	BET [m ² /g]
1	A	6.8	1.5
2	B	6.8	< 1.0
3	C	8.0	< 1.0

Table 2: pH values of solution after preparation of surface-treated calcium carbonate.

- 20 Example 1B – Preparation of surface-treated calcium carbonate – pilot-scale

Sample 4

- 30 kg of phosphate citrate buffer solution D was used. This solution was then added
 25 to 15 kg of the above-mentioned dry calcium carbonate in a ploughshare mixer.

Concentrations of the solution were such that the dose of citrate ion on calcium carbonate was 2.0 % and the dose of phosphate ion on calcium carbonate was 1.9 %. This slurry was then mixed for 10 minutes and emptied into a drum. One sample, T0, taken immediately after mixing was sieved at 106 μm and was dried at 115°C, and a
5 second sample, T1, was left overnight to mature, after which it was sieved at 106 μm and was dried at 115°C.

Sample 5

10 15 kg of the above-mentioned calcium carbonate was wet sieved at 140 μm to remove the fine material and was added to a ploughshare mixer. The final wet-sieved sample had approximately 3 kg water. 15 kg of phosphate citrate buffer solution E was used. This solution was then added to the wet-sieved calcium carbonate in the ploughshare mixer. Concentrations of the solution were such that the dose of citrate
15 ion on calcium carbonate was 2.0 % and the dose of phosphate ion on calcium carbonate was 1.9 %. This slurry was then mixed for 10 minutes and emptied into a drum. One sample, T0, taken immediately after mixing was sieved at 106 μm and was dried at 115°C, and a second sample, T1, was left overnight to mature, after which it was sieved at 106 μm and was dried at 115°C.

20

Sample 6

25 kg of the above-mentioned calcium carbonate was wet sieved at 140 μm to remove the fine material and was added to a ploughshare mixer. The final wet-sieved
25 sample had approximately 5 kg of water. 5 kg of phosphate citrate buffer solution F was used. This solution was then added to the wet-sieved calcium carbonate in the ploughshare mixer. Concentrations of the solution were such that the dose of citrate ion on calcium carbonate was 2.0 % and the dose of phosphate ion on calcium carbonate was 1.9 %. This slurry was then mixed for 10 minutes and emptied into a
30 drum. One sample, T0, taken immediately after mixing was sieved at 106 μm and

was dried at 115°C, and a second sample, T1, was left overnight to mature, after which it was sieved at 106 µm and was dried at 115°C.

Sample 7

5

25 kg of the above-mentioned calcium carbonate was wet sieved at 140 µm to remove the fine material and was added to a ploughshare mixer. The final wet-sieved sample had approximately 11 kg of water. 5 kg of phosphate buffer solution G was used. This solution was then added to the wet-sieved calcium carbonate in the
10 ploughshare mixer. Concentration of the solution was such that the dose of phosphate ion on calcium carbonate was 7.4 %. This slurry was then mixed for 10 minutes and emptied into a drum. One sample, T0, taken immediately after mixing was sieved at 106 µm and was dried at 115°C, and a second sample, T1, was left overnight to mature, after which it was sieved at 106 µm and was dried at 115°C. Samples were
15 taken both with and without a washing step after treatment, but before drying.

Sample 8

25 kg of the above-mentioned calcium carbonate was wet sieved at 140 µm to
20 remove the fine material and was added to a ploughshare mixer. The final wet-sieved sample had approximately 5 kg of water. 15 kg of citrate buffer solution H was used. This solution was then added to the wet-sieved calcium carbonate in the ploughshare mixer. Concentration of the solution was such that the dose of citrate ion on calcium carbonate was 1.2 %. This slurry was then mixed for 10 minutes and emptied into a
25 drum. One sample, T0, taken immediately after mixing was sieved at 106 µm and was dried at 115°C, and a second sample, T1, was left overnight to mature, after which it was sieved at 106 µm and was dried at 115°C.

Example 2A – Stability of surface-treated calcium carbonate – lab-scale

The samples prepared according to Example 1A were analyzed with regard to their stability under acidic conditions at pH 5 and pH 6 by titrating the samples with acetic acid (2.0 mol/l). The untreated calcium carbonate was also analyzed as comparative sample.

Stability at pH 5

10 A 2.0 mol/l solution of acetic acid was prepared from concentrated acetic acid (from Sigma-Aldrich, CAS No. 64-19-7, puriss. 99-100%).

0.9 to 1.1 g of the sample was weighted into a plastic cup, and 100 ml of an ethanol (A15-A ethanol absolutus from Alcosuisse) - water mixture (60/40 v/v) was added.

15

The titration of the sample was performed in triplicate with the prepared acetic acid solution over time in order to reach a pH value of 5.0 with a control band of 0.5. The titration was performed over a time period of 60 minutes.

20 Stability at pH 6

A 0.1 mol/l solution of acetic acid was prepared from concentrated acetic acid (from Sigma-Aldrich, CAS No. 64-19-7, puriss. 99-100%).

25 Exactly 1.2 g of the sample was weighted in a plastic cup (accuracy 0.1 mg), and 100 ml of an ethanol (A15-A ethanol absolutus from Alcosuisse) - water mixture (60/40 v/v) was added.

The titration of the sample was performed in triplicate with the prepared acetic acid solution over time in order to reach a pH value of 6.0 with a control band of 0.1. The titration was performed over a time period of 60 minutes.

- 5 The final results are listed in the following Table 2 (results at pH 5) and Table 3 (results at pH 6). The results given in Tables 3 and 4 show the acid consumption per hour, measured between 15 and 60 minutes.

Sample	Acid consumption per hour [mmol acetic acid / kg CaCO ₃]	Reduction of acid consumption per hour [%] [(a _n /b)*100] with n = 1,2,3
Calcium carbonate (comparative) (b)	10 605 ± 223	
Sample 1 (a ₁)	2 861 ± 168	73
Sample 2 (a ₂)	1 973 ± 41	81
Sample 3 (a ₃)	2 232 ± 109	79

Table 3: Acid stability at pH 5.

10

Sample	Acid consumption per hour [mmol acetic acid / kg CaCO ₃]	Reduction of acid consumption per hour [%] [(a _n /b)*100] with n = 1,2,3
Calcium carbonate (comparative) (b)	399 ± 17	
Sample 1 (a ₁)	124 ± 5	69
Sample 2 (a ₂)	27 ± 2	93
Sample 3 (a ₃)	35 ± 6	91

Table 4: Acid stability at pH 6.

As can be seen from the above results, both at pH 5 and pH 6, the inventive surface-treated calcium carbonate samples 1 to 3 showed less acid consumption per hour, and, thus, an improved acid stability compared to the comparative untreated calcium carbonate sample.

5

Example 2B – Stability of surface-treated calcium carbonate – pilot-scale

The samples prepared according to Example 1B were analyzed with regard to their stability under acidic conditions at pH 5 by titrating the samples with acetic acid (1.0 mol/l). The untreated calcium carbonate was also analyzed as comparative sample.

10

Stability at pH 5

A 1.0 mol/l solution of acetic acid was prepared from concentrated acetic acid (from Sigma-Aldrich, CAS No. 64-19-7, puriss. 99-100%).

15

0.9 to 1.1 g of the sample was weighted into a plastic cup, and 100 ml of an ethanol (A15-A ethanol absolutus from Alcosuisse) - water mixture (60/40 v/v) was added.

20

The titration of the sample was performed in triplicate with the prepared acetic acid solution over time in order to reach a pH value of 5.0 with a control band of 0.5. The titration was performed over a time period of 60 minutes.

The final results are listed in the following Table 5. The results given in Tables 5 show the acid consumption per hour, measured between 15 and 60 minutes.

25

Sample	pH at t = 0 min	Acid consumption per hour [mmol acetic acid / kg CaCO ₃]
Sample 4 (T0)	6.9	5 470 ± 302
Sample 4 (T1)	6.9	3 514 ± 52
Sample 5 (T0)	7.3	3 462 ± 152
Sample 5 (T1)	8.1	1 025 ± 48
Sample 6 (T0)	8.1	1 673 ± 221
Sample 6 (T1)	8.6	228 ± 44
Sample 7 (T0)	6.7	3 397 ± 126
Sample 7 (T1)	7.4	3 109 ± 14
Sample 8 (T0)	6.9	4 670 ± 233
Sample 8 (T1)	6.8	3 855 ± 387

Table 5: Acid stability at pH 5.

Example 3A – Preparation of body scrub formulations – from abrasive material prepared in lab-scale

5

Each of the different body scrub formulations was prepared according to the following guide formulation:

		wt.-%	grams
A)	Tegin	6.00	18.00
	Isopropyl Myristate	2.00	6.00
	Phenonip	1.00	3.00
	Lanette O	3.00	9.00
B)	Water	42.50	127.50
	Panthenol 75L	1.00	3.00
	Akucel 3285	0.50	1.50
C)	Marlinat 242/70	20.00	60.00
	EUR-AMID N2	2.00	6.00
	Dow Corning HMW 2220 non-ionic Emulsion	1.00	3.00
	EURONAC AMF ULTRA	1.00	3.00

D)	Abrasive material	20.00	60.00
		100.00	300.00

The abrasive material used in part D is listed in Table 6 below.

Formulation	wt.-% abrasive material, based on total weight of formulation	Abrasive material
1 (comparative)	20	calcium carbonate
2	20	sample 1
3	20	sample 2
4	20	sample 3

Table 6: Composition of prepared body scrub formulations.

5 **Procedure:**

1. Melt part A and B separately and keep warm at 85°C (in a water bath)
2. Mix both parts (A and B) under intensive agitation using a Heidolph RZR 2041 mixer at 800 – 1 000 rpm.
3. Homogenize intensively by using a ultra TurraxTM (from IKA, Staufen, Germany) and cool down to room temperature under agitation using a
10 Heidolph RZR 2041 mixer (300 to 350 rpm).
4. Add part C step by step and mix under slow agitation using Heidolph RZR 2041 mixer (150 to 200 rpm) until part C is homogeneously incorporated (appr. 10 - 15 minutes).
- 15 5. Add part D step by step and mix under slow agitation using Heidolph RZR 2041 mixer (150 to 200 rpm; appr. 10 - 15 minutes) until a homogeneous mixture is obtained. The final product can be filled in glass flasks.

Table 7 below is an overview over the type of product used in the above guide
20 formulation as well as the suppliers of these compounds.

- 51 -

Ingredients	INCI Nomenclature	Suppliers
Tegin	Glyceryl Stearate SE	1)
Isopropyl myristate	Isopropyl Myristate	2)
Phenochem	Phenoxyethanol (and) Methylparaben (and) Ethylparaben (and) Butylparaben (and) Propylparaben (and) Isobutylparaben	3)
Lanette O	Cetearyl Alcohol	4)
Water dem.	Aqua (Water)	
D-Panthenol 75 L	Panthenol	5)
Akucell AF 3285	Cellulose Gum	6)
Marlinat 242/70	Sodium Laureth Sulfate	7)
Euro-Amid N2	Cocamide MIPA (and) Laureth-4	8)
Dow Corning HWM 2220 non-ionic emulsion	Divenyldimethicone/Dimethicone Copolymer (and) C12-C13 Pareth -3 (and) C12-C13 Pareth-23	9)
Euronac AMF Ultra	Glycol Distearate (and) Cocamidopropyl Betaine	8)
Omyacare [®] S 20-KA	Calcium Carbonate	10)

Suppliers:

1	Hänseler AG, Switzerland	2	Omya Hamburg GmbH, Germany
3	SLI Chemicals GmbH, Germany	4	Cognis GmbH, Germany
5	DSM, Switzerland	6	Akzo Nobel Functional Chemicals BV; Netherlands
7	Sasol, Germany	8	EOC Surfactants, Belgium
9	Dow Corning Corporation, USA	10	Omya AG, Switzerland
11	Clariant (Schweiz) AG, Switzerland		

- 5 Example 3B – Preparation of body scrub formulations – from abrasive material prepared in pilot-scale (Sample 6 (T0 and T1))

Each of the different body scrub formulations was prepared according to the following guide formulation:

		wt.-%	grams
A)	Tegin	6.00	18.00
	Isopropyl Myristate	2.00	6.00
	Phenonip	1.00	3.00
	Lanette O	3.00	9.00
B)	Water	42.50	127.50
	Panthenol 75L	1.00	3.00
	Akucel 3285	0.50	1.50
C)	Galaxy 70-LES	20.00	60.00
	Texapon WW 100	2.00	6.00
	Dow Corning HMW 2220 non-ionic Emulsion	1.00	3.00
	EURONAC AMF ULTRA	1.00	3.00
D)	Abrasive material	20.00	60.00
		100.00	300.00

The abrasive material used in part D is listed in Table 8 below.

Formulation	wt.-% abrasive material, based on total weight of formulation	Abrasive material
5	20	sample 6 (T1)

Table 8: Composition of prepared body scrub formulations.

5 **Procedure:**

1. Melt part A and B separately and keep warm at 85°C (in a water bath)
2. Mix both parts (A and B) under intensive agitation using a Heidolph RZR 2041 mixer at 800 – 1 000 rpm.
3. Homogenize intensively by using a ultra TurraxTM (from IKA, Staufen,
10 Germany) and cool down to room temperature under agitation using a
Heidolph RZR 2041 mixer (300 to 350 rpm).
4. Add part C step by step and mix under slow agitation using Heidolph RZR
2041 mixer (150 to 200 rpm) until part C is homogeneously incorporated (appr.
10 - 15 minutes).

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5. Add part D step by step and mix under slow agitation using Heidolph RZR 2041 mixer (150 to 200 rpm; appr. 10 - 15 minutes) until a homogenous mixture is obtained. The final product can be filled in glass flasks.

5 Table 9 below is an overview over the type of product used in the above guide formulation as well as the suppliers of these compounds.

Ingredients	INCI Nomenclature	Suppliers
Tegin	Glyceryl Stearate SE	1)
Isopropyl myristate	Isopropyl Myristate	2)
Phenochem	Phenoxyethanol (and) Methylparaben (and) Ethylparaben (and) Butylparaben (and) Propylparaben (and) Isobutylparaben	3)
Lanette O	Cetearyl Alcohol	4)
Water dem.	Aqua (Water)	
D-Panthenol 75 L	Panthenol	5)
Akucell AF 3285	Cellulose Gum	6)
Galaxy 70-LES	Surfactant	2)
Texapon WW 100	Blend of MIPA-Laureth Sulfate, Cocamide DEA (and) Laureth-4	11)
Dow Corning HWM 2220 non-ionic emulsion	Divenyldimethicone/Dimethicone Copolymer (and) C12-C13 Pareth -3 (and) C12-C13 Pareth-23	9)
Euronac AMF Ultra	Glycol Distearate (and) Cocamidopropyl Betaine	8)
Omyacare [®] S 20-KA	Calcium Carbonate	10)

Suppliers:

1	Hänseler AG, Switzerland	2	Omya Hamburg GmbH, Germany
3	SLI Chemicals GmbH, Germany	4	Cognis GmbH, Germany
5	DSM, Switzerland	6	Akzo Nobel Functional Chemicals BV; Netherlands
7	Sasol, Germany	8	EOC Surfactants, Belgium
9	Dow Corning Corporation, USA	10	Omya AG, Switzerland
11	Clariant (Schweiz) AG, Switzerland	11	BASF

Example 4 – Sensory evaluation of the prepared body scrub formulations

The sensory properties of the prepared body scrub formulations 1 to 5 were tested by applying approx. 0.075 ml of the body scrub on the hand or the finger by using a small spoon. The sensory properties of the formulations mentioned below were marked with a rating from 0 to 10, wherein 0 means “not good” and 10 means “very good”.

Evaluated sensory properties:

10

- Aspect

Descriptor	Description
Separation	It is a visible separation between the both phases.
No separation	No separation is visible between the both phases.
Shiny	The product reflects the light under a standard lamp.
No shiny	The product is mat and reflects no light under a standard lamp.
Reaction	Presence of a reaction between the exfoliator and the emulsion.
No reaction	No reaction is visible between the exfoliator and the emulsion.

- Hand movement

15

Descriptor	Description
Fluid	When the product is placed between the thumb and index finger by applying a pressure, it has no holding, flows off the fingers and moves away from the pressure zone. No resistance is felt.
Non fluid	When the product is placed between the thumb and index finger by applying a pressure, there is no flow between the both fingers and it moves not away from the pressure zone. A resistance is felt.

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Stringy	When the product is placed between the thumb and index finger and a distance is slowly applied between the both fingers, it is a continuous string. It breaks when the distance between the fingers becomes too large.
Non stringy	When the product is placed between the thumb and index finger and a distance is slowly applied between the both fingers, there is no string/elongated filament formed.
Slippery	When the product is placed between the thumb and index finger and a movement of friction is made, there is no resistance of particles. The particles make the movement easier.
Non slippery	When the product is placed between the thumb and index finger and a movement of friction is made, there is a resistance. The particles restrict the movement.

- Spread

Descriptor	Description
Spread	Between 5 and 10 turns on the hand, there is a good distribution of product.
Non spread	Between 5 and 10 turns on the hand, there is no repartition of product.
Foaming	Between 10 and 15 rotations on the hand, the product forms foam.
Non foaming	No foaming is visible between 10 and 15 rotations on the hand.
Non Soft (exfoliation)	The particles give no pleasant sensation during the application on the skin.
Soft (exfoliation)	A pleasant and soft exfoliation is felt during the application.

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- After one minute

Descriptor	Description
Greasy	When the product is placed between the thumb and index finger and a movement of friction is applied, the products have an oily aspect.
Non greasy	When the product is placed between the thumb and index finger and a movement of friction is applied, there is no oily aspect.
Sticky	By performing a pressure with index finger on the hand, there is an adhesion.
Non sticky	By performing a pressure with index finger on the hand, there is no adhesion.

- After two minutes

5

Descriptor	Description
Penetrating	The product is disappearing and no residue is detected when touching skin after two minutes.
Non penetrating	There can still a residue be detected on the skin after touching the skin after two minutes.

- During cleaning

Descriptor	Description
Greasy	Under water, when the product is placed between the thumb and index finger and a movement of friction is applied, the products give oily aspect.
Non greasy	Under water, when the product is placed between the thumb

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	and index finger and a movement of friction is applied, there is no oily aspect.
Slippery	Under water, by performing a pressure with index finger on the hand, there is no resistance and good sliding.
Non slippery	Under water, by performing a pressure with index finger on the hand, there is a resistance and no sliding on the hand.

- After rinsing and drying

Descriptor	Description
Greasy	After one minute, when the skin is drying, an oily aspect is felt when a movement is made between the thumb and index fingers.
Non greasy	After one minute, when the skin is drying, no oily aspect is felt when a movement is made between the thumb and index fingers.
Soft	After one minute, when the index finger makes a sliding on the hand, the skin is soft and a dry touch is felt.
Non soft	After one minute, when the index finger makes a sliding on the hand, the skin is rough and no soft touch is felt.

5

Results:

Formulation	1	2	3	4	5
Aspect					
Shiny	8	8	8	7	n.d.
Reaction	0	0	0	0	n.d.

Hand movement					
Fluid	4	5	5	4	0
Stringy	7	6	2	3	2
Slippery	5	7	4	4	5
Spread					
Foaming	5	6	6	6	8
Spread	4	7	6	6	3
Soft (exfoliation)	2	3	3	3	2
After one minute					
Greasy	4	6	4	3	2
Sticky	5	6	4	5	
After two minutes					
Penetrating	8	8	8	8	8
During cleaning					
Greasy	6	6	6	6	3
Slippery	7	8	8	7	8
After rinsing and drying					
Soft	8	9	9	8	9
Greasy	5	4	4	4	1

Table 10: Sensory properties after 6 weeks storage at room temperature.

n.d. = not determined

Formulation	1	2	3	4	5
Aspect					
Shiny	8	8	8	8	n.d.
Reaction	0	0	0	0	n.d.
Hand movement					
Fluid	4	5	4	6	0
Stringy	3	1	2	4	2

Slippery	7	8	4	6	4
Spread					
Foaming	6	6	6	6	6
Spread	4	7	5	5	4
Soft (exfoliation)	2	2	2	2	2
After one minute					
Greasy	2	3	3	2	2
Sticky	2	2	3	2	1
After two minutes					
Penetrating	8	8	8	8	9
During cleaning					
Greasy	6	7	7	7	2
Slippery	7	8	8	7	6
After rinsing and drying					
Soft	8	8	8	8	9
Greasy	5	2	3	4	1

Table 11: Sensory properties after 6 weeks storage at 5°C.

Formulation	1	2	3	4	5
Aspect					
Shiny	7	8	8	8	n.d.
Reaction	0	0	0	0	n.d.
Hand movement					
Fluid	7	6	7	7	0
Stringy	3	4	3	3	2
Slippery	7	6	6	7	5
Spread					
Foaming	6	7	7	6	8

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Spread	7	6	7	6	4
Soft (exfoliation)	4	4	4	3	2
After one minute					
Greasy	3	2	2	3	3
Sticky	2	4	2	2	1
After two minutes					
Penetrating	8	8	8	7	8
During cleaning					
Greasy	6	7	6	6	6
Slippery	8	8	8	7	8
After rinsing and drying					
Soft	8	8	8	8	8
Greasy	6	2	2	2	3

Table 12: Sensory properties after 6 weeks storage at 40°C.

As can be gathered from the results compiled in Tables 10 to 12 above, compared to the others formulation, inventive formulation 2 showed the best “slippery” effect on the skin. Foaming is similar for all, but better at 5°C and 40°C. Spread is improved for the samples stored at 40°C, because the viscosity decreased at the higher storage temperature. The best spread remains the same for the formulations 2 and 4.

After rinsing and cleaning of the skin, the evaluation of the softness (descriptor “soft”) gave practically the same results for all formulae. A greasy aspect leads to a noticeable difference between the samples under peeling.

It has to be noted that formulation 5 cannot be compared with formulations 1 to 4 since different components has been used as ingredient C, however, this formulation also shows a good performance.

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In conclusion, all inventive body scrub formulations showed good sensory performance, confirming that the surface-treated calcium carbonate obtained by the process of the present invention is suitable for cosmetic products such as body scrub.

Claims

1. A process for producing a surface-treated calcium carbonate with improved stability in environments with a pH of 4.5 to 7, wherein the process comprises the steps of:
- 5 i) providing calcium carbonate,
 - ii) providing at least one acid having a pK_a value from 0 to 8, when measured at 20°C,
 - iii) providing at least one conjugate base,
 - 10 iv) contacting the calcium carbonate of step i), the at least one acid of step ii), and the at least one conjugate base of step iii) to form surface-treated calcium carbonate,
- wherein the at least one acid of step ii) and/or the at least one conjugate base of step iii) are provided in form of an aqueous solution.
- 15
2. The process of claim 1, wherein step iv) comprises the steps of:
- a1) contacting the calcium carbonate of step i) and the at least one acid of step ii) to form a pre-treated calcium carbonate, and
 - a2) contacting the pre-treated calcium carbonate of step a1) with the at least one conjugate base of step iii) to form surface-treated calcium carbonate,
- 20 wherein at least the at least one acid of step ii) is provided in form of an aqueous solution.
3. The process of claim 1, wherein step iv) comprises the steps of:
- 25 b1) contacting the calcium carbonate of step i) and the at least one conjugate base of step iii) to form a pre-treated calcium carbonate, and
 - b2) contacting the pre-treated calcium carbonate of step b1) with the at least one acid of step ii) to form surface-treated calcium carbonate,
- wherein at least the at least one conjugate base of step iii) is provided in form of an aqueous solution.
- 30

4. The process of claim 1, wherein the at least one acid of step ii) and the at least one conjugate base of step iii) are provided together in form of an aqueous buffer solution, and in step iv) the calcium carbonate of step i) is contacted with the aqueous buffer solution to form surface-treated calcium carbonate.
5. The process of claim 4, wherein step iv) comprises the steps of:
c1) mixing the calcium carbonate of step i), the aqueous buffer solution, and optionally water, to form an aqueous suspension of surface-treated calcium carbonate, and
c2) separating the surface-treated calcium carbonate from the aqueous suspension obtained from step c1).
6. The process of any one of the preceding claims, wherein the calcium carbonate of step i) is natural ground calcium carbonate, precipitated calcium carbonate, dolomite, agglomerates or aggregates thereof, or a mixture of the aforementioned materials, and preferably natural ground calcium carbonate.
7. The process of any one of the preceding claims, wherein the calcium carbonate of step i) is in form of particles having a volume determined median particle size d_{50} from 1 to 1 500 μm , preferably from 25 to 1 400 μm , more preferably from 100 to 1 200 μm , even more preferably from 200 to 1 000 μm , and most preferably from 300 to 800 μm .
8. The process of any one of the preceding claims, wherein the at least one acid of step ii) is selected from the group consisting of phosphoric acid, citric acid, sulphurous acid, boric acid, acetic acid, tartaric acid, formic acid, propanoic acid, oxalic acid, phosphonic acid, their acidic salts, and mixtures thereof, preferably selected from the group consisting of phosphoric acid, citric acid, tartaric acid, oxalic acid, their acidic salts, and mixtures thereof, and most preferably selected from the

group consisting of phosphoric acid, citric acid, their acidic salts, and mixtures thereof.

9. The process of any one of the preceding claims, wherein the at least one
5 conjugate base of step iii) is an alkali metal salt and/or alkaline earth metal salt of an acid having a pK_a value from 0 to 8, when measured at 20°C, preferably the at least one conjugate base of step iii) is an alkali metal salt and/or alkaline earth metal salt of an acid selected from the group consisting of phosphoric acid, citric acid, sulphurous acid, boric acid, acetic acid, tartaric acid, formic acid, propanoic acid,
10 oxalic acid, phosphonic acid, and mixtures thereof, more preferably the at least one conjugate base of step iii) is a sodium and/or potassium salt of an acid selected from the group consisting of phosphoric acid, citric acid, sulphurous acid, boric acid, acetic acid, tartaric acid, formic acid, propanoic acid, oxalic acid, phosphonic acid, and mixtures thereof, and most preferably the at least one conjugate base of step iii)
15 is a sodium and/or potassium salt of an acid selected from the group consisting of phosphoric acid, citric acid, and mixtures thereof.

10. The process of any one of claims 4 to 9, wherein the aqueous buffer solution has a pH value from 4.0 to 7.5, preferably from 4.5 to 6.0, and most preferably from
20 4.8 to 5.5.

11. The process of any one of claims 4 to 10, wherein the aqueous buffer solution has a concentration from 0.01 mol/kg to 2 mol/kg, preferably from 0.04 to 1.0 mol/kg, more preferably from 0.06 to 0.5 mol/kg, even more preferably from
25 0.07 to 0.4 mol/kg, and most preferably from 0.08 to 0.2 mol/kg.

12. The process of any one of the preceding claims, wherein the calcium carbonate of step i) is in form of particles having a specific BET surface area in the range of > 0 to 5 m^2/g , preferably in the range of > 0 to 2 m^2/g , and more preferably
30 in the range of > 0 to 1 m^2/g .

13. The process of any one of claims 1 to 12, further comprising a step v) of drying the surface-treated calcium carbonate.
- 5 14. A suspension of a surface-treated calcium carbonate with improved stability in environments with a pH of 4.5 to 7 obtainable by a process according to any one of claims 1 to 12.
- 10 15. The suspension of a surface-treated calcium carbonate of claim 14, wherein the surface-treated calcium carbonate has a reduced acid consumption per hour at pH 5 and pH 6 when treated with acetic acid, the reduction being at least 25 %, more preferably at least 50 %, and most preferably at least 70 %.
- 15 16. The suspension of a surface-treated calcium carbonate of claim 14 or 15, wherein the surface-treated calcium carbonate is in form of particles having a specific BET surface area in the range of > 0 to $5 \text{ m}^2/\text{g}$, preferably in the range of > 0 to $2 \text{ m}^2/\text{g}$, and more preferably in the range of > 0 to $1.6 \text{ m}^2/\text{g}$.
- 20 17. A dried surface-treated calcium carbonate with improved stability in environments with a pH of 4.5 to 7 obtainable by a process according claim 13.
- 25 18. The dried surface-treated calcium carbonate of claim 17, wherein the surface-treated calcium carbonate has a reduced acid consumption per hour at pH 5 and pH 6 when treated with acetic acid, the reduction being at least 25 %, more preferably at least 50 %, and most preferably at least 70 %.
- 30 19. The dried surface-treated calcium carbonate of claim 17 or 18, wherein the surface-treated calcium carbonate is in form of particles having a specific BET surface area in the range of > 0 to $5 \text{ m}^2/\text{g}$, preferably in the range of > 0 to $2 \text{ m}^2/\text{g}$, and more preferably in the range of > 0 to $1.6 \text{ m}^2/\text{g}$.

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20. An abrasive cleaning composition comprising a suspension of a surface-treated calcium carbonate according to claims 14 to 16 or a dried surface-treated calcium carbonate according to claims 17 to 19.

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21. Use of a suspension of surface-treated calcium carbonate according to claims 14 to 16 as abrasive material, preferably as abrasive material for cleaning application.

10 22. Use of a dried surface-treated calcium carbonate according to claims 17 to 19 as abrasive material, preferably as abrasive material for cosmetic application and/or cleaning application, more preferably as abrasive material for cosmetic application, and most preferably as abrasive material for topical skin application.

15 23. Use of an abrasive cleaning composition according to claim 20 for cleaning a surface, preferably for cleaning an animate surface, and more preferably for cleaning an animate surface selected from the group consisting of human skin, animal skin, human hair, animal hair, and tissues of the oral cavity such as teeth, gums, tongue or buccal surfaces.

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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2016/050536

A. CLASSIFICATION OF SUBJECT MATTER
 INV. C09C1/02 A61K8/19 C11D3/14
 ADD.

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)
 C09C A61K C11D A61Q C09K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
 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.
X Y A	US 2012/111520 A1 (SHEN JING [CN] ET AL) 10 May 2012 (2012-05-10) claims 1-17 paragraphs [0036] - [0042], [0054] -----	1-19 2,4,5 20-23
X Y A	US 5 156 719 A (PASSARETTI JUNE D [US]) 20 October 1992 (1992-10-20) claims 1-12 column 3, line 63 - column 4, line 18 column 4, lines 40-53 column 6, lines 38-48 -----	1,3,6-19 2,4,5 20-23
X A	WO 2013/191903 A1 (3M INNOVATIVE PROPERTIES CO [US]; HAEBERLEIN INGO R [DE]; SCHMID BREND) 27 December 2013 (2013-12-27) claims 1,7,8 paragraphs [0036] - [0042], [0054] -----	20-23 1-19

Further documents are listed in the continuation of Box C.

See patent family annex.

* Special categories of cited documents :

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Date of the actual completion of the international search 19 February 2016	Date of mailing of the international search report 29/02/2016
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2016/050536

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2012111520 A1	10-05-2012	CN 102051071 A US 2012111520 A1	11-05-2011 10-05-2012
US 5156719 A	20-10-1992	NONE	
WO 2013191903 A1	27-12-2013	EP 2861202 A1 US 2015125814 A1 WO 2013191903 A1	22-04-2015 07-05-2015 27-12-2013