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(54) **COMPOSITIONS**

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(57) **ABSTRACT**

A composition comprising alkaline earth metal carbonate and phyllosilicate, use of a composition comprising alkaline earth metal carbonate and phyllosilicate as a filler in a paper product and a method of preparing a composition comprising alkaline earth metal carbonate and phyllosilicate.

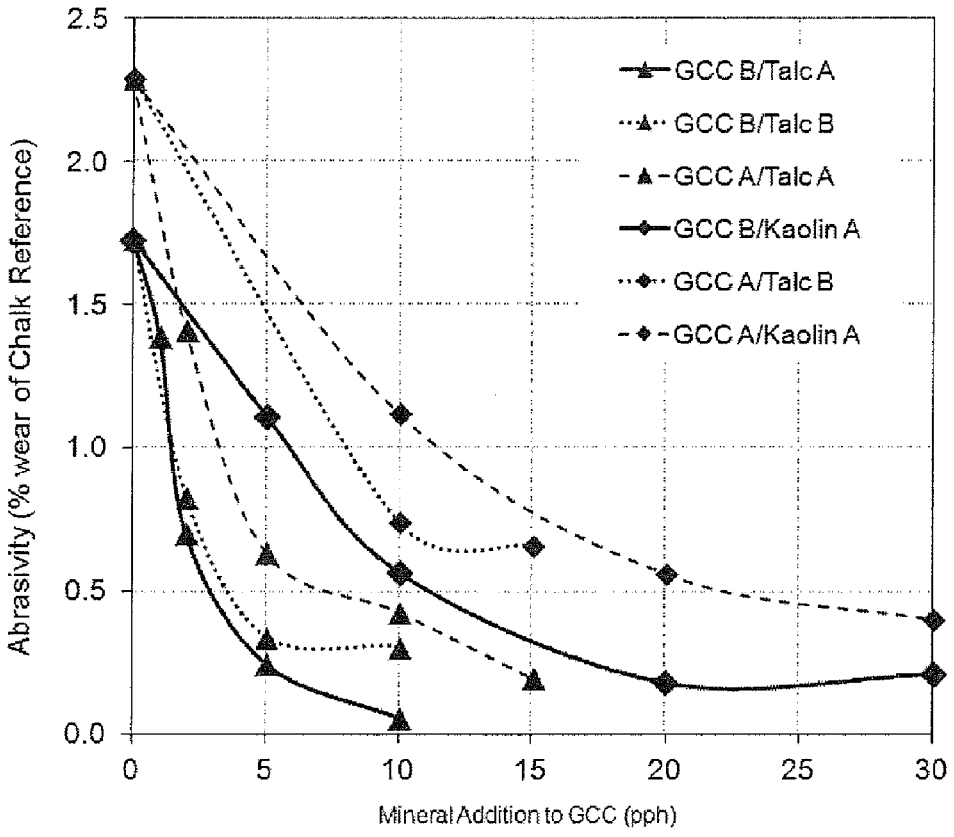


FIG. 1

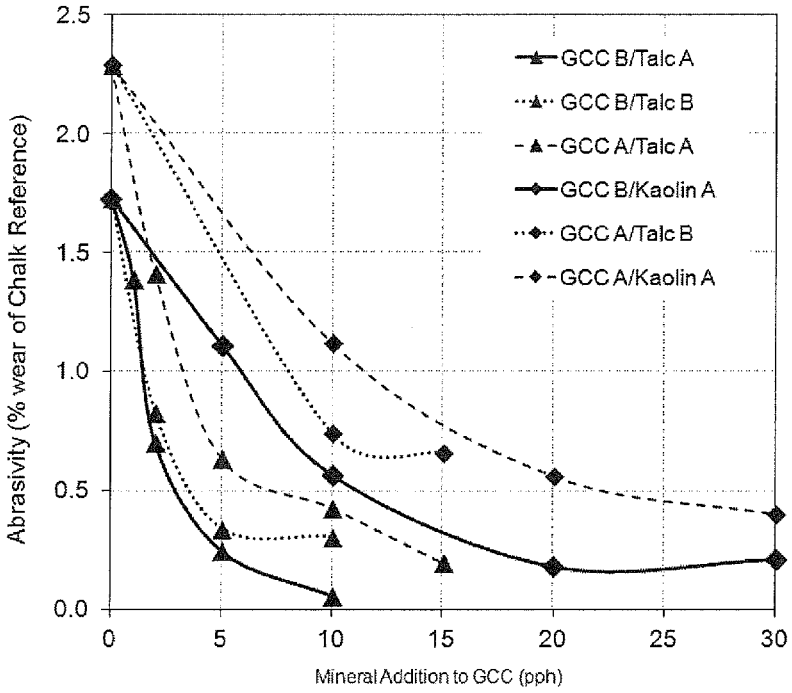
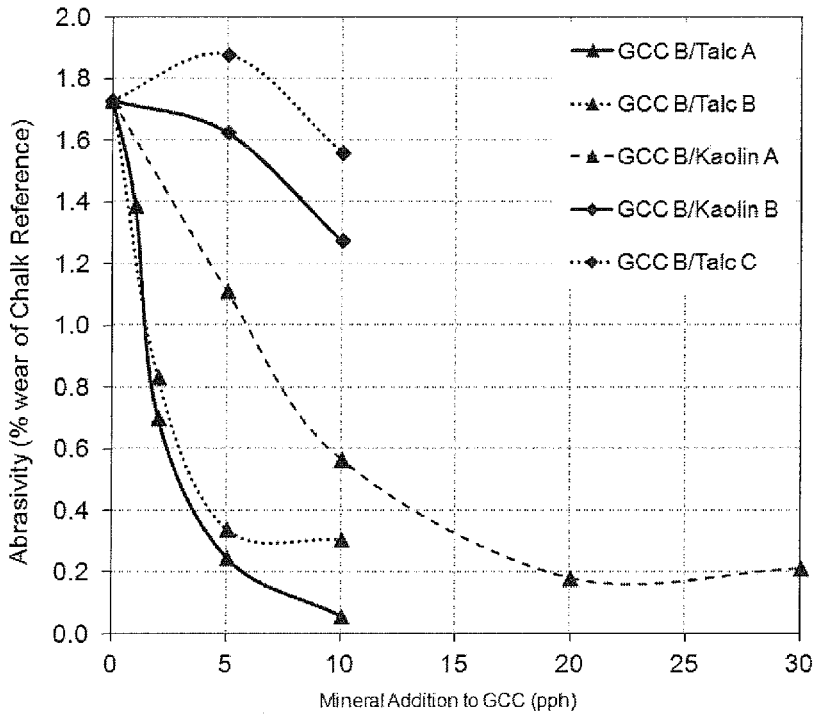

Abrasivity (% wear of Chalk Reference)
2.5
2.0
1.5
1.0
0.5
0.0
0
5
10
15
20
25
30
Mineral Addition to GCC (pph)
GCC B/Talc A
GCC B/Talc B
GCC A/Talc A
GCC B/Kaolin A
GCC A/Talc B
GCC A/Kaolin A

FIG. 2


Abrasivity (% wear of Chalk Reference)
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0
5
10
15
20
25
30
Mineral Addition to GCC (pph)
GCC B/Talc A
GCC B/Talc B
GCC B/Kaolin A
GCC B/Kaolin B
GCC B/Talc C

COMPOSITIONS

FIELD OF THE INVENTION

[0001] The present invention relates generally to compositions comprising alkaline earth metal carbonate and phyllosilicate. The present invention further relates to the use of these compositions as a filler in a paper product. As such, the present invention also relates to a papermaking composition comprising a composition comprising alkaline earth metal carbonate and phyllosilicate, and paper products prepared from this papermaking composition. The present invention also relates to a process for making a paper product. The present invention additionally relates to a process for preparing a composition comprising alkaline earth metal carbonate and phyllosilicate.

BACKGROUND OF THE INVENTION

[0002] Compositions comprising one or more inorganic particulate materials, are used widely in a number of applications. These include, for example, as a filler or extender in numerous materials such as adhesives, sealants, glass, ceramics, rubber, paints, paper and plastics. The presence of an inorganic particulate material may provide advantageous properties such as colour, opacity, brightness, gloss, rheology, hardness, chemical resistance, thermal resistance or thermal conductivity.

[0003] For example, compositions comprising inorganic particulate material may be used in paper manufacture. In paper products, such compositions may typically be used as fillers, for example to replace a portion of other more expensive components of the paper product. Fillers may also be added with an aim of modifying the physical, mechanical and/or optical properties of the paper product. The amount of filler added must be balanced against the physical, mechanical and/or optical requirements of the final paper product. For example, the amount of filler added may affect the opacity, brightness and/or yellowness (for example yellowness index (b*(CIE)) of the final paper product.

[0004] The use of compositions comprising inorganic particulate material in paper manufacture may also affect the paper production process. For example, the use of inorganic particulate material may contribute to abrasion of the papermaking machine. For example, the use of inorganic particulate material may cause abrasion of the wire and felt at the wet-end of the papermaking machine, wear of doctor blades (for example at the press section), internal wear of pumps, and slitter knife wear in conversion operations. It is difficult to achieve a balance between obtaining a paper product which has desirable properties (such as opacity, brightness and/or yellowness) and reducing or minimising abrasion of the paper making machine.

[0005] It is therefore desirable to provide an alternative and/or an improved composition comprising inorganic particulate material, which is suitable for use in paper manufacture. For example, it may be desirable to provide a composition comprising inorganic particulate material which shows improved (i.e. reduced) abrasivity in comparison to other compositions comprising inorganic particulate material. Alternatively or additionally, it may be desirable to provide a composition comprising inorganic particulate material which has favourable optical properties, for example favourable opacity, brightness and/or yellowness (for example yellowness index (b*(CIE)). It may be desirable to at least maintain the optical properties of the composition, or it may be desirable to improve the optical properties of the composition. For example, it may be desirable to provide a composition comprising inorganic particulate material which shows increased opacity and/or brightness and/or decreased yellowness in comparison to other compositions comprising inorganic particulate material. In particular, it may be desirable to provide a composition suitable for paper manufacture and/or paper coating which at least maintains the optical properties of the final paper product whilst reducing abrasion of the papermaking machine. The provision of a composition which may have one or more of these desirable properties may enable alternative or improved papermaking compositions and/or paper products to be produced.

SUMMARY OF THE INVENTION

[0006] In accordance with a first aspect of the present invention, there is provided a composition comprising alkaline earth metal carbonate and phyllosilicate, wherein the solids content of the composition comprises at least about 45 wt % alkaline earth metal carbonate and at least about 2 wt % phyllosilicate.

[0007] In accordance with a second aspect of the present invention, there is provided a composition comprising alkaline earth metal carbonate and phyllosilicate, wherein from about 45 wt % to about 85 wt % of particles in the composition are smaller than about 2 μm, from about 15 wt % to about 30 wt % of particles in the composition are smaller than about 0.5 μm, and up to about 20 wt % of particles in the composition are larger than about 10 μm.

[0008] In accordance with a third aspect of the present invention, there is provided a composition comprising alkaline earth metal carbonate and phyllosilicate, wherein from about 35 wt % to about 90 wt % of the alkaline earth metal carbonate particles are smaller than about 2 μm and from about 5 wt % to about 90 wt % of the phyllosilicate particles are smaller than about 2 μm.

[0009] In accordance with a fourth aspect of the present invention, there is provided a use of a composition of the first, second or third aspect of the present invention as a filler in a paper product.

[0010] In accordance with a fifth aspect of the present invention, there is provided a papermaking composition comprising a composition of the first, second or third aspect of the present invention.

[0011] In accordance with a sixth aspect of the present invention, there is provided a paper product prepared from the papermaking composition of the fifth aspect of the present invention.

[0012] In accordance with a seventh aspect of the present invention, there is provided a paper product comprising a filler, wherein the filler comprises a composition of the first, second or third aspect of the present invention.

[0013] In accordance with an eighth aspect of the present invention, there is provided a process for preparing a composition of the first, second or third aspect of the present invention comprising combining alkaline earth metal carbonate and phyllosilicate.

[0014] In accordance with a ninth aspect of the present invention, there is provided a process for making a paper product comprising combining a composition of the first, second or third aspect of the present invention with a fibrous

pulp suitable for making a paper product to form a papermaking composition, and forming a paper product from the papermaking composition.

[0015] In certain embodiments of the second or third aspect of the present invention, the solids content of the composition comprising alkaline earth metal carbonate and phyllosilicate comprises at least about 45 wt % alkaline earth metal carbonate.

[0016] In certain embodiments of any aspect of the present invention, the solids content of the composition comprising alkaline earth metal carbonate and phyllosilicate comprises from about 45 wt % to about 98 wt % alkaline earth metal carbonate. In certain embodiments, the solids content of the composition comprises from about 45 wt % to about 97 wt % alkaline earth metal carbonate. In certain embodiments, the solids content of the composition comprises from about 45 wt % to about 95 wt % alkaline earth metal carbonate. In certain embodiments, the solids content of the composition comprises at least about 50 wt % alkaline earth metal carbonate. In certain embodiments, the solids content of the composition comprises from about 50 wt % to about 90 wt % alkaline earth metal carbonate. In certain embodiments, the solids content of the composition comprises from about 70 wt % to about 90 wt % alkaline earth metal carbonate.

[0017] In certain embodiments of the second or third aspect of the present invention, the solids content of the composition comprising alkaline earth metal carbonate and phyllosilicate comprises at least about 2 wt % phyllosilicate.

[0018] In certain embodiments of any aspect of the present invention, the solids content of the composition comprising alkaline earth metal carbonate and phyllosilicate comprises from about 2 wt % to about 55 wt % phyllosilicate. In certain embodiments, the solids content of the composition comprises at least about 3 wt % phyllosilicate. In certain embodiments, the solids content of the composition comprises from about 3 wt % to about 55 wt % phyllosilicate. In certain embodiments, the solids content of the composition comprises at least about 5 wt % phyllosilicate. In certain embodiments, the solids content of the composition comprises from about 5 wt % to about 55 wt % phyllosilicate. In certain embodiments, the solids content of the composition comprises at least about 10 wt % phyllosilicate. In certain embodiments, the solids content of the composition comprises from about 10 wt % to about 50 wt % phyllosilicate. In certain embodiments, the solids content of the composition comprises from about 10 wt % to about 30 wt % phyllosilicate.

[0019] In certain embodiments of any aspect of the present invention, the alkaline earth metal carbonate is calcium carbonate, for example ground calcium carbonate (GCC). In certain embodiments, the alkaline earth metal carbonate is marble.

[0020] In certain embodiments of any aspect of the present invention, the phyllosilicate is kaolin. In certain embodiments of any aspect of the present invention, the phyllosilicate is talc. In certain embodiments, the phyllosilicate is a combination or blend of kaolin and talc.

[0021] In certain embodiments of any aspect of the present invention, the solids content of the composition comprises from about 10 wt % to about 30 wt % kaolin. In certain embodiments, the solids content of the composition comprises from about 2 wt % to less than about 21 wt % talc. In certain embodiments, the solids content of the composition comprises from about 3 wt % to about 15 wt % talc.

[0022] In certain embodiments of any aspect of the present invention, from about 35 wt % to about 90 wt % of the alkaline earth metal carbonate particles are smaller than about 2 μm. In certain embodiments, from about 80 wt % to about 100 wt % of the alkaline earth metal carbonate particles are smaller than about 5 μm. In certain embodiments, from about 4 wt % to about 35 wt % of the alkaline earth metal carbonate particles are smaller than about 0.5 μm.

[0023] In certain embodiments of any aspect of the present invention, from about 5 wt % to about 90 wt % of the phyllosilicate particles are smaller than about 2 μm. In certain embodiments, from about 20 wt % to about 100 wt % of the phyllosilicate particles are smaller than about 5 μm. In certain embodiments, from about 0 wt % to about 55 wt % of the phyllosilicate particles are smaller than about 0.5 μm.

[0024] In certain embodiments of any aspect of the present invention, the phyllosilicate comprises kaolin and from about 30 wt % to about 90 wt % of the kaolin particles are smaller than about 2 μm. In certain embodiments, the phyllosilicate is talc and from about 5 wt % to about 40 wt % of the talc particles are smaller than about 2 μm.

[0025] In certain embodiments of any aspect of the present invention, the composition comprising alkaline earth metal carbonate and phyllosilicate comprises less than about 0.3% dispersant based on the total weight of the dry alkaline earth metal carbonate.

[0026] In certain embodiments of any aspect of the present invention, from about 45 wt % to about 85 wt % of particles in the composition comprising alkaline earth metal carbonate and phyllosilicate are smaller than about 2 μm.

[0027] In certain embodiments of any aspect of the present invention, from about 15 wt % to about 30 wt % of particles in the composition comprising alkaline earth metal carbonate and phyllosilicate are smaller than about 0.5 μm.

[0028] In certain embodiments of any aspect of the present invention, up to about 20 wt % of particles in the composition comprising alkaline earth metal carbonate and phyllosilicate are larger than about 10 μm.

[0029] In certain embodiments of any aspect of the present invention, the composition comprising alkaline earth metal carbonate and phyllosilicate demonstrates at least about 10% less abrasivity in comparison to a corresponding composition which does not comprise the phyllosilicate. In certain embodiments, the composition demonstrates at least about 20% less abrasivity in comparison to the corresponding composition which does not comprise the phyllosilicate.

[0030] In certain embodiments of any aspect of the present invention, the composition has a brightness between about 85 and about 95. In certain embodiments, the composition has a brightness between about 88 and about 95.

[0031] In certain embodiments of any aspect of the present invention, the composition comprising alkaline earth metal carbonate and phyllosilicate is an aqueous suspension. In certain embodiments, the composition is a dry mineral blend.

[0032] In certain embodiments of the fifth aspect of the present invention, the papermaking composition comprises a fibrous pulp and optionally further comprises one or more additives selected from one or more retention aids, one or more sizing agents, one or more dyes, one or more optical brightening agents and one or more strength aids.

[0033] In certain embodiments of the ninth aspect of the present invention, the fibrous pulp comprises cellulose.

[0034] The details, examples and preferences provided in relation to any particular one or more of the stated aspects of the present invention apply equally to all aspects of the present invention. Any combination of the embodiments, examples and preferences described herein in all possible variations thereof is encompassed by the present invention unless otherwise indicated herein, or otherwise clearly contradicted by context.

DETAILED DESCRIPTION OF THE INVENTION

[0035] In certain embodiments of the present invention, a composition comprising alkaline earth metal carbonate and phyllosilicate is provided, which is advantageous in that it demonstrates low abrasion whilst maintaining or improving optical properties such as opacity, brightness and yellowness. In other embodiments of the present invention, an improved process for making paper is provided, which may, for example, reduce abrasion of the papermaking machine. In still other embodiments of the present invention, an alternative process for making paper is provided.

[0036] In accordance with certain embodiments of the present invention, it has been surprisingly found that addition of phyllosilicate to a composition comprising alkaline earth metal carbonate results in a composition which demonstrates reduced abrasion in comparison to a composition comprising alkaline earth metal carbonate which does not comprise the phyllosilicate. In certain embodiments of the present invention, it has been surprisingly found that addition of phyllosilicate to a composition comprising alkaline earth metal carbonate results in a composition which has optical properties such as opacity, brightness and yellowness which are substantially similar, at least as good or better than that of compositions comprising alkaline earth metal carbonate which do not comprise the phyllosilicate. In certain embodiments of the present invention, the compositions described herein are used for paper manufacture in order to obtain a paper product which has favourable optical properties (e.g. maintained or improved optical properties) whilst reducing abrasion of the papermaking machine.

Compositions Comprising Alkaline Earth Metal Carbonate and Phyllosilicate

[0037] There is provided herein a composition comprising, consisting essentially of, or consisting of alkaline earth metal carbonate and phyllosilicate.

[0038] Any one of the alkaline earth metal carbonate, phyllosilicate or combinations thereof may be referred to herein as inorganic particulate material.

[0039] In certain aspects, the composition of the present invention comprises alkaline earth metal carbonate and phyllosilicate, wherein the solids content of the composition comprises at least about 45 wt % alkaline earth metal carbonate and at least about 2 wt % phyllosilicate.

[0040] The weight % of alkaline earth metal carbonate in the solids content of the composition is the percentage mass of alkaline earth metal carbonate in the material on a dry basis. Similarly, the weight % of phyllosilicate in the solids content of the composition is the percentage mass of phyllosilicate in the material on a dry basis.

[0041] In other aspects, the composition of the present invention comprises alkaline earth metal carbonate and phyllosilicate, wherein from about 45 wt % to about 85 wt % of particles in the composition are smaller than about 2 μm, from about 15 wt % to about 30 wt % of particles in the composition are smaller than about 0.5 μm, and up to about 20 wt % of particles in the composition are larger than about 10 μm.

[0042] The weight % of particles in the composition being smaller than about 2 μm is the percentage mass of particles which are smaller than about 2 μm in the total mass of particles present in the composition. Similarly, the weight % of particles in the composition being larger than about 10 μm is the percentage mass of particles which are larger than about 10 μm in the total mass of particles present in the composition.

[0043] In other aspects, the composition of the present invention comprises alkaline earth metal carbonate and phyllosilicate, wherein from about 35 wt % to about 90 wt % of the alkaline earth metal carbonate particles are smaller than about 2 μm and from about 5 wt % to about 90 wt % of the phyllosilicate particles are smaller than about 2 μm.

[0044] The weight % of alkaline earth metal carbonate particles being smaller than about 2 μm is the percentage mass of alkaline earth metal carbonate particles which are smaller than about 2 μm in the total mass of alkaline earth metal carbonate particles in the composition. Similarly, the weight % of phyllosilicate particles being smaller than about 2 μm is the percentage mass of phyllosilicate particles which are smaller than about 2 μm in the total mass of phyllosilicate particles in the composition.

[0045] In certain embodiments of any aspect of the present invention the composition is an aqueous suspension. In certain embodiments, the solids content of the aqueous suspension is from about 20% to about 75% by weight of the composition. For example, the solids content of the composition may be from about 30% to about 65%, for example from about 40% to about 60%, by weight. The solids content of the aqueous suspension is the percentage mass of material remaining after the aqueous suspension has been dried to contain zero moisture.

[0046] In other embodiments of any aspect of the present invention, the composition is a dry mineral blend.

[0047] In certain embodiments, the composition may initially be in the form of an aqueous suspension and the aqueous suspension may then be treated to remove at least a portion or substantially all of the water to form a partially dried or essentially completely dried product. For example, at least about 10% by volume of water in the aqueous suspension may be removed from the aqueous suspension, for example, at least about 20% by volume, or at least about 30% by volume, or least about 40% by volume, or at least about 50% by volume, or at least about 60% by volume, or at least about 70% by volume or at least about 80% by volume or at least about 90% by volume, or at least about 100% by volume of water in the aqueous suspension may be removed. Any suitable technique can be used to remove water from the aqueous suspension including, for example, by gravity or vacuum-assisted drainage, with or without pressing, or by evaporation, or by filtration, or by a combination of these techniques. The partially dried or essentially completely dried product will comprise alkaline earth metal carbonate and phyllosilicate particulate material and any other optional additives that may have been added to the

aqueous suspension prior to drying. The partially dried or essentially completely dried product may be stored or packaged for sale. The partially dried or essentially completely dried product may be optionally re-hydrated and incorporated in papermaking compositions and other paper products, as described herein.

[0048] In certain embodiments of any aspect of the present invention, the solids content of the composition consists essentially of or consists of alkaline earth metal carbonate and phyllosilicate. For example, the solids content of the composition may consist essentially of or consist of from about 45 wt % to about 98 wt % alkaline earth metal carbonate and from about 2 wt % to about 55 wt % phyllosilicate. For example, the solids content of the composition may consist essentially of or consist of from about 45 wt % to about 97 wt % alkaline earth metal carbonate and from about 3 wt % to about 55 wt % phyllosilicate. For example, the solids content of the composition may consist essentially of or consist of from about 45 wt % to about 95 wt % alkaline earth metal carbonate and from about 5 wt % to about 55 wt % phyllosilicate. For example, the solids content of the composition may consist essentially of or consist of from about 50 wt % to about 90 wt % alkaline earth metal carbonate and from about 10 wt % to about 50 wt % phyllosilicate. For example, the solids content of the composition may consist essentially of or consist of from about 70 wt % to about 90 wt % alkaline earth metal carbonate and from about 10 wt % to about 30 wt % phyllosilicate.

[0049] In certain embodiments of any aspect of the present invention, the solids content of the composition consists essentially of or consists of calcium carbonate and talc. For example, the solids content of the composition may consist essentially of or consist of from about 45 wt % to about 98 wt % calcium carbonate and from about 2 wt % to about 55 wt % talc. For example, the solids content of the composition may consist essentially of or consist of from about 70 wt % to about 98 wt % calcium carbonate and from about 2 wt % to about 30 wt % talc. For example, the solids content of the composition may consist essentially of or consist of from about 80 wt % to about 98 wt % calcium carbonate and from about 2 wt % to about 20 wt % talc. For example, the solids content of the composition may consist essentially of or consist of from about 85 wt % to about 98 wt % calcium carbonate and from about 2 wt % to about 15 wt % talc. For example, the solids content of the composition may consist essentially of or consist of from about 80 wt % to about 97 wt % calcium carbonate and from about 3 wt % to about 20 wt % talc, for example the solids content of the composition may consist essentially of or consist of from about 85 wt % to about 97 wt % calcium carbonate and from about 3 wt % to about 15 wt % talc.

[0050] In certain embodiments of any aspect of the present invention, the solids content of the composition consists essentially of or consists of calcium carbonate and kaolin. For example, the solids content of the composition may consist essentially of or consist of from about 45 wt % to about 98 wt % calcium carbonate and from about 2 wt % to about 55 wt % kaolin. For example, the solids content of the composition may consist essentially of or consist of from about 50 wt % to about 90 wt % calcium carbonate and from about 10 wt % to about 50 wt % kaolin. For example, the solids content of the composition may consist essentially of or consist of from about 60 wt % to about 90 wt % calcium carbonate and from about 10 wt % to about 40 wt % kaolin. For example, the solids content of the composition may consist essentially of or consist of from about 70 wt % to about 90 wt % calcium carbonate and from about 10 wt % to about 30 wt % kaolin.

[0051] In other embodiments of any aspect of the present invention, the solids content of the composition comprises alkaline earth metal carbonate and phyllosilicate. In certain embodiments, the composition may further comprise other solids, such as other inorganic particulate materials. For example, the composition may further comprise one or more other inorganic particulate materials which are suitable for use as fillers in papermaking compositions.

[0052] In certain embodiments, when the alkaline earth metal carbonate, phyllosilicate or any other inorganic particulate material present in the composition is obtained from naturally occurring sources, it may be that some mineral impurities will inevitably contaminate the ground material. For example, naturally occurring calcium carbonate occurs in association with other minerals. In general, however, the inorganic particulate material used in certain embodiments of the present invention, for example the alkaline earth metal carbonate and/or phyllosilicate may contain less than about 5% by weight, for example less than about 1% by weight of other mineral impurities based on the total dry weight of that particular inorganic particulate material. For example, calcium carbonate may contain less than about 5% by weight, for example less than about 1% by weight, of other mineral impurities based on the total dry weight of calcium carbonate in the composition.

[0053] In certain embodiments of any aspect of the present invention, the composition comprises less than about 0.3% dispersant based on the total weight of dry alkaline earth metal carbonate. For example, the composition may comprise less than about 0.2% dispersant, for example less than about 0.1% dispersant based on the total weight of dry alkaline earth metal carbonate. For example, the composition may comprise no dispersant.

[0054] In certain embodiments, the solids content is equal to or higher than 40 wt % and the composition comprises less than about 0.3% dispersant based on the total weight of dry alkaline earth metal carbonate.

[0055] In certain embodiments of any aspect of the present invention, the composition has a particle size distribution such that from about 45 wt % to about 85 wt % of particles in the composition are smaller than about 2 μm. For example, from about 50 wt % to about 80 wt %, for example from about 55 wt % to about 75 wt %, for example from about 60 wt % to about 70 wt % of particles may be smaller than about 2 μm.

[0056] In certain embodiments of any aspect of the present invention, the composition has a particle size distribution such that from about 15 wt % to about 30 wt % of particles in the composition are smaller than about 0.5 μm. For example from about 17 wt % to about 30 wt %, for example from about 17 wt % to about 25 wt %, for example from about 17 wt % to about 23 wt % of particles may be smaller than about 0.5 μm. For example, from about 20 wt % to about 30 wt %, for example from about 20 wt % to about 25 wt % of particles may be smaller than about 0.5 μm.

[0057] In certain embodiments of any aspect of the present invention, the composition has a particle size distribution such that up to about 20 wt % of particles in the composition are larger than about 10 μm. For example, from about 1 wt

% to about 20 wt %, for example from about 1 wt % to about 15 wt %, for example from about 1 wt % to about 10 wt %, for example from about 1 wt % to about 5 wt % of particles may be larger than about 10 μm. For example, from about 2 wt % to about 20 wt %, for example from about 2 wt % to about 15 wt %, for example from about 2 wt % to about 10 wt %, for example from about 2 wt % to about 5 wt % of particles may be larger than about 10 μm. For example, from about 5 wt % to about 20 wt %, for example from about 5 wt % to about 15 wt %, for example from about 5 wt % to about 10 wt % of particles may be larger than about 10 μm.

[0058] In certain embodiments of any aspect of the present invention, the composition demonstrates at least about 10% less abrasivity in comparison to a corresponding composition comprising alkaline earth metal carbonate which does not comprise the phyllosilicate. For example, the composition may demonstrate at least about 20% less abrasivity, for example at least about 30% less abrasivity, for example at least about 40% less abrasivity, for example at least about 50% less abrasivity, for example at least about 60% less abrasivity, for example at least about 70% less abrasivity in comparison to a corresponding composition comprising alkaline earth metal carbonate which does not comprise the phyllosilicate.

[0059] Unless otherwise stated, abrasivity is measured by providing a piece of fabric and rotating a roller against said fabric whilst continuously applying diluted mineral slurry onto the fabric. The mineral slurry may have different solids contents depending on the abrasivity of the mineral material. For example, a slurry with lower % solids may be used for high abrasive materials, whereas a slurry with higher % solids may be used for low abrasive materials. Abrasivity is quantified by the average weight loss of the fabric over a set period of time in comparison to a slurry comprising a reference control material.

[0060] In certain embodiments of any aspect of the present invention, the composition has a brightness from about 85 to about 95. For example, the composition may have a brightness from about 88 to about 95, for example from about 90 to about 95.

[0061] Unless otherwise stated, brightness referred to herein is ISO brightness. The ISO brightness is the percentage of light reflected by a body compared to that reflected by a perfectly reflecting diffuser measured at 457 nm. A Datacolor Elrepho 450X spectrophotometer may be used.

[0062] A test surface is produced by pulverizing a dried material, for example using an Imerys pulveriser, to disperse it completely then compressing it to form a powder tablet.

[0063] The reflectance values of this tablet are measured at 457 nm. The primary standard adopted was an ISO level 2 reflectance standard, supplied and calibrated by Physikalisch-Technische Bundesanstalt (P.T.B.) Germany. A working standard, in this case a ceramic tile, was used to calibrate the photometer for brightness measurements which had been calibrated previously against the level 2 standard.

Alkaline Earth Metal Carbonate

[0064] The alkaline earth metal carbonate used in certain embodiments of the present invention may be selected from the carbonate of any metal belonging to Group II of the Periodic Table, for example the carbonates of beryllium, magnesium, calcium and strontium. In certain embodiments, the alkaline earth metal carbonate is calcium carbonate, for example ground calcium carbonate (GCC) or precipitated calcium carbonate (PCC). In certain embodiments, the alkaline earth metal carbonate is magnesium carbonate. In certain embodiments, the alkaline earth metal carbonate is calcium magnesium carbonate, for example dolomite ($CaMg(CO_3)_2$). In certain embodiments, the alkaline earth metal carbonate is obtained from naturally occurring mineral sources, for example limestone, chalk, marble, travertine and tufa. In certain embodiments, the alkaline earth metal carbonate is marble. The alkaline earth metal carbonate may be selected from any one or more of the materials listed above. The alkaline earth metal carbonate may comprise a blend of any of the listed materials. For example, the alkaline earth metal carbonate may comprise a blend of calcium carbonate and magnesium carbonate. For example, the alkaline earth metal carbonate may comprises a blend of calcium carbonate and calcium magnesium carbonate. For example, a mixture of two or more particulate alkaline earth metal carbonates may be ground together (i.e., co-ground). In certain embodiments, the alkaline earth metal carbonate is co-ground with the phyllosilicate. For example, ground calcium carbonate (GCC) may be co-ground with kaolin and/or talc. For example, marble may be co-ground with kaolin and/or talc. Hereinafter, certain embodiments of the present invention may tend to be discussed in terms of calcium carbonate. However, the invention should not be construed as being limited to such embodiments.

[0065] Calcium carbonate is particularly suitable for use in connection with certain embodiments of the present invention. Examples of calcium carbonate include ground calcium carbonate (GCC) and precipitated calcium carbonate (PCC).

[0066] The calcium carbonate used in certain embodiments of the present invention may be obtained from a natural source by grinding or may be prepared synthetically by precipitation (PCC), or may be a combination of the two, i.e. a mixture of the naturally derived ground material and the synthetic precipitated material. The PCC may also be ground.

[0067] Ground calcium carbonate (GCC) is typically obtained by grinding a mineral source such as chalk, marble or limestone, which may be followed by a particle size classification step, in order to obtain a product having the desired degree of fineness. The particulate solid material may be ground autogenously, i.e. by attrition between the particles of the solid material themselves, or alternatively, in the presence of a particulate grinding medium comprising particles of a different material from the calcium carbonate to be ground.

[0068] Wet grinding of calcium carbonate involves the formation of an aqueous suspension of the calcium carbonate which may then be ground, optionally in the presence of a suitable dispersing agent. Reference may be made to, for example, EP-A-614948 (the contents of which are incorporated by reference in their entirety) for more information regarding the wet grinding of calcium carbonate.

[0069] PCC may be used as the source of particulate calcium carbonate in certain embodiments of the present invention, and may be produced by any of the known methods available in the art. TAPPI Monograph Series No 30, "Paper Coating Pigments", pages 34-35 describes the three main commercial processes for preparing precipitated calcium carbonate which is suitable for use in preparing products for use in the paper industry, but may also be used in connection with the certain embodiments of the present invention. In all three processes, limestone is first calcined

to produce quicklime, and the quicklime is then slaked in water to yield calcium hydroxide or milk of lime. In the first process, the milk of lime is directly carbonated with carbon dioxide gas. This process has the advantage that no by-product is formed, and it is relatively easy to control the properties and purity of the calcium carbonate product. In the second process, the milk of lime is contacted with soda ash to produce, by double decomposition, a precipitate of calcium carbonate and a solution of sodium hydroxide. The sodium hydroxide should be substantially completely separated from the calcium carbonate if this process is to be commercially attractive. In the third main commercial process, the milk of lime is first contacted with ammonium chloride to give a calcium chloride solution and ammonia gas. The calcium chloride solution is then contacted with soda ash to produce, by double decomposition, precipitated calcium carbonate and a solution of sodium chloride.

[0070] The process for making PCC results in very pure calcium carbonate crystals and water. The crystals can be produced in a variety of different shapes and sizes, depending on the specific reaction process that is used. The three main forms of PCC crystals are aragonite, rhombohedral and scalenohedral, all of which are suitable for use in certain embodiments of the present invention, including mixtures thereof.

[0071] In certain embodiments, the solids content of the composition comprising alkaline earth metal carbonate and phyllosilicate comprises at least about 45 wt % alkaline earth metal carbonate. For example, the solids content of the composition may comprise from about 45 wt % to about 98 wt % alkaline earth metal carbonate, for example from about 45 wt % to about 97 wt % alkaline earth metal carbonate, for example from about 45 wt % to about 95 wt % alkaline earth metal carbonate, for example from about 45 wt % to about 90 wt % alkaline earth metal carbonate. In certain embodiments, the solids content of the composition comprises at least about 50 wt % alkaline earth metal carbonate. For example, the solids content of the composition may comprise from about 50 wt % to about 98 wt %, for example from about 50 wt % to about 97 wt %, for example from about 50 wt % to about 95 wt %, for example from about 50 wt % to about 90 wt % alkaline earth metal carbonate. In certain embodiments, the solids content of the composition comprises from about 60 wt % to about 98 wt %, for example from about 60 wt % to about 97 wt %, for example from about 60 wt % to about 95 wt %, for example from about 60 wt % to about 90 wt % alkaline earth metal carbonate. In certain embodiments, the solids content of the composition comprises from about 70 wt % to about 98 wt %, for example from about 70 wt % to about 97 wt %, for example from about 70 wt % to about 95 wt %, for example from about 70 wt % to about 90 wt % alkaline earth metal carbonate. In certain embodiments, the solids content of the composition comprises from about 70 wt % to about 90 wt % alkaline earth metal carbonate. In certain embodiments, the solids content of the composition comprises from about 80 wt % to about 98 wt %, for example from about 80 wt % to about 97 wt %, for example from about 80 wt % to about 95 wt %, for example from about 80 wt % to about 90 wt % alkaline earth metal carbonate. In certain embodiments, the solids content of the composition comprises from about 85 wt % to about 98 wt %, for example from about 85 wt % to about 97 wt %, for example from about 85 wt % to about 95 wt %, for example from about 85 wt % to about 90 wt % alkaline earth metal carbonate. In certain embodiments, the solids content of the composition comprises from about 85 wt % to about 97 wt % alkaline earth metal carbonate. In certain embodiments, the solids content of the composition may comprise from about 50 wt % to about 85 wt %, for example from about 55 wt % to about 80 wt %, for example from about 60 wt % to about 75 wt % alkaline earth metal carbonate.

[0072] In certain embodiments, the alkaline earth metal carbonate may have a particle size distribution such that from about 25 wt % to about 90 wt % of the particles are smaller than about 2 μm. In certain embodiments, from about 35 wt % to about 90 wt % of alkaline earth metal particles are smaller than about 2 μm. For example from about 45 wt % to about 90 wt %, for example from about 50 wt % to about 90 wt %, for example from about 55 wt % to about 90 wt %, for example from about 60 wt % to about 90 wt %, for example from about 65 wt % to about 90 wt %, for example from about 70 wt % to about 90 wt % of alkaline earth metal carbonate particles are smaller than about 2 μm. In certain embodiments, from about 35 wt % to about 80 wt %, for example from about 40 wt % to about 80 wt %, for example from about 45 wt % to about 80 wt % of alkaline earth metal carbonate particles are smaller than about 2 μm. For example, from about 45 wt % to about 75 wt %, for example from about 45 wt % to about 70 wt %, for example from about 50 wt % to about 70 wt % of alkaline earth metal carbonate particles may be smaller than about 2 μm.

[0073] In certain embodiments, the alkaline earth metal carbonate may have a particle size distribution such that from about 80 wt % to about 100 wt % of particles are smaller than about 5 μm. In certain embodiments, from about 81 wt % to about 99 wt %, for example from about 81 wt % to about 98 wt %, for example from about 81 wt % to about 97 wt % of particles are smaller than about 5 μm.

[0074] In certain embodiments, the alkaline earth metal carbonate may have a particle size distribution such that from about 4 wt % to about 35 wt % of particles are smaller than about 0.5 μm. In certain embodiments, from about 6 wt % to about 30 wt %, for example from about 6 wt % to about 28 wt %, for example from about 8 wt % to about 25 wt % of particles are smaller than about 0.5 μm.

[0075] Unless otherwise stated, particle size properties referred to herein for the inorganic particulate materials are as measured in a well known manner by sedimentation of the particulate filler or material in a fully dispersed condition in an aqueous medium using a Sedigraph 5100 machine as supplied by Micromeritics Instruments Corporation, Norcross, Ga., USA (telephone: +17706623620; web-site: www.micromeritics.com), referred to herein as a "Micromeritics Sedigraph 5100 unit". Such a machine provides measurements and a plot of the cumulative percentage by weight of particles having a size, referred to in the art as the 'equivalent spherical diameter' (e.s.d), less than given e.s.d values.

[0076] In certain embodiments, the alkaline earth metal carbonate may comprise dispersant. In certain embodiments, the alkaline earth metal carbonate may comprise less than about 0.3% dispersant, for example less than about 0.2% dispersant, for example less than about 0.1% dispersant, based on the weight of dry alkaline earth metal carbonate. In certain embodiments, the alkaline earth metal carbonate does not comprise dispersant.

Phyllosilicate

[0077] The phyllosilicate used in certain aspects of the present invention may be selected from kaolin, talc and mica. In one embodiment, a single particulate phyllosilicate mineral is used in order to produce a ground material. For example, the single particulate phyllosilicate mineral may be kaolin or the single particulate phyllosilicate mineral may be talc. In another embodiment, a combination of two or more phyllosilicates may be used, for example a combination of kaolin and talc may be used. For example, a mixture of two or more particulate phyllosilicate minerals may be ground together (i.e., co-ground). For example, kaolin and talc may be co-ground to obtain a phyllosilicate mixture for use in the compositions disclosed herein. For example, kaolin and/or talc may be co-ground together with the alkaline earth metal carbonate material used in the present invention. For example, kaolin and/or talc may be co-ground with ground calcium carbonate (GCC). For example, kaolin and/or talc may be co-ground with marble. Hereinafter, certain embodiments of the present invention may tend to be discussed in terms of kaolin or talc. However, the invention should not be construed as being limited to such embodiments.

[0078] Kaolin clay is particularly suitable for use in the present invention. Kaolin clay may be used in a processed or unprocessed form. Kaolin clay used in this invention may be a processed material derived from a natural source, namely raw natural kaolin clay mineral. The processed kaolin clay may typically contain at least about 50% by weight kaolinite ($Al_2Si_2O_5(OH)_4$). For example, most commercially processed kaolin clays contain greater than about 75% by weight kaolinite and may contain greater than about 90%, in some cases greater than about 95% by weight of kaolinite.

[0079] Kaolin clay used in the present invention may be prepared from the raw natural kaolin clay mineral by one or more other processes which are well known to those skilled in the art, for example by known refining or beneficiation steps.

[0080] For example, the clay mineral may be bleached with a reductive bleaching agent, such as sodium hydrosulfite. If sodium hydrosulfite is used, the bleached clay mineral may optionally be dewatered, and optionally washed and again optionally dewatered, after the sodium hydrosulfite bleaching step.

[0081] The clay mineral may be treated to remove impurities, e.g. by flocculation, flotation, or magnetic separation techniques well known in the art. Alternatively the clay mineral may be untreated in the form of a solid or as an aqueous suspension.

[0082] The process for preparing the particulate kaolin clay used in the present invention may also include one or more comminution steps, e.g., grinding or milling. Light comminution of a coarse kaolin is used to give suitable delamination thereof. The comminution may use beads or granules of a plastic (e.g. nylon), sand or ceramic grinding or milling aid. The coarse kaolin may be refined to remove impurities and improve physical properties using well known procedures. The kaolin clay may be treated by a known particle size classification procedure, e.g., screening and centrifuging (or both), to obtain particles having a desired particle size distribution.

[0083] Talc is also particularly suitable for use in the present invention. The talc may comprise, include, consist essentially of, or consist of natural talc particulate or synthetic talc particulate or a mixture of natural talc particulate and synthetic talc particulate.

[0084] As used herein, the term "natural talc" means talc derived from a natural resource, i.e., natural talc deposits. Natural talc may be either the hydrated magnesium silicate of formula $Si_4Mg_3O_{10}(OH)_2$, which is arranged as a stack of laminae, or the mineral chlorite (hydrated magnesium aluminium silicate), or a mixture of the two, optionally associated with other minerals, for example, dolomite. Natural talc occurs as rock composed of talc crystals.

[0085] As used herein, the term "synthetic talc" means talc that has been synthesized using a man-made synthetic process.

[0086] In certain embodiments, the solids content of the composition comprising alkaline earth metal carbonate and phyllosilicate may comprise at least about 2 wt % phyllosilicate. For example, the solids content of the composition may comprise from about 2 wt % to about 55 wt % phyllosilicate. For example, the solids content of the composition may comprise from about 2 wt % to about 45 wt %, for example from about 2 wt % to about 40 wt %, for example from about 2 wt % to about 30 wt %, for example from about 2 wt % to about 20 wt %, for example from about 2 wt % to about 15 wt % phyllosilicate. In certain embodiments, the solids content of the composition may comprise at least about 3 wt % phyllosilicate. For example, the solids content of the composition may comprise from about 3 wt % to about 55 wt % phyllosilicate. For example, the solids content of the composition may comprise from about 3 wt % to about 45 wt %, for example from about 3 wt % to about 40 wt %, for example from about 3 wt % to about 30 wt %, for example from about 3 wt % to about 20 wt %. In certain embodiments, the solids content of the composition comprises from about 3 wt % to about 15 wt % phyllosilicate. In certain embodiments, the solids content of the composition may comprise at least about 5 wt % phyllosilicate. For example, the solids content of the composition may comprise from about 5 wt % to about 55 wt % phyllosilicate. For example, the solids content of the composition may comprise from about 5 wt % to about 45 wt %, for example from about 5 wt % to about 40 wt %, for example from about 5 wt % to about 30 wt %, for example from about 5 wt % to about 20 wt %, for example from about 5 wt % to about 15 wt % phyllosilicate. In certain embodiments, the solids content of the composition comprises at least about 10 wt % phyllosilicate. For example, the solids content of the composition may comprise from about 10 wt % to about 50 wt % phyllosilicate. In certain embodiments, the solids content of the composition comprises from about 10 wt % to about 40 wt %, for example from about 10 wt % to about 30 wt %, for example from about 10 wt % to about 25 wt % phyllosilicate. In certain embodiments, the solids content of the composition comprises from about 10 wt % to about 30 wt % phyllosilicate.

[0087] In certain embodiments, the solids content of the composition comprises from about 2 wt % to about 55 wt % kaolin, for example from about 2 wt % to about 50 wt %, for example from about 2 wt % to about 40 wt %, for example from about 2 wt % to about 30 wt % kaolin. For example, the solids content of the composition may comprise from about 5 wt % to about 55 wt % kaolin, for example from about 5 wt % to about 50 wt %, for example from about 5 wt % to about 40 wt %, for example from about 5 wt % to

about 35 wt %, for example from about 5 wt % to about 30 wt % kaolin. In certain embodiments, the solids content of the composition may comprise from about 10 wt % to about 50 wt % kaolin, for example from about 10 wt % to about 40 wt % kaolin. In certain embodiments, the solids content of the composition comprises from about 10 wt % to about 30 wt % kaolin. In certain embodiments, the solids content of the composition may comprise from about 20 wt % to about 55 wt %, for example from about 30 wt % to about 55 wt %, for example from about 30 wt % to about 55 wt % kaolin. In certain embodiments, the solids content of the composition may comprise from about 45 wt % to about 55 wt % kaolin.

[0088] In certain embodiments, the solids content of the composition comprises from about 2 wt % to about 55 wt % talc. For example the solids content of the composition may comprise from about 2 wt % to about 50 wt %, for example from about 2 wt % to about 40 wt %, for example from about 2 wt % to about 30 wt % talc, for example from about 2 wt % to about 20 wt %, for example from about 2 wt % to about 15 wt % talc. In certain embodiments, the solids content of the composition comprises from about 3 wt % to about 55 wt %, for example from about 3 wt % to about 50 wt %, for example from about 3 wt % to about 40 wt %, for example from about 3 wt % to about 30 wt %, for example from about 3 wt % to about 20 wt % talc. In certain embodiments, the solids content of the composition comprises from about 3 wt % to about 15 wt % talc. In certain embodiments, the solids content of the composition comprises from about 5 wt % to about 55 wt % talc. For example, the solids content of the composition may comprise from about 5 wt % to about 50 wt %, for example from about 5 wt % to about 40 wt %, for example from about 5 wt % to about 30 wt %, for example from about 5 wt % to about 20 wt %, for example from about 5 wt % to about 15 wt % talc. For example, the solids content of the composition may comprise from about 10 wt % to about 50 wt %, for example from about 10 wt % to about 40 wt %, for example from about 10 wt % to about 30 wt %, for example from about 10 wt % to about 20 wt % talc. In certain embodiments, the solids content of the composition may comprise from about 2 wt %, for example from about 2 wt %, for example about 5 wt %, to less than about 25 wt %, for example less than about 23 wt %, for example less than about 21 wt %, for example less than about 20 wt % talc.

[0089] In certain embodiments, the phyllosilicate may have a particle size distribution such that from about 5 wt % to about 90 wt % of the particles are smaller than about 2 μm. For example from about 5 wt % to about 80 wt %, for example from about 5 wt % to about 70 wt %, for example from about 5 wt % to about 60 wt %, for example from about 5 wt % to about 50 wt %, for example from about 5 wt % to about 40 wt %, for example from about 5 wt % to about 30 wt % of phyllosilicate particles are smaller than about 2 μm. In certain embodiments, from about 5 wt % to about 40 wt % of phyllosilicate particles are smaller than about 2 μm. In certain embodiments from about 8 wt % to about 90 wt % of phyllosilicate particles are smaller than about 2 μm. For example, from about 8 wt % to about 80 wt %, for example from about 8 wt % to about 70 wt %, for example from about 8 wt % to about 60 wt %, for example from about 8 wt % to about 50 wt %, for example from about 8 wt % to about 40 wt %, for example from about 8 wt % to about 30 wt % of phyllosilicate particles are smaller than about 2 μm. In certain embodiments, from about 8 wt % to about 40 wt % of phyllosilicate particles are smaller than about 2 μm. In certain embodiments, from about 15 wt % to about 90 wt %, for example from about 20 wt % to about 90 wt %, for example from about 30 wt % to about 90 wt %, for example from about 40 wt % to about 90 wt %, for example from about 50 wt % to about 90 wt % of phyllosilicate particles are smaller than about 2 μm. In certain embodiments, from about 30 wt % to about 90 wt % of phyllosilicate particles are smaller than about 2 μm. In certain embodiments, from about 20 wt % to about 80 wt %, for example from about 30 wt % to about 80 wt %, for example from about 40 wt % to about 80 wt %, for example from about 50 wt % to about 80 wt % of phyllosilicate particles are smaller than about 2 μm. In certain embodiments, from about 20 wt % to about 70 wt %, for example from about 30 wt % to about 70 wt %, for example from about 40 wt % to about 70 wt %, for example from about 50 wt % to about 70 wt % of phyllosilicate particles are smaller than about 2 μm.

[0090] In certain embodiments, the phyllosilicate may have a particle size distribution such that from about 20 wt % to about 100 wt % of particles are smaller than about 5 μm. In certain embodiments, from about 20 wt % to about 90 wt %, for example from about 20 wt % to about 80 wt %, for example from about 20 wt % to about 70 wt % of particles are smaller than about 5 μm.

[0091] In certain embodiments, the composition comprises talc and the talc has a particle size distribution such that from about 20 wt % to about 80 wt % of the talc particles are smaller than about 5 μm. For example, from about 20 wt % to about 70 wt %, for example from about 30 wt % to about 70 wt %, for example from about 40 wt % to about 70 wt % of talc particles are smaller than about 5 μm.

[0092] In certain embodiments, the composition comprises kaolin and the kaolin has a particle size distribution such that from about 70 wt % to about 100 wt % of the kaolin particles are smaller than about 5 μm. For example, from about 80 wt % to about 100 wt % of the kaolin particles are smaller than about 5 μm. For example, from about 81 wt % to about 99 wt %, for example from about 81 wt % to about 98 wt %, for example from about 81 wt % to about 97 wt % of kaolin particles are smaller than about 5 μm.

[0093] In certain embodiments, the phyllosilicate may have a particle size distribution such that from about 0 wt % to about 55 wt % of particles are smaller than about 0.5 μm. In certain embodiments, from about 0 wt % to about 20 wt %, for example from about 0 wt % to about 10 wt % of particles are smaller than about 0.5 μm. In certain embodiments from about 5 wt % to about 40 wt %, for example from about 10 wt % to about 40 wt %, for example from about 10 wt % to about 30 wt % of particles are smaller than about 0.5 μm.

[0094] In certain embodiments, the composition comprises talc and the talc has a particle size distribution such that from about 0 wt % to about 20 wt % of talc particles are smaller than about 0.5 μm. For example, from about 0 wt % to about 15 wt %, for example from about 0 wt % to about 10 wt % of talc particles may be smaller than about 0.5 μm. For example, from about 2 wt % to about 20 wt %, for example from about 2 wt % to about 10 wt % of particles may be smaller than about 0.5 μm.

[0095] In certain embodiments, the composition comprises kaolin and the kaolin has a particle size distribution such that from about 5 wt % to about 40 wt % of the kaolin

particles are smaller than about 0.5 μm. For example, from about 10 wt % to about 40 wt %, for example from about 10 wt % to about 30 wt % of kaolin particles may be smaller than about 0.5 μm. For example, from about 10 wt % to about 25 wt %, for example from about 15 wt % to about 25 wt % of kaolin particles may be smaller than about 0.5 μm.

[0096] In certain embodiments, the phyllosilicate is kaolin and from about 10 wt % to about 90 wt %, for example from about 20 wt % to about 90 wt % of the kaolin particles are smaller than about 2 μm. For example, from about 30 wt % to about 90 wt % of the kaolin particles may be smaller than about 2 μm. For example, from about 40 wt % to about 90 wt %, for example from about 45 wt % to about 90 wt %, for example from about 55 wt % to about 90 wt % of the kaolin particles may be smaller than about 2 μm. In certain embodiments, from about 20 wt % to about 80 wt %, for example from about 30 wt % to about 80 wt %, for example from about 40 wt % to about 80 wt %, for example from about 50 wt % to about 80 wt % of the kaolin particles are smaller than about 2 μm. In certain embodiments, from about 20 wt % to about 70 wt %, for example from about 30 wt % to about 70 wt %, for example from about 40 wt % to about 70 wt %, for example from about 50 wt % to about 70 wt % of kaolin particles are smaller than about 2 μm.

[0097] In certain embodiments, the phyllosilicate is talc and from about 5 wt % to about 60 wt %, for example from about 5 wt % to about 50 wt %, for example from about 5 wt % to about 40 wt %, for example from about 5 wt % to about 30 wt % of the talc particles are smaller than about 2 μm. In certain embodiments, the phyllosilicate is talc and from about 5 wt % to about 40 wt % of talc particles are smaller than about 2 μm. In certain embodiments, the phyllosilicate is talc and from about 8 wt % to about 60 wt %, for example from about 8 wt % to about 50 wt %, for example from about 8 wt % to about 50 wt %, for example from about 8 wt % to about 40 wt %, for example from about 8 wt % to about 30 wt % of the talc particles are smaller than about 2 μm. In certain embodiments, from about 8 wt % to about 40 wt % of talc particles are smaller than about 2 μm. In certain embodiments, from about 10 wt % to 50 wt %, for example from about 10 wt % to about 40 wt %, for example from about 10 wt % to about 35 wt %, for example from about 15 wt % to about 30 wt %, for example from about 20 wt % to about 30 wt % of the talc particles may be smaller than about 2 μm.

Further Additives

[0098] The composition may comprise further additives. In particular, when the composition is in the form of an aqueous suspension, the composition may comprise further additives. For example, the composition may further comprise further additives selected from one or more dispersing agents, one or more biocides, one or more suspending aids, one or more thickening agents, one or more anti-settling agents one or more salts or one or more other additives.

[0099] For example, the one or more dispersing agent may be made from monomers and/or co-monomers selected from the group consisting of acrylic acid, methacrylic acid, itaconic acid, crotonic acid, fumaric acid, maleic anhydride acid, isocrotonic acid, aconitic acid (cis or trans), mesaconic acid, sinapinic acid, undecylenic acid, angelic acid, canellic acid, hydroxyacrylic acid, acrolein, acrylamide, acrylonitrile, dimethylaminoethyl methacrylate, vinylpyrrolidone, vinylcaprolactam, ethylene, propylene, isobutylene, diisobutylene, vinyl acetate, styrene, [alpha]-methyl styrene, methyl vinyl ketone, the esters of acrylic and methacrylic acids and mixtures thereof. The dispersing agent may, for example, be polyacrylic acid and/or polymethacrylic acid.

[0100] For example, the one or more biocides may be selected from an aldehyde-releasing biocide, an aldehyde-based biocide, a phenolic biocide, an isothiazoline biocide, or any mixture thereof. The biocide may be selected from one or more of the following: formaldehyde, acetaldehyde, glyoxal, succinaldehyde, glutaraldehyde, 2-propenal, phthalic dialdehyde and mixtures thereof, and in certain embodiments is formaldehyde, glutaraldehyde, benzyl alcoholmono(poly)-hemiformal, ethyleneglycolhemiformal (EGHF), [1,2-Ethanediylbis(oxy)]-bis-methanol, tetrahydro-1,3,4,6-tetrakis(hydroxylmethyl)imidazo [4,5-d]imidazole-2,5 (1H,3H)-dione (also commonly referred to as TetraMethylolAcetyleneDiurea TMAD), orthophenylphenol (OPP), 2-methyl-4-isothiazoline-3-one (MIT), 5-chloro-2-methyl-2H-isothiazolin-3-one (CIT), 1,2-benzisothiazoline-3-one (BIT), or mixtures thereof.

[0101] For example, the thickening agent may be selected from polyurethanes, acrylic polymers, latex, styrene, butadiene, polyvinylalcohol, cellulose, cellulose-derived macromolecules, saccharides and organosilicones.

Use of the Compositions as a Filler in a Paper Product

[0102] There is provided herein a use of any of the compositions disclosed herein as a filler in a paper product. Further provided herein is a papermaking composition comprising any of the compositions disclosed herein. A paper product prepared from said papermaking composition is also provided herein. In addition, a paper product comprising a filler, wherein the filler comprises any of the compositions disclosed herein is provided.

[0103] The compositions disclosed herein include not only the first, second and third aspects of the present invention, but also any of the embodiments disclosed herein, including any combination of these embodiments in all possible variations thereof.

[0104] The compositions comprising alkaline earth metal carbonate and phyllosilicate disclosed herein can be incorporated into papermaking compositions, which in turn can be used to prepare paper products. The term paper product, as used in connection with the present invention, should be understood to mean all forms of paper, including board, such as, for example, white-lined board and linerboard, cardboard, paperboard, coated board, and the like. There are numerous types of paper, coated or uncoated, which may be made using the compositions disclosed herein, including paper suitable for books, magazines, newspapers and the like, and office papers. The paper may be calendered or super calendered as appropriate; for example super calendered magazine paper for rotogravure and offset printing may be made according to the present methods. Paper suitable for light weight coating (LWC), medium weight coating (MWC) or machine finished pigmentisation (MFP) may also be made according to the present methods. Coated paper and board having barrier properties suitable for food packaging and the like may also be made according to the present methods.

[0105] In a typical papermaking process, a fibrous pulp is prepared by any suitable chemical or mechanical treatment, or combination thereof, which are well known in the art. In certain embodiments, the fibrous pulp comprises cellulose

(i.e. the fibrous pulp is a cellulose-containing pulp). The cellulose-containing pulp may be derived from any suitable source such as wood, grasses (e.g., sugarcane, bamboo) or rags (e.g., textile waste, cotton, hemp or flax). The pulp may be bleached in accordance with processes which are well known to those skilled in the art and those processes suitable for use in the present invention will be readily evident. The bleached cellulose pulp may be beaten, refined, or both, to a predetermined freeness (reported in the art as Canadian standard freeness (CSF) in cm^3). A suitable paper stock may then be prepared from the bleached and beaten pulp.

[0106] The papermaking composition typically comprises, in addition to the composition comprising alkaline earth metal carbonate and phyllosilicate, paper stock and other conventional additives known in the art. The papermaking composition of the present invention may comprise up to about 45% by weight inorganic particulate material derived from the composition comprising alkaline earth metal carbonate and phyllosilicate, based on the total dry contents of the papermaking composition. For example, the papermaking composition may comprise from about 1% to about 45% by weight of inorganic particulate material derived from the composition comprising alkaline earth metal carbonate and phyllosilicate, based on the total dry contents of the papermaking composition. For example, the papermaking composition may comprise from about 5 wt % to about 45 wt %, for example from about 10 wt % to about 45 wt %, for example from about 20 wt % to about 45 wt %, for example from about 30 wt % to about 45 wt % of inorganic particulate material derived from the composition comprising alkaline earth metal carbonate and phyllosilicate, based on the total dry contents of the papermaking composition. The papermaking composition may also contain a retention aid, for example a non-ionic, cationic or anionic retention aid or a microparticle retention system, in an amount in the range from about 0.1 to 2% by weight, based on the dry weight of the papermaking composition. The papermaking composition may also contain a sizing agent which may be, for example, a long chain alkylketene dimer, a wax emulsion or a succinic acid derivative. The papermaking composition may also contain dye and/or an optical brightening agent. The papermaking composition may also comprise dry and wet strength aids such as, for example, starch or epichlorhydrin copolymers.

[0107] Further provided herein is a process for making a paper product comprising combining and/or blending any of the compositions disclosed herein (comprising alkaline earth metal carbonate and phyllosilicate) with a fibrous pulp suitable for making a paper product to form a papermaking composition, and forming a paper product from the papermaking composition.

[0108] In certain embodiments, the fibrous pulp comprises cellulose. In certain embodiments, the fibrous pulp may be formed in a grinder vessel or homogenizer by addition of the fibrous substrate comprising cellulose in a dry state, for example, in the form of a dry paper broke or waste, directly to the grinder vessel. The aqueous environment of the grinder vessel or homogenizer will then facilitate the formation of a pulp. Grinding may suitably be performed in a conventional manner. The grinding may, for example, be an attrition grinding process in the presence of a particulate grinding medium, or may be an autogenous grinding process, i.e., one in the absence of a grinding medium. By grinding medium is meant a medium which is co-ground with the fibrous substrate.

[0109] The steps required for the formation of a paper product from a papermaking composition are conventional and well known in the art and generally comprise the formation of paper sheets having a targeted basis weight, depending on the type of paper being made.

[0110] In certain embodiments, the process for making a paper product further comprises coating and/or calendaring the paper. In certain embodiments, the process for making paper further comprises coating the paper product with a paper product coating composition. The paper product coating composition may comprise any of the compositions comprising alkaline earth metal carbonate and phyllosilicate disclosed herein.

[0111] In certain embodiments, the process for making a paper product using the compositions or papermaking compositions disclosed herein results in decreased abrasion of the papermaking machine in comparison to a process for making a paper product which does not use the compositions or papermaking compositions disclosed herein. In certain embodiments, favourable optical properties of the paper product, for example favourable opacity, brightness and/or yellowness, are maintained or not significantly reduced. In certain embodiments, the paper product has improved optical properties, for example improved opacity, brightness and/or yellowness.

[0112] In certain embodiments, paper products prepared using the compositions and/or papermaking compositions disclosed herein exhibit optical properties, for example opacity, brightness and/or yellowness, which are within a desired range such that the paper product is suitable for a particular purpose. In certain embodiments, paper products prepared using the compositions disclosed herein exhibit improved optical properties, for example opacity, brightness and/or yellowness, in comparison to other conventional paper products, for example paper products prepared using a corresponding filler composition comprising alkaline earth metal carbonate but not comprising the phyllosilicate. In certain embodiments, these desired and/or improved properties can be achieved whilst reducing or minimising abrasion of the papermaking machine.

Other Uses of the Composition Comprising Alkaline Earth Metal Carbonate and Phyllosilicate

[0113] The compositions described herein may also be suitable for other applications. In particular, the compositions described herein may also be suitable for other applications where it is desirable to use a composition comprising inorganic particulate material which exhibits low abrasivity. Alternatively or additionally, the compositions described herein may also be suitable for other applications where it is desirable to use a composition comprising inorganic particulate material which has the optical properties, for example opacity, brightness and yellowness of the compositions disclosed herein.

[0114] For example, the compositions disclosed herein may be suitable for use in other materials such as coatings (for example adhesive coatings, optical coatings, light-sensitive coatings and protective coatings), adhesives, sealants, glass, ceramics, rubber, plastics, paints and inks. For example, the compositions disclosed herein may be suitable for use in a paper coating composition. For example, the compositions disclosed herein may be used as a filler or extended in these materials.

Process for Making the Compositions Comprising Alkaline Earth Metal Carbonate and Phyllosilicate

[0115] There is provided herein a process for making any of the compositions disclosed herein comprising combining or blending alkaline earth metal carbonate and phyllosilicate.

[0116] In certain embodiments, the process comprises combining alkaline earth metal carbonate with phyllosilicate, wherein the solids content of the composition comprises at least about 45 wt % alkaline earth metal carbonate and at least about 2 wt % phyllosilicate. In one embodiment, the process comprises combining at least about 45 wt % alkaline earth metal carbonate with at least about 2 wt % phyllosilicate.

[0117] In certain embodiments, the process comprises combining alkaline earth metal carbonate with phyllosilicate, wherein from about 45 wt % to about 85 wt % of particles in the composition are smaller than about 2 μm, from about 15 wt % to about 30 wt % of particles in the composition are smaller than about 0.5 μm, and up to about 20 wt % of particles in the composition are larger than about 10 μm.

[0118] In certain embodiments, the process comprises combining alkaline earth metal carbonate with phyllosilicate, wherein from about 35 wt % to about 90 wt % of the alkaline earth metal carbonate particles are smaller than about 2 μm and from about 5 wt % to about 90 wt % of the phyllosilicate particles are smaller than about 2 μm.

[0119] In certain embodiments, the alkaline earth metal carbonate is provided in an aqueous slurry having a solids content that may range from about 25 wt % to about 75 wt %, for example from about 35 wt % to about 75 wt %. The aqueous slurry of alkaline earth metal carbonate may include 0.3 wt % or less dispersant.

[0120] In certain embodiments, the phyllosilicate is provided as a filter cake having a water content that may range from about 0 wt % to about 25 wt %. The phyllosilicate filter cake may include no dispersant.

[0121] In certain embodiments, the alkaline earth metal carbonate is provided in an aqueous slurry having a solids content that may range from 25 wt % to 75 wt % and include 0.3 wt % or less dispersant while the phyllosilicate is provided as a filter cake having a water content that may range from 0 wt % to 25 wt % and include no dispersant.

[0122] The alkaline earth metal carbonate or phyllosilicate may be reduced in particle size, for example using stirred media mills in the presence of commercially available synthetic media, water and commercially available organic dispersants such as sodium polyacrylate. The alkaline earth metal carbonate or phyllosilicate may be combined by mixing or blending.

[0123] In certain embodiments, an alkaline earth metal carbonate slurry is mixed or blended with a phyllosilicate slurry.

[0124] In certain embodiments, the phyllosilicate is made down into an alkaline earth metal carbonate. In certain embodiments, the phyllosilicate is made down into an alkaline earth metal carbonate slurry. In certain embodiments, the phyllosilicate is made down into the alkaline earth metal carbonate without any additional dispersant being added. In certain embodiments, making down the phyllosilicate into an alkaline earth metal carbonate, optionally with no additional dispersant, provides a composition which has improved stability. For example, the composition may have higher solids with reduced or no sedimentation in comparison to a composition prepared by another method.

[0125] In certain embodiments, the alkaline earth metal carbonate or phyllosilicate may be used to prepare aqueous suspensions by any method known to those skilled in the art. For example, the inorganic particulate material may be added to a stirred media mill with water and any additional optional additives such as dispersants, thickeners, biocides and anti-settling agents. The contents may be stirred at high speed for a predetermined length of time to give a target particle size distribution. The resultant mineral suspension may be separated from the media using screens.

BRIEF DESCRIPTION OF THE DRAWINGS

[0126] Certain embodiments of the invention will now be described, by way of example only and without limitation, with reference to the following Figures and Examples, in which:

[0127] FIG. **1** shows the abrasivity of compositions of different types of ground calcium carbonate which comprise different amounts of talc or kaolin.

[0128] FIG. **2** shows the abrasivity of compositions of calcium carbonate which comprise different amounts of talc or kaolin.

EXAMPLES

[0129] Samples of ground calcium carbonate, kaolin and talc shown in Table 1 below were obtained from commercial sources.

TABLE 1

Sample	Brightness (ISO)	wt % particles smaller than 5 μm	wt % particles smaller than 2 μm
Talc A	80.7	31.6	8.5
Talc B	82.8	74.0	30.1
Talc C	86.8	68.8	32.8
Kaolin A	87.8	84.9	49.5
Kaolin B	81.8	89.1	57.7
GCC A	92.5	95.2	60.8
GCC B	93.3	98.3	74.0

[0130] Compositions comprising ground calcium carbonate (GCC) and either kaolin or talc were prepared by blending slurries of each component in the required ratio.

[0131] Abrasivity and brightness of these compositions was then determined by the methods described above in the detailed description of the invention.

Example 1

[0132] The brightness and particle size distribution of the compositions disclosed in Table 2 below was determined.

TABLE 2

Composition	Brightness (ISO)	% particles smaller than 5 μm	% particles smaller than 2 μm	% particles smaller than 0.5 μm
GCC B	93.3	98.3	74.0	25.1
GCC B + 5 wt % Talc A	92.9	96.6	72.3	24.3
GCC B + 5 wt % Talc B	92.8	97.4	72.7	23.7
GCC B + 10 wt % Kaolin A	92.7	97.4	72.0	23.6

[0133] It was surprisingly found that the brightness of the compositions comprising ground calcium carbonate and either talc or kaolin did not change considerably in comparison to ground calcium carbonate alone.

Example 2

[0134] Compositions comprising ground calcium carbonate and different amounts of talc or kaolin were prepared as described above. The abrasivity of these compositions was determined. The results are shown in FIGS. **1** and **2**.

[0135] It was surprisingly found that addition of talc or kaolin to ground calcium carbonate reduced the abrasivity of the composition.

1. A composition comprising alkaline earth metal carbonate and phyllosilicate, wherein the solids content of the composition comprises:

at least about 45 wt % alkaline earth metal carbonate; and

at least about 2 wt % phyllosilicate, and

wherein the composition has a brightness between about 85 and about 95.

2. The composition of claim **1**, wherein the solids content of the composition comprises from about 45 wt % to about 98 wt % alkaline earth metal carbonate.

3. The composition of claim **1**, wherein the solids content of the composition comprises from about 2 wt % to about 55 wt % phyllosilicate.

4-15. (canceled)

16. The composition of claim **1**, wherein the alkaline earth metal carbonate is calcium carbonate.

17-18. (canceled)

19. The composition of claim **1**, wherein the phyllosilicate is kaolin.

20. The composition of claim **1**, wherein the phyllosilicate is talc.

21-32. (canceled)

33. The composition of claim **1**, wherein the composition comprises less than about 0.3% dispersant based on the total weight of the dry alkaline earth metal carbonate.

34-35. (canceled)

36. The composition of claim **1**, wherein up to about 20 wt % of particles in the composition are larger than about 10 μm.

37. The composition claim **1**, wherein the composition demonstrates at least about 10% less abrasivity in comparison to a corresponding composition in accordance with claim **1** which does not comprise said phyllosilicate.

38. The composition of claim **1**, wherein the composition demonstrates at least about 20% less abrasivity in comparison to a corresponding composition in accordance with claim **1** which does not comprise said phyllosilicate.

39-42. (canceled)

43. A composition comprising alkaline earth metal carbonate and phyllosilicate, wherein from about 45 wt % to about 85 wt % of particles in the composition are smaller than about 2 μm, from about 15 wt % to about 30 wt % of particles in the composition are smaller than about 0.5 μm, and up to about 20 wt % of particles in the composition are larger than about 10 μm.

44. The composition of claim **43**, wherein the alkaline earth metal carbonate is calcium carbonate.

45-46. (canceled)

47. The composition of claim **43**, wherein the phyllosilicate is kaolin.

48. The composition of claim **43**, wherein the phyllosilicate is talc.

49-76. (canceled)

77. The composition of claim **43**, wherein the composition demonstrates at least about 10% less abrasivity in comparison to a corresponding composition in accordance with claim **43** which does not comprise said phyllosilicate.

78. The composition of claim **43**, wherein the composition demonstrates at least about 20% less abrasivity in comparison to a corresponding composition in accordance with claim **43** which does not comprise said phyllosilicate.

79-125. (canceled)

126. A papermaking composition comprising the composition of claim **1**.

127. (canceled)

128. A paper product prepared from the papermaking composition of claim **126**.

129. A paper product comprising a filler, wherein the filler comprises the composition of claim **1**.

130. A process for preparing the composition of claim **1** comprising:

combining alkaline earth metal carbonate with phyllosilicate.

131. A process for making a paper product comprising:

combining the composition of claim **1** with a fibrous pulp suitable for making a paper product to form a papermaking composition; and

forming a paper product from the papermaking composition.

132. The process of claim **131**, wherein the fibrous pulp comprises cellulose.

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