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(54) Title: NONWOVEN ARTICLES COMPRISING ABRASIVE PARTICLES

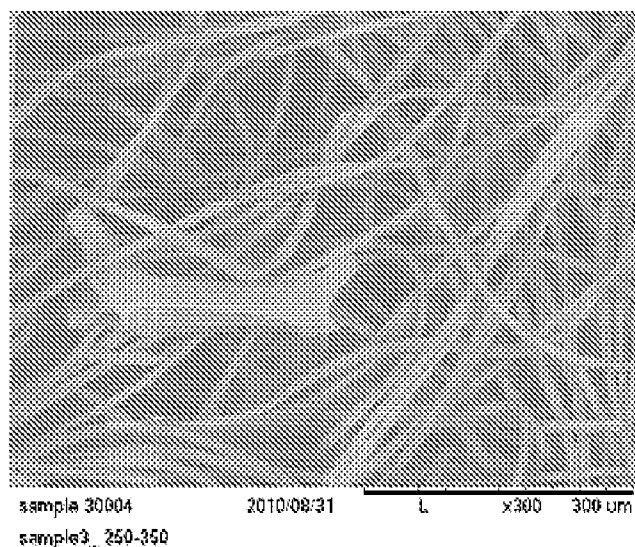


Fig 1

(57) Abstract: A nonwoven article comprising a web of
fibers and abrasive particles, the abrasive particles em-
bedded in the web of fibers, wherein the abrasive
particles have a mean solidity below 0.85.



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NONWOVEN ARTICLES COMPRISING ABRASIVE PARTICLES

TECHNICAL FIELD

The invention relates to the field of dry nonwoven articles comprising abrasive particles. The invention relates particularly to nonwoven articles comprising abrasive particles for use in surface
5 cleaning.

BACKGROUND OF THE INVENTION

Articles containing abrasive components such as particles are known in the art. Such articles may be used for cleaning a variety of surfaces; especially those surfaces that tend to become soiled with difficulty to remove stains and soils.

10 Such articles may comprise a substrate and a plurality of abrasive particles where the abrasive particles are disposed either on the surface of the substrate or within the substrate such that the abrasive particles at least partially protrude from at least one surface and the substrate during use. Examples of substrates that might include such abrasive particles include nonwoven articles including disposable wipes, paper towel, floor wipes, home care napkins, beauty care napkins, and
15 baby wipes. Examples of abrasive particles include inorganic particles such as carbonate salt, clay, silica, silicate, shale ash, perlite and/or organic particles such as polymeric beads comprised of polypropylene, PVC, melamine, urea, polyacrylate and derivatives.

When used as a component of a nonwoven article, many commonly known abrasive particles may not be fully satisfactory. The abrasive particles may separate from the rest of the article, in particular
20 while scouring is exercised with the article. This may lead to inefficient cleaning and to unacceptable deposition of particles on the surface to be cleaned. Separately, the abrasive particles may move or “roll” while scouring, relative to the substrate, again leading to a loss of their abrasive cleaning efficiency.

The inventors have discovered that this could be alleviated by the use of particles having specific
25 shape. This shape may be expressed as the “Solidity” of the particles.. Selecting particles of the specified solidity may lead to both improvements in extent to which the particles are retained by the substrate, and improvements in cleaning by preventing “rolling” of the particles and maintaining the orientation of the particles, relative to the substrate and therefore relative to the surface being cleaned, during scouring.

Also, maintaining the orientation of the particles relative to the substrate may generate less damage to the surface to be cleaned.

SUMMARY OF THE INVENTION

5 In one aspect, a dry nonwoven article comprises a web of fibers and abrasive particles at least particallt embedded in the web, wherein the abrasive particles have a mean solidity below about 0.85.

The articles according to the invention have an improved retention of the abrasive particles, in particular during scouring. The specific shape of the abrasive particles leads to an improved maintenance of the particles within the web of fibers

10 as well as improved maintenance of the orientation of the particles relative to the substrate, and therefore relative to the surface being cleaned, which may in turn improve the cleaning properties while having limited damage to the surface to be cleaned. Without being bound by theory, the inventors believe that the improved cleaning efficiency is linked to the fact that the specific shape of the particles limits their rolling within the web of fibers while scouring.

15 DESCRIPTION OF THE DRAWINGS

Fig 1 is a picture of a hard surface wipe as described in example 2.

Fig 2 is a picture of a hard surface wipe as described in example 3.

Fig 3 is a picture of a floor wipe as described in example 5.

Fig 4 is a picture of a baby toilet wipe as described in example 7.

20 Fig 5 is a picture of a disposable hard surface wipe as described in example 8.

Fig 6 is a picture of a disposable hard surface wipe as described in example 8.

Fig 7 is a picture of a disposable towel as described in example 9.

DETAILED DESCRIPTION OF THE INVENTION

All percentages, ratios and proportions used herein are by weight percent unless otherwise specified.

As used herein, the mean Equivalent Circle Diameter (ECD) is measured according to ASTM F1877-05 Section 11.3.2 or similar to the area-equivalent diameter (ISO 9276-6:2008(E) section 7). The mean ECD of particle population is calculated as the volume-weighted average of respective ECD of a particle population of at least about 1000 particles, or at least about 10,000 particles, or
5 above about 50,000 particles, or above about 100,000 particles after excluding from the measurement and calculation the data of particles having area-equivalent diameter (ECD) of below about 10 micrometers.

As used herein, Form factor is a mesoshape descriptor and is a quantitative, 2-dimension image analysis shape description and is being measured according to ISO 9276-6:2008(E) section 8.2.
10 Form factor is sometimes described in literature as being the difference between a particle's shape and a perfect sphere. Form factor values range from 0 to 1, where a form factor of 1 describes a perfectly spherical particle or disc-shaped particle as measured in a two dimensional projected image.

$$Form\ Factor = \frac{4\pi A}{P^2}$$

where A is projection area, which is 2D descriptor and P is the length of the perimeter of the
15 particle. The applicants refer herein to Form factor as being volume-weighted mean Form Factor extracted from a distribution of particle measurements. As used herein, the MOHS hardness scale refers to an internationally recognized scale for measuring the hardness of a compound versus a compound of known hardness, see Encyclopedia of Chemical Technology, Kirk-Othmer, 4 th Edition Vol 1, page 18 or Lide, D.R (ed) CRC Handbook of Chemistry and Physics, 73 rd edition,
20 Boca Raton, Fla.: The Rubber Company, 1992-1993. Many MOHS Test kits are commercially available containing material with known MOHS hardness. For measurement and selection of abrasive material with selected MOHS hardness, it is recommended to execute the MOHS hardness measurement with un- shaped particles e.g.: with spherical or granular forms of the abrasive material since MOHS measurement of shaped particles will provide erroneous results.

25 As used herein, the Shore® D hardness of the materials may be determined according to ASTM D2240-05 (2010). Shore® D hardness measurement may be carried out by using an ASTM durometer, such as the Type D Style Durometer available from Pacific Transducer Corp. of Los Angeles, California, or from ELECTROMATIC Equipment Co., Inc. 600 Oakland Ave Cedarhurst, NY 11516.

As used herein, Solidity is a quantitative, 2-dimensional image analysis shape description, and is being measured according to ISO 9276-6:2008(E) section 8.2 as implemented via the Occhio Nano 500 Particle Characterisation Instrument with its accompanying software Callistro version 25 (Occhio s.a. Liege, Belgium). While particle shape can be defined in 3-dimension with dedicated analytical technique, the applicant has found, that the characterization of the particles shape in 2-dimension is most relevant and correlates with the abrasive performance of the cleaning particles. During the particle shape analysis protocol, the particles are orientated toward the surface – via gravity deposition - similarly to the expected particle orientation during the cleaning process. Hence, the object of the present invention regards the characterization of 2-D shape of a particle/particle population as defined by the projection of its shape on the surface on which the particle/particle population is deposited.

The non-spherical particle herein has at least one edge or surface having a concave curvature. Solidity is a mesoshape parameter, which describes the overall concavity of a particle or particle population. Solidity values range from 0 to 1, where a solidity number of 1 describes a non-concave particle, as measured in literature as being:

$$\text{Solidity} = A/A_c$$

Where A is the projected area of the particle and A_c is the area of the convex hull (envelope) bounding the projection of the particle. The applicants refer herein to solidity as being volume-weighted mean solidity extracted from a distribution of particle measurements.

As used herein, the terms “mean solidity”, or “mean Form factor”, mean the volume-weighted average of the solidity, or Form Factor values from a population of at least about 1000 particles, or at least about 10,000 particles, or above about 50,000 particles, or above about 100,000 particles, after excluding from the measurement and calculation, the solidity or form factor data of particles having area-equivalent diameter (ECD) of below 10 micrometers.

As used herein, the Vickers hardness HV is measured at 23 °C according to standard methods ISO 14577-1, ISO 14577-2, ISO 14577-3. The Vickers hardness is measured from a solid block of the raw material at least 2 mm in thickness. The Vickers hardness micro indentation measurement is carried out by using the Micro-Hardness Tester (MHT), manufactured by CSM Instruments SA, Peseux, Switzerland. As per the ISO 14577 instructions, the test surface should be flat and smooth, having a roughness (Ra) value less than 5% of the maximum indenter penetration depth. For a 200

micrometer maximum depth this equates to a Ra value less than 10 micrometer. As per ISO 14577, such a surface may be prepared by any suitable means, which may include cutting the block of test material with a new sharp microtome or scalpel blade, grinding, polishing or by casting melted material onto a flat, smooth casting form and allowing it to thoroughly solidify prior testing.

- 5 Suitable general settings for the Micro-Hardness Tester (MHT) are as follows:

Control mode: Displacement, Continuous

Maximum displacement: 200 μm Approach speed: 20 nm/s

Zero point determination: at contact

Hold period to measure thermal drift at contact: 60s

- 10 Force application time: 30s

Frequency of data logging: at least every second

Hold time at maximum force: 30s

Force removal time: 30s

Shape / Material of indenter tip: Vickers Pyramid Shape / Diamond Tip

- 15 As used herein, the term nonwoven means: a manufactured sheet, web or batt of directionally or randomly orientated fibers, bonded by friction, and/or cohesion and/or adhesion, excluding paper and products which are woven, knitted, tufted, stitch-bonded incorporating binding yarns or filaments, or felted by wet-milling, whether or not additionally needled. The fibers may be of natural or man-made origin and may be staple or continuous filaments or be formed in situ.
- 20 Commercially available fibers have diameters ranging from less than about 0.001 mm to more than about 0.2 mm and they come in several different forms: short fibers (known as staple, or chopped), continuous single fibers (filaments or monofilaments), untwisted bundles of continuous filaments (tow), and twisted bundles of continuous filaments (yarn). Nonwoven fabrics can be formed by many processes such as meltblowing, spunbonding, solvent spinning, electrospinning, and carding.
- 25 The basis weight of nonwoven fabrics is usually expressed in grams per square meter (gsm).

A nonwoven article comprises a web of fibers and abrasive particles.

The web of fibers

The web of fibers may comprise synthetic fibers and/or natural fibers. The fibers may be water insoluble.

Synthetic fibers suitable for use in the substrate of the disclosed wipe may include, but are not limited to, nylons, polyesters, acrylics, olefin fibers such as polyethylene and polypropylene, carbon fibers, glass fibers, metal fibers.

The natural fibers may be cellulose-containing fibers including, but not limited to, cotton fiber, flax fiber, hemp fiber, sisal fiber, jute fiber, kenaf fiber, bamboo fiber, coconut fiber, and wood pulp. Naturally derived fiber suitable for use in this disclosure may include, but are not limited to, rayon, lyocell, and viscose or other materials derived from natural fibers. For example, lyocell may be derived from wood pulp, viscose may be derived from wood or cotton fibers, and rayon may be derived from a wide variety of cellulose-containing natural fibers. The web of fibers may comprise at least about 80% of cellulosic fibers. The web of fibers may be a paper substrate.

The web of fibers may be formed by water or air or mechanical entanglement, meltblown, spunbond, thermally or chemically bond. The fibers may comprise carded, staple, wet laid, air laid and/or spunbond fibers. The web of fibers may be made according to a hydro-entangling process.

Processes to prepare the web of fibers comprising paper include wet-laid papermaking processes and air-laid papermaking processes, and embossing and printing processes. Such processes typically comprise the steps of preparing a fiber composition in the form of a suspension in a medium, either wet, more specifically aqueous medium, or dry, more specifically gaseous (i.e., with air as medium). The aqueous medium used for wet-laid processes is oftentimes referred to as a fiber slurry. The fibrous suspension is then used to deposit a plurality of fibers onto a forming wire or papermaking belt such that an embryonic fibrous structure can be formed, after which drying and/or bonding the fibers together results in a fibrous structure. Further processing the fibrous structure can be carried out such that a finished fibrous structure can be formed. For example, in typical papermaking processes, the finished fibrous structure is the fibrous structure that is wound on the reel at the end of papermaking, and can subsequently be converted into a finished product (e.g., a sanitary tissue product). Fibrous structures can be made by methods known in the art, including by the method and apparatus described in U.S. Patent No. 4,637,859, issued Jan. 20, 1987, to Trokhan.

In one embodiment, the web of fibers may be degradable. The web of fibers may be at least 50% degradable according to ASTM 6400D.

In one embodiment, the web of fibers may have a basis weight of about 10 to about 120 gram per square meter, for example from about 15 to 100 or from about 20 to about 80 or from about 25
5 to about 75 or from about 30 to about 60 grams per square meter.

In one embodiment, the fibers of the web of fibers may have a diameter or a width of between about 8 microns and about 100 microns. The fibers may have a length above about 1mm. The fibers may have a length between about 1mm and about 5mm. The fibers, when stapled may have a length between about 5mm and about 50mm. The fibers may be much longer when spun bond or
10 meltblown.

In one embodiment, the mesh aperture of the web of fibers may be between about 20 microns and about 100 microns.

In one embodiment, the web of fibers may have a thickness between about 0.5mm and about 5mm, for example between about 1.5 and about 2 mm.

15 When the nonwoven articles comprises more than one layer of web of fibers, one or more than one or each of the web of fibers may be as defined as above.

The abrasive particles

The nonwoven article comprises abrasive particles.

In order to produce particles with desired solidity, the abrasive particles may be produced from a
20 foam material, in particular a friable foam material, but other means such as printing and extruding are also possible. The particle or foam material may comprise polyurethane, polyisocyanurate, polyphenolic, polyethylene, polypropylene, polyvinyl chloride, polycarbonate, polyacrylate, polystyrene, polyesters, polyamide and mixtures, melamine, urea, minerals and mixtures thereof.

In one embodiment, the abrasive particles are made from biodegradable thermoplastic materials
25 selected the group consisting of biodegradable polyesters selected from the group consisting of polyhydroxy-alkanoates, such as polyhydroxyButyrate, polyhydroxyButyrate-co-valerate and polyhydroxyButyrate-co-hexanoate, poly(lactic acid), poly(glycolic), polycaprolactone,

polyesteramide, aliphatic copolyesters, aromatic copolyesters such as co-polyester containing mix of succinic, adipic, terephthalic diacids, propanediol, butanediol, pentanediol monomer and mixtures thereof; thermoplastic starch; polycarboxylic anhydrides and derivatives, cellulose esters particularly cellulose acetate and/or nitrocellulose and their derivatives; and mixtures thereof; for example a
5 blend of a biodegradable polyester and a thermoplastic starch.

In one embodiment, the abrasive particles may comprise sugar-derived material e.g.: monomeric or polymeric sugar, especially isosorbide-containing materials.

In one embodiment, the abrasive particles may be made from a material comprising, or consisting essentially of wax, natural waxes such as carnauba, candellila, shellac, beeswax, etc., or alternatively
10 synthetic waxes such as montan, microcrystalline, polyethylene-derived wax, etc., and where the wax or wax blend has a high melting point, typically above about 60°C, and in one embodiment above about 80°C.

In one embodiment, the abrasive particles herein may comprise one or more mineral materials. Typical mineral materials of interest are derived from carbonate, sulphate, phosphate hydroxide, fluoride salts of Calcium, Barium, Iron, Magnesium, Manganese, Zinc, Copper, Borate, sodium,
15 potassium, ammonium, alumina or silicate and blends whereas the material can be synthesized from extensively known inorganic synthesis processes (e.g.: Synthesis of Inorganic Materials -Wiley or Handbook of Inorganic Compounds -CRC) or extracted from mining & processing natural occurring inorganic material, alternatively be a mix of synthetic and natural material.

20 In one embodiment, the abrasive particles are insoluble in water so effective scouring is maintained during the total usage of the nonwoven article especially when wiping wet soil or wet surfaces, or if the nonwoven article is wetted or rinsed before or during the cleaning work.

In another embodiment, the abrasive particles are partially soluble or substantially soluble in water. The solubility of the particle may be chosen so that when wetting occurs, the dissolution kinetic is
25 adjusted to deliver effective scouring before the particles partially or totally dissolve.

In one embodiment, the abrasive particles may be degradable according to ASTM 6400D. At least about 50% of the abrasive particles may be degradable according to ASTM 6400D.

In one embodiment, the abrasive particles may be derived from a natural source and may comprise at least about 50% of material derived from a natural source.

In one embodiment, the abrasive particles have a mean solidity below about 0.85. In one embodiment, the particles have a mean solidity from about 0.3 to about 0.8, or from about 0.35 to about 0.75, or from about 0.4 to about 0.7, or from about 0.5 to about 0.65.

5 In one embodiment, the mean solidity of the particles may be chosen to obtain optimized properties including maintenance of the position of the particles within the web of fibers, but also cleaning properties and limitation of the damages to the surface to be cleaned.

In one embodiment, the abrasive particles may have a mean form factor between about 0.1 and about 0.6. In one embodiment,, the abrasive particles have a mean form factor between about 0.1 and about 0.5, or below about 0.4, or below about 0.3, or even below about 0.25.

10 In one embodiment, abrasive having both a mean form factor between about 0.1 and about 0.6 and a mean solidity between about 0.3 and about 0.85 were particularly suitable. Such parameters may provide non-rolling, sharp particles. Such particles may provide more soil removal while damaging less the surface to be cleaned.

In one embodiment, the abrasive particles may have a HV Vickers hardness from 3 to 50 kg/mm².

15 In one embodiment, the abrasive particles may be produced from materials having a Shore® D hardness comprised between 40 and 90.

In one embodiment,, the precursor materials of particle abrasives for use herein have a MOHS hardness of from about 1 to about 5.5, or from about 1.5 to about 5, or from about 2 to about 5, or from about 2.5 to about 3.5.

20 In one embodiment, the abrasive particles may have a mean Equivalent Circle Diameter (“mean ECD”) ranging from about 20 to about 1000 μm. The particles may have a mean ECD ranging from about 75 to about 500 μm, or from about 100 to about 300 μm, or between about 150 and about 250 μm. Such particles may provide an optimize cleaning per weight of particles and/or may be better maintained within the web of fibers.

25 In one embodiment, the abrasive particles may have a mean ECD ranging from about 50 to about 1000%, or from about 80 to about 800%, or from about 100 to about 500%, or about 200-400% of the mean ECD of the mesh aperture of the web of fibers.

In one embodiment, the abrasive particles may have mean ECD ranging from about 5% to about 100%, or from about 10% to about 50%, or from about 15% to about 40%, or from about 20 to about 30%, of the thickness of the nonwoven article.

5 In one embodiment, the abrasive particles may have mean ECD ranging from about 5% to about 100%, or from about 10% to about 50%, or from about 15% to about 40%, or from about 20 to about 30%, of the thickness of the web of fibers.

The nonwoven article

10 In one embodiment, the nonwoven article comprises one or more layers of webs of fibers, for example from 2 to 4 layers of webs of fibers. The nonwoven article may comprise from about 85% to about 99.7% or from about 95% to about 99% by weight of web of fibers.

In one embodiment, the nonwoven article comprises abrasive particles having a mean solidity below about 0.85. The nonwoven article may comprise from about 0.3% to about 10% or from about 1% to about 3% by weight of abrasive particles having a mean solidity below about 0.85.

15 In one embodiment, the weight ratio of abrasive particles /web of fibers in the nonwoven articles may be between about 0.003 and about 0.1.

In one embodiment, the nonwoven article comprises from about 0.1 to about 10 gram of abrasive particles per square meter of the web of fibers. In one embodiment, the nonwoven articles comprises from about 0.1 to about 5, or from about 0.2 to about 4, or from about 0.25 to about 2, or from about 0.5 to about 1.5 grams of abrasive particles per square meter of the web of fibers.

20 In one embodiment, the abrasive particles may be dispersed randomly on or substantially within the web of fibers. The abrasive particles may be more concentrated at one or both outer surfaces of the web of fibers. The abrasive particulate may be non-randomly dispersed onto the web of fibers in pattern, wherein the pattern covers less than about 30% of one outer facing surface of the substrates. More than about 40%, or more than about 60% or about 80%, by weight of the total amount of
25 abrasive particles in the web of fibers may be present on less than about 30%, or less than about 20% or less than about 10% of one facing surface of the web of fibers. In another embodiment (...enumerate higher amounts of coverage)

In one embodiment, the abrasive particles may have contrasting appearance to the web of fibers so they are visually noticeable by simple mean. The Delta L*, and/or the Delta a* and/or the Delta b* may be above 10, preferably above 20, more preferably above 30 wherein the Delta L*, Delta a*, and Delta b* are respectively the delta of the respective values of the abrasive particulates and the web of fibers.

In one embodiment, the abrasive particles may have similar appearance to the web of fibers so they are less visually noticeable. The Delta L*, and/or the Delta a* and/or the Delta b* may be below 10, or 5 wherein the Delta L*, Delta a*, and Delta b* are respectively the delta of the respective values of the abrasive particulates and the web of fibers.

In one embodiment, the abrasive particles may be embedded within the web of fibers. The abrasive particles may be embedded within the web of fibers by any means.

In one embodiment, the abrasive particles may be embedded within the web of fibers by entanglement in the web of fibers for example by pre-mixing the fibers and the abrasive particles before forming the web of fibers.

In one embodiment, the abrasive may be embedded on or substantially within the web of fibers simply depositing the particle at the surface of the web and applying mechanical pressure or air pressure, or vacuum or vibration or simply by adjusting the roll winding pressure or alternatively to laminate another web of fibers on top. A particularly effective embedding method is via needle punching the fiber web after depositing the particles whereby large control of process parameters are possible to tailor accurately the embedment (cf.: Handbook of Nonwoven, S.J.Russell, Woodhead publishing, chap.5.9)

In one embodiment, the abrasive particle may be deposited onto the web of fibers by mean of vibrating mesh reservoir in dry condition. The abrasive particles may be deposited onto the web of fibers by air spraying the particles onto the web of fibers also in dry condition. The abrasive particles may be suspended in a liquid carrier that evaporates during or after the deposition process e.g.: whereby water or carbon dioxide are good examples. The abrasive particles may be suspended in the melt of the functional paste. For liquid or melt application, conventional spray, slot or printing processes are suitable.

In one embodiment, the abrasive particles may be embedded on or substantially within the web of fibers by melt bonding with fibers. The melt bonding may take place during the web forming process (e.g., meltblown-spunbond fibers), during consolidation of the web, or by post treatment using a blend of fibers having different melting temperature or by using bicomponent fibers whereby both components having different melting temperature.

In one embodiment, the abrasive particles may be embedded in the web of fibers by means of an adhesive. In this case, it is critical that the abrasive particles retain a substantial fraction of their shape to deliver effective cleaning. This can be achieved by controlling the amount of adhesive to deliver good bonding with minimal particle coverage. Alternatively the adhesive can cover the totality of the particle surface but the adhesive load and spreadable features are such that the shape is preserved.

In one embodiment, the nonwoven article may comprise from about 0.03% to about 5% or from about 0.5% to about 1% by weight of an adhesive. In one embodiment, the weight ratio of abrasive particles/adhesive in the nonwoven articles may be between about 10 and about 1 or between about 6 and about 2. In one embodiment, from 5% to 50% by weight of the abrasive particles in the nonwoven article may be embedded in the web of fibers by an adhesive. The adhesive may be waterproof. Exemplary adhesives include: ELVANOL®71-30 8.5%, available from DuPont™, Wilmington, DE, and AQUANOL LAM 6014 14%, available from Henkel Corporation, Rocky Hill, CT, USA.

In one embodiment, the abrasive particles may be embedded on or substantially within the web of fibers by means of a functional paste. The functional paste must feature significant non-flowing behavior before usage in order to retain dryness and retain the abrasives particle but may release both the functional additives and the particles during the cleaning operation. In most cases the paste is substantially soluble or fully soluble in water so release can occur, especially when cleaning wet soils or wet surfaces or when the dry substrate is wetted or rinsed before or during the cleaning work. The paste may contain preferably a water soluble ligand e.g.: most preferably containing ethylene-glycol or vinyl alcohol or acrylamide moieties and functional additives such as surfactant, solvent, buffer systems especially base on citric and/or baking soda, perfume, biocides, etc, with or without adhesives. Since the paste is preferably water soluble, it may cover fully or partially the abrasive particles. Preferable paste-to-abrasive weight ratio range from about 0.3 to about 5.

In one embodiment, the nonwoven article may comprise from about 1% to about 10% of paste/abrasive particle mix. In one embodiment, the nonwoven article may comprise from about 1 to about 10 gram of paste/abrasive particles mix per square meter of the web of fibers, or from about 1 to about 5, or from about 2 to about 4 grams of paste/abrasive particles mix per square meter of the web of fibers.

In one embodiment, the abrasive particles may be deposited onto the web of fibers by air spraying the particles onto the web of fibers. The abrasive particle may be deposited onto a web of fibers while an adhesive composition is simultaneously sprayed. The web of fibers may be pretreated with an adhesive on a surface of the web. Heating, pressure or a combination thereof may be applied to provide the desired adhesion of abrasive particles to the web.

In one embodiment, the nonwoven article may be disposable. Disposable is used in its ordinary sense to mean an article that is disposed or discarded after a limited number of usage events, preferably less than 25 or less than 10 or less than 2 usage events.

In one embodiment, the nonwoven article may have a length of from about 5 to about 60 cm, or from about 10 to about 20 cm, a width of from 5 to about 30 cm, or from about 10 to about 20 cm. In one embodiment, the nonwoven article may have a thickness between about 0.5 mm and about 10 mm, for example between about 2 and about 5 mm.

In one embodiment, the nonwoven article is dry. By dry it is meant that the article does not comprise more than about 5% by weight of a liquid. The article may exhibit a moisture retention of less than about 3 grams, or less than about 1 gram or less than about 0.25g or less than about 0.1g before usage. The nonwoven article may be dry-to-the-touch. By “dry-to-the-touch” it is meant that the nonwoven article are free of water or other solvents in an amount that would make them feel damp or wet to the touch. The article may comprise less than about 3% or less than about 1% by weight of liquid. The article may comprise less than about 5%, or less than about 3%, or less than about 1% by weight of water.

In one embodiment, the nonwoven article may comprise an additive. The additive may improve cleaning performance and/or enhance the cleaning experience. The additive may comprise wax, such as microcrystalline wax, oil, adhesive, perfume and combinations thereof.

In one embodiment, the nonwoven article may be pre-moistened. The nonwoven article may comprise a liquid. The nonwoven article may comprise at least about 1%, or at least about 3%, or at least about 5%, by weight of a liquid. The liquid may provides improved cleaning of a target surface, such as a floor. The liquid may not require a post-cleaning rinsing operation. The nonwoven
5 article may be loaded with at least about 1, 1.5 or 2 grams of liquid per gram of dry substrate, but typically not more than about 5 grams per gram. The liquid may comprise a surfactant, such as APG surfactant, agglomerating chemicals, disinfectants, bleaching solutions, perfumes, secondary surfactants etc.

In one embodiment, the nonwoven article may comprise layers, to provide for absorption and
10 storage of cleaning fluid deposited on the target surface. If desired, the nonwoven article may comprise absorbent gelling materials to increase the absorbent capacity of the nonwoven article. The absorbent gelling materials may be distributed within the nonwoven article in such a manner to avoid rapid absorbency and absorb fluids slowly, to provide for the most effective use of the nonwoven article.

In one embodiment, the nonwoven article may comprise one or more webs of fibers disposed in a laminate. The lowest, or downwardly facing outer layer, may comprise apertures to allow for absorption of cleaning solution therethrough and to promote the scrubbing of the target surface. Intermediate layers may provide for storage of the liquids, and may comprise the absorbent gelling materials. The nonwoven article may have an absorbent capacity of at least about 10, 15, or 20
20 grams of cleaning solution per gram of dry nonwoven article, as set forth in commonly assigned US Patent 6,003,191 and 6,601,261. The top, or upwardly facing outer layer, may be liquid impervious in order to minimize loss of absorbed fluids. The top layer may further provide for releasable attachment of the nonwoven article to a cleaning implement. The top layer may be made of a polyolefinic film, such as LDPE. The outer layer of web of fibers may have a basis weight of about
25 5 to 30 gram per square meter, for example from about 10 to 20 grams per square meter. Such basis weight has been found to be particularly suitable when the abrasive particles are between the outer layer and another web of fibers.

In one embodiment, the nonwoven article may be used with a stick-type cleaning implement. The cleaning implement may comprise a plastic head for holding the cleaning sheet and an elongate
30 handle articulable connected thereto. The handle may comprise a metal or plastic tube or solid rod. A suitable stick-type cleaning implement may be made according to commonly assigned US patents

Des. 391,715; D409,343; D423,742; D481,184; D484,287; D484,287 and/or D588,770. A suitable vacuum type cleaning implement may be made according to the teachings of US patents 7,137,169, D484,287 S, D615,260 S and D615,378 S. A motorized implement may be made according to commonly assigned US patent 7,516,508.

- 5 In one embodiment, the cleaning implement may further comprise a reservoir for storage of cleaning solution. The reservoir may be replaced when the cleaning solution is depleted and/or refilled as desired. The reservoir may be disposed on the head or the handle of the cleaning implement. The neck of the reservoir may be offset per commonly assigned US patent 6,390,335. The cleaning solution contained therein may be made according to the teachings of commonly assigned US patent
10 6,814,088.

The surface to be cleaned

The invention also concerns a process to clean a surface with the article of the invention.

- The nonwoven article may be used to clean a surface. The surface may be inanimate or animate, such as household hard surface, dish surfaces, hard and soft tissue surface of the oral cavity, such as
15 teeth, gums, tongue and buccal surfaces, human and animal skin, hair.

- By "household hard surface", it is meant herein any kind of surface typically found in and around houses like kitchens, bathrooms, e.g., floors, walls, tiles, windows, cupboards, sinks, showers, shower plastified curtains, wash basins, WCs, fixtures and fittings and the like made of different materials like ceramic, vinyl, no-wax vinyl, linoleum, melamine, glass, Inox[®], Formica[®], any
20 plastics, plastified wood, metal or any painted or varnished or sealed surface and the like. Household hard surfaces also include household appliances including, but not limited to refrigerators, freezers, washing machines, automatic dryers, ovens, microwave ovens, dishwashers and so on. Such hard surfaces may be found both in private households as well as in commercial, institutional and industrial environments.

- 25 By "dish surfaces" it is meant herein any kind of surfaces found in dish cleaning, such as dishes, cutlery, cutting boards, pans, and the like. Such dish surfaces may be found both in private households as well as in commercial, institutional and industrial environments.

In one embodiment, the process may include a step of wetting the nonwoven article before the cleaning step with water, an aqueous composition, a solvent composition, and/or a composition comprising a surfactant.

EXAMPLES

5 Examples :

Example 1 : Hard surface wipe : abrasive particles are loaded on a vibrating grid of 15 mesh before depositing by gravity at the surface of a nonwoven across the full surface targeting a particle load of about 0.5 gram per square meter. Abrasive particles are made from polyurethane foam, said particles having Mean Area-equivalent Diameter (ECD) of about 238 μ m and Mean Solidity of about 0.59.

10 The non-woven material is a carded hydroentangled substrate of about 58 g/m², consisting of about 60% polypropylene and about 40% viscose fibers of a dry thickness of about 0.57mm.

Example 2 : Hard surface wipe : Abrasive particles are air-sprayed at the surface of a nonwoven across the full surface using sandblasting spraying nozzle at about 1 bar to achieve effective particle embedding at the surface. Abrasive particles made from polyurethane foam, said particles having
15 Mean Area-equivalent Diameter (ECD) about : 280 μ m and Mean Solidity of about 0.77. The non-woven material is a carded hydroentangled substrate of about 58 g/m², consisting of about 60% polypropylene and about 40% viscose fibers of a dry thickness of about 0.57mm.

Example 3 : Hard surface wipe : as in example 2 except that the abrasive material is made of PolyhydroxyButyrate-co-valerate foam, and has Mean Area-equivalent Diameter (ECD) of about:
20 220 μ m and Mean Solidity of about 0.83.

Example 4 : Hard surface wipe : abrasive particles are loaded on a vibrating grid of 15 mesh before depositing by gravity at the surface of a nonwoven across the full surface targeting a particle load of about 0.5 gram per square meter. A needle-punching process is applied prior to winding in order to further embed the abrasive particle in the fiber web (needle foster formed barb gauge 20, needle
25 board density about 20,000/m², about 15,000 punch/min.). Abrasive particles are made from polyurethane foam, said particles having Mean Area-equivalent Diameter (ECD) of about 307 μ m and Mean Solidity of about 0.63 and a form factor of about 0.16. The non-woven material is a carded hydroentangled substrate of about 58 g/m², consisting of about 60% polypropylene and about 40% viscose fibers of a dry thickness of about 0.57mm.

Example 5: Floor wipe : abrasive particles are loaded on a vibrating grid of 15 mesh before depositing by gravity at the surface of a nonwoven to form a discontinuous strip of particles whereby the particle load on that stripe is about 1 gram per square meter and the stripe width is about 3 cm, representing about 12% of the floor wipe total surface and needlepunching as in example 3 is applied on the stripe. Abrasive particles are made from polyurethane foam, said particles having Mean Area-equivalent Diameter (ECD) of about 216 μ m and Mean Solidity of about 0.66. The non-woven material is a carded hydroentangled substrat of about 98 g/m², consisting of about 60% polypropylene and about 40% viscose fibers of a dry thickness of about 0.82mm prior to needlepunching.

Example 6 : Toilet flushable wipe: about 2 parts of abrasive particles are mixed with about 85 parts of cellulosic fibers and about 15 parts of styrene-butadiene resin binder in an air-laid latex bond web-forming process yielding a substrate of about 50 gram per square meter, of about 0.45mm dry thickness. Cellulose fibers are mix of natural and synthetic cellulose fibers (about 40% Hardwood kraft fibers, about 40%, Eucalyptus fibers, and about 20% lyocell fibers). Abrasive particles are made from PolyhydroxyButyrate-co-valerate foam, said particles having Mean Area-equivalent Diameter (ECD) of about 220 μ m and Mean Solidity of about 0.83.

Example 7: Baby toilet wipe: about 2 parts of abrasive particles are mixed with about 40 parts of viscose fibers, about 33 parts of woodpulp and about 22 parts polyethylene tetraphthalate fibers in hydroentangled, resin bond process yielding a substrate of about 70 gram per square meter and about 0.55mm thickness. Abrasive particles are made from PolyhydroxyButyrate-co-valerate foam, said particles having Mean Area-equivalent Diameter (ECD) of about 320 μ m and Mean Solidity of about 0.81.

Example 8 : Disposable Hard surface towel : an abrasive-containing paste is applied by gravure printing process on a disposable paper substrate in a discontinuous pattern whereby about 200mg of paste is deposited per wipe. in a printed pattern covering about 20% of the wipe area. Each wipe has dimensions of: 278 x 262 mm. The paste contains about 22% of abrasive particles (from PU foam, said particles having Mean Area-equivalent Diameter (ECD) of about 307 μ m and Mean Solidity of about 0.63 and a form factor of about 0.16), about 20% greenbentin D0/80 (nonionic surfactant), about 20% of Euro Surfex 1213 (anionic surfactant), about 18% of C12-14 alkyl dimethyl amine-oxide and about 20% of Polyethylene glycol 8000. The about 60 gram per square meter, and about

0.6mm dry thickness fiber web is made of about 1/3 Eucalyptus fibers, about 1/3 Hardwood kraft fibers and about 1/3 Hardwood sulfite fibers

Example 9 : disposable towel : Abrasive particles are air-sprayed at the surface of a paper substrate across the full surface using sandblasting spraying nozzle at about 1 bar to achieve effective particle embedding at the surface. Abrasive particles made from polyurethane foam, said particles having
5 Mean Area-equivalent Diameter (ECD) about: 280 μm and Mean Solidity of about 0.77. The paper substrate is about 58 grams per square meter, and about 0.65 mm dry thickness fiber web and is made of about 46% Eucalyptus fibers, about 13% Hardwood kraft fibers and about 41% Hardwood sulfite fibers

10 Example 10 : disposable towel : Material is as example 8, but about 10 grams per square meter of cellulosic fiber web is deposited by airlaid deposition resin bond process on the substrate.

Example 11 : disposable towel : Material is as example 8, but about 5 grams per square meter of polypropylene fiber web is deposited by spunbond process on the substrate.

Example 12 : disposable towel : Abrasive particles are mixed at about 15%w with a dilute water-soluble adhesive; this mixture is then applied to a 26 grams per square meter paper ply in a dot
15 pattern to about 5% of the sheet area at a loading of about 350 grams per square meter within that pattern. Another 26 grams per square meter paper ply is introduced above and embossing plates matching the dot pattern are used to compress the plys together. The laminated sheet is dried to remove water. Abrasive particles are made from polyurethane foam having Mean Area-equivalent
20 Diameter (ECD) : about 280 μm and Mean Solidity of about 0.77. The 26 grams per square meter, fiber web plys are made of about 46% Eucalyptus fibers, about 13% Hardwood kraft fibers and about 41% Hardwood sulfite fibers. The water-soluble adhesive may be AQUANOL LAM 6014 (14% active polyvinyl alcohol) or ELVANOL 71-30 (8.5% active polyvinyl alcohol).

The dimensions and values disclosed herein are not to be understood as being strictly limited to the
25 exact numerical values recited. Instead, unless otherwise specified, each such dimension is intended to mean both the recited value and a functionally equivalent range surrounding that value. For example, a dimension disclosed as "40 mm" is intended to mean "about 40 mm".

Every document cited herein, including any cross referenced or related patent or application and any patent application or patent to which this application claims priority or benefit thereof, is hereby

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

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

CLAIMS

What is claimed is:

1. A nonwoven article characterized by comprising a web of fibers and abrasive particles, the abrasive particles embedded in the web of fibers, wherein the abrasive particles have a mean solidity below 0.85.
2. The article according to claim 1, wherein the nonwoven article is dry.
3. The article according to claim 1, wherein the abrasive particles have a mean solidity between 0.3 and 0.8.
4. The article according to claim 1, wherein the abrasive particles have a mean form factor between 0.1 and 0.6.
5. The article according to claim 1, wherein the abrasive particles have a mean ECD between 20 and 1000.
6. The article according to claim 1, wherein the abrasive particles have a mean Shore® D hardness between 40 and 90.
7. The article according to claim 1, comprising from 0.1 to 10 g of abrasive particles per square meter of the web of fibers.
8. The article according to claim 1, wherein at least 50% of the abrasive particulate is degradable according to ASTM 6400D.
9. The article according to claim 1, wherein the nonwoven article is made of at least 2 superposing webs of fibers and the abrasive particles are located at the webs interfaces.
10. The article according to claim 1, wherein the particles are embedded within the web of fibers by needle punching of the web after deposition of the particles.
11. The article according to claim 1, wherein the mean ECD of the abrasive particles is from above 5% to below 100% of the thickness of the dry substrate.
12. The article according to claim 1, wherein the abrasive particles have a HV Vicker hardness from 20 to 100.

13. The article according to claim 1, wherein the abrasive particles comprise from 0.1 to 10 grams per square meter of the web of fibers.
14. The article according to claim 1, comprising between 2 and 4 webs of fibers.

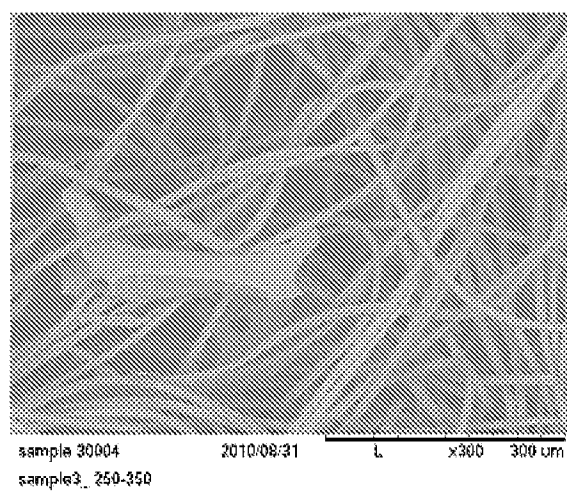


Fig 1

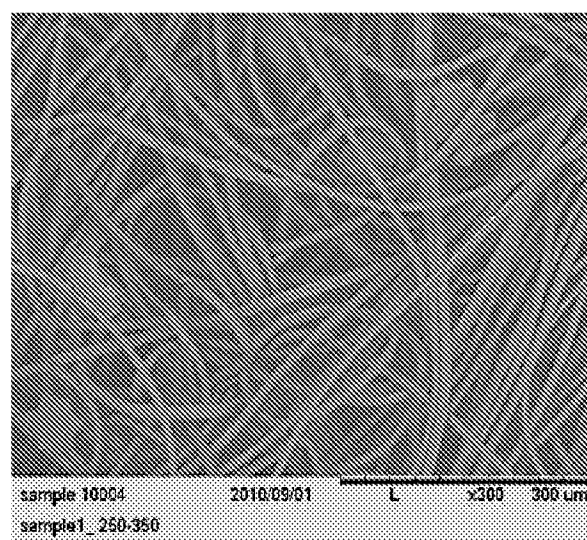


Fig 2

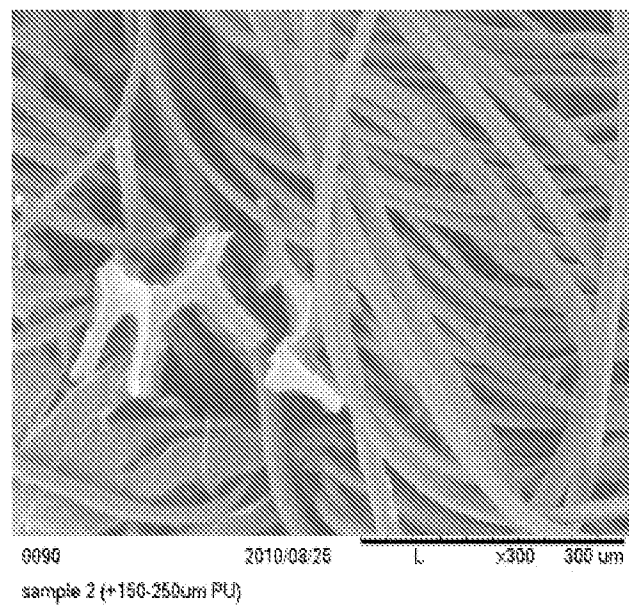


Fig 3

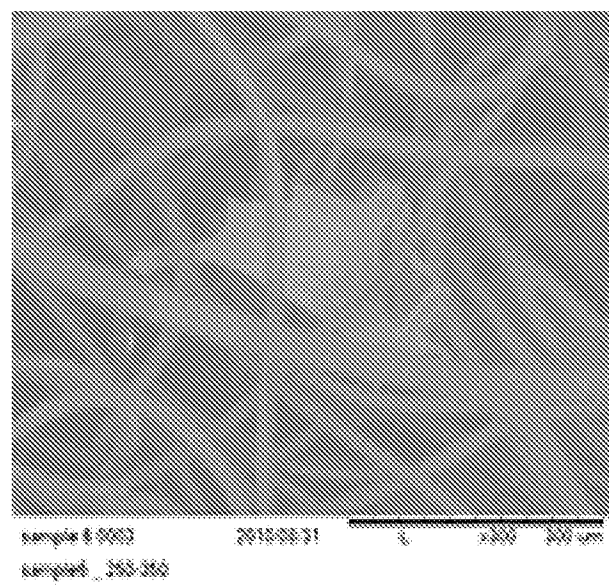


Fig 4

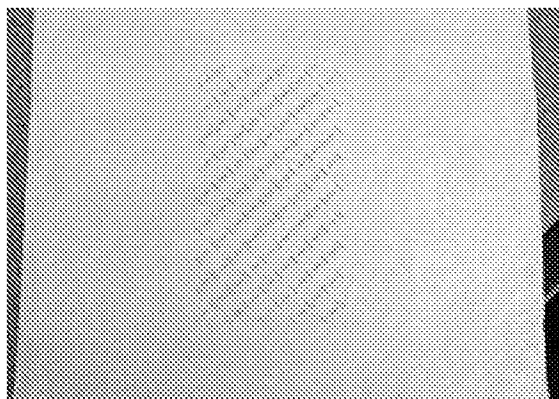


Fig 5

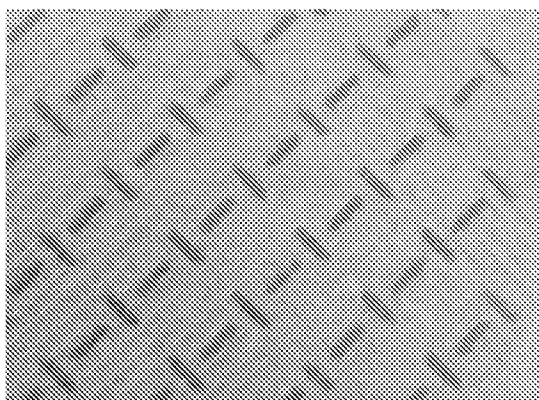


Fig 6



Fig 7

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2015/038745

A. CLASSIFICATION OF SUBJECT MATTER
INV. C11D3/14 C11D17/04
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)
C11D

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	US 2014/105831 A1 (GONZALES DENIS ALFRED [BE] ET AL) 17 April 2014 (2014-04-17)	1-14
Y	paragraphs [0077], [0080], [0083], [0086], [0088]; claims; examples 17-19 -----	1-14
X	US 2013/022556 A1 (GONZALES DENIS ALFRED [BE] ET AL) 24 January 2013 (2013-01-24)	1-14
Y	paragraph [0099]; claims; examples 17-19 -----	1-14
X	US 2012/321567 A1 (GONZALES DENIS ALFRED [BE] ET AL) 20 December 2012 (2012-12-20)	1-14
Y	paragraphs [0089] - [0093]; claims; examples 17-19 -----	1-14
Y	US 5 213 588 A (WONG ARTHUR [US] ET AL) 25 May 1993 (1993-05-25) column 14, lines 25-37; claims; examples ----- -/-	1-14

☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

14 September 2015

Date of mailing of the international search report

23/09/2015

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INTERNATIONAL SEARCH REPORT

International application No

PCT/US2015/038745

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2008/032605 A1 (CHAN TRACY L [US]) 7 February 2008 (2008-02-07) paragraphs [0001], [0002], [0005], [0021], [0024], [0032]; claims -----	1-14

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2015/038745

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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