GROUND CALCIUM CARBONATE COMPOSITES FOR STORAGE ARTICLES AND METHOD OF MAKING SAME

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Related U.S. Application Data
Continuation of application No. 12/013,077, filed on Jan. 11, 2008.
Provisional application No. 60/956,690, filed on Aug. 18, 2007.

The present invention is directed to an environmentally friendly composite structure and storage article fabricated therefrom. The composite structure includes a fiber-containing layer, such as a fiberboard layer or other layer having fibers from natural and/or synthetic sources, and a ground calcium carbonate-containing layer covering the fiber-containing layer. The ground calcium carbonate-containing layer is substantially continuously bonded to the fiber-containing layer along the surface of the fiber-containing layer. The fiber-containing layer and ground calcium carbonate-containing layer can be shaped, sized and manufactured such that the composite structure formed therefrom is capable of being shaped to form the storage article. The composite structure has advantages in that it has a high degree of pliability and flexibility that is increased over the pliability of the fiber-containing layer alone, which renders it highly attractive to consumers. The composite structure further has tensile strength and other characteristics that allow it to be readily machined into desired storage article forms, such as box and carton forms.
GROUND CALCIUM CARBONATE COMPOSITES FOR STORAGE ARTICLES AND METHOD OF MAKING SAME

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to U.S. Provisional Application No. 60/956,690, filed Aug. 18, 2007, which is hereby incorporated by reference in its entirety.

STATEMENT RE: FEDERALLY SPONSORED RESEARCH/DEVELOPMENT

[0002] Not Applicable

BACKGROUND OF THE INVENTION

[0003] Technical Field

[0004] The present invention relates generally to storage articles such as retail and/or shipping product packages having a ground calcium carbonate-containing material that is highly attractive, efficient to manufacture, and environmentally friendly.

[0005] Related Art

[0006] Packages and packaging material for product retail and shipping purposes are typically designed to be sufficiently durable to allow reliable use of the materials. Considerations that are taken into account in the development of such packages and materials include their resistance to heat, fire, tearing, wrinkling, scuffing and moisture, as well as resistance to infiltration by rodents and pests, and the ability of the packages and materials to deter theft. The packages and packaging materials are also desirably relatively inexpensive to manufacture, and are preferably attractive enough to the customer in appearance, feel and touch to encourage use of the products as well as to enhance the product image or association.

[0007] However, it can be difficult to create packaging products that are both attractive to consumers and inexpensive to fabricate while also being sufficiently durable to meet the needs of retail and shipping use. For example, some lower cost packaging options are poorly configured to prevent theft because of minimal investment in protective structures. Examples of packages that may not be as great of a theft deterrent are common blister packages, consumer style folding cartons and boxes, and shrink-wrapped or flexible film style packaging. While clamshell style packaging is an example of more theft resistant packaging due to the typically higher gauge materials used therein, the packaging is also typically more expensive due to the use of the higher cost materials.

[0008] A further problem that exists with prior packaging products is that these products may not incorporate environmentally friendly materials and designs, particularly at low cost levels that offer affordability. Environmentally friendly materials can have desirable attributes such as biodegradability, compostability, a high recycled content, recycle-ability, and may also use less energy, pollute less, and generate fewer greenhouse gases in their manufacture than previous materials. Such environmentally friendly materials are increasingly in demand from consumers and retailers, and can be beneficial for manufacturers by reducing adverse environmental impact of the material.

[0009] An example of an environmentally friendly material is ground calcium carbonate (GCC), which is a material that can be combined with bonding agents and extruded to form material layers. Environmentally friendly ground calcium carbonate extrusion materials include materials similar to ones with the tradename XTERRANE™, Taipei, Taiwan, and materials from other manufacturers, which may be incorporated into a synthetic commercial printing paper and other consumer materials. The ground calcium carbonate material can be fabricated from natural sources, such as limestone, and can be biodegradable and compostable, uses less energy, no water, and fewer chemicals, and thus represents an advantage over other non-biodegradable and less environmentally friendly materials.

[0010] FIGS. 1a through 1c show a blister card package 10 that incorporates an environmentally friendly ground calcium carbonate material in a non-composite form, and that is commercially available from One Source Industries in Irvine, Calif. The blister card package 10 is formed by adhering a front card portion 12a to a back card portion 12b, with the front card portion 12a having a cutout sized to fit a plastic “blister” 14 therewith in which the retail product 16 is contained and displayed. The blister 14 has flanges 18 that are sealed in between the two card portions 12a and 12b to form a sturdy blister card package 10. In this embodiment, a front card portion 12a may be fabricated of a card of ground calcium carbonate containing material, and the back card portion 12b can be formed of a rigid paperboard card. The front and back card portions 12a, 12b can then be heat sealed together to join the cards in a limited surface area that is dictated by the heat sealing pattern at the interface between the two card portions 12a, 12b, thereby trapping the blister between the two card portions 12a, 12b. Adhesive or glue can also be applied at various regions of the interface between the front and back card portions, such as about the blister flanges 18 or about a periphery of the cards. The typically rigid cartridg materials used for the back and/or front card portions 12a, 12b, and use of adhesive or other agents in the adhesion of the card portions 12a, 12b forms a rigid and stiff overall card package, which has the advantages of imparting theft and tear resistance to the blister card package. The ground calcium carbonate-containing material also imparts an attractive look to the blister card package, with the ground calcium carbonate material having the added advantage that it is environmentally friendly, and renders the package readily printable with advertising or product information.

[0011] However, a problem with such blister card products is that they are typically not as attractive to consumers in terms of look, feel and touch, as other less environmentally sound products, due to the rigidity and tactile unpleasantness of the stiff packaging. Also, some large club stores require that packages have designs with sufficient external strength to allow for vertical and other stacking of the packages in pallet pack layers, which can be difficult to achieve when incorporating a plastic “blister” portion into the packaging. The blister packaging also may not provide the best theft deterrence. Other limitations of this style of package include the inability to fold, glue, die cut and form the package materials, greatly reducing the package utility. Also, because the materials are temporarily attached along a limited surface area seal pattern in order to trap and contain the blisters, the materials’ performance is greatly limited in strength, pliability, wrinkle and tear resistance. Also, the packaging is susceptible to separation because of die cut openings and
exposure to natural elements such as moisture and detachment and tearing upon contact.

[0012] A configuration that is often used for shipping and/or retail packages is a carton or box shape that is space efficient, durable and theft resistant. Carton or box packaging can be formed of cardboard materials such as Kraft boards, box boards, corrugated boards, etc., that are durable and readily machinable, for example by automated scoring, folding, bending, die-cutting, and even cartoning, to form a desired box form. Unfortunately, the cardboard materials used to form such package soften do not have a surface that lends itself to high quality printing, and therefore the cardboard boxes and cartons often have an unrefined and industrial look that can be unattractive to consumers. Additionally, cardboard boxes and cartons have little or no resistance to heat, fire, tearing, wrinkling and scuffing. While ground calcium carbonate-containing materials can be provided in forms that are readily printable, these materials and the products incorporating them, including the blister package described above, are typically not readily machinable, as they are lacking in the tensile strength and other characteristics that are necessary for proper machining of the product.

[0013] Accordingly, there remains a need in the art for retail and/or shipping packages that are durable and cost effective while also being attractive to consumers in terms of appearance and touch. There is also a need for retail and/or shipping packages that are durable and attractive while incorporating environmentally friendly materials and being resistant to theft. There is a further need for compositions for forming attractive retail and/or shipping products that are readily machinable either at the point of manufacture (e.g., via scoring, folding, die-cutting, thermo or vacuum forming) or the point of distribution (e.g., via cartoning and gluing).

BRIEF SUMMARY OF THE INVENTION

[0014] The present invention specifically addresses and alleviates the above-identified deficiencies in the art. In this regard, the present invention is directed to an environmentally friendly composite suitable for fabricating storage articles at least partially therefrom (e.g., a retail and/or shipping package). The composite structure includes a fiber-containing layer, such as a cardboard layer or other layer containing fibers from natural and/or synthetic sources, and a ground calcium carbonate-containing layer covering the fiber-containing layer, where the ground calcium carbonate-containing layer is substantially continuously bonded to the fiber-containing layer along the surface of the fiber-containing layer at the interface between the layers. The fiber-containing layer and ground calcium carbonate-containing layer can be shaped, sized and manufactured such that the composite structure formed therefrom is capable of being shaped to form at least a portion of the storage article. Surprisingly, the composite structure formed from the fiber-containing layer and ground calcium carbonate has a high degree of pliability and flexibility that is increased over the pliability and flexibility of the fiber-containing layer or ground calcium carbonate-containing layer alone. The composite structure also has enhanced characteristics such as a bright and attractive printing surface that, along with the pliability, render it attractive to consumers. The composite structure further has tensile strength and other characteristics that allow it to be readily machined into desired storage article forms, such as storage boxes and cartons, which have high durability as well as good moisture resistance and biodegradability.

[0015] In one version, the composite structure is formed by bonding the ground calcium carbonate-containing layer to the fiber-containing layer under conditions selected to form the composite. For example the ground calcium carbonate layer can be adhered to the fiber-containing layer by applying adhesive to the layers and joining the layers together in a hot or cold application process.

[0016] In yet another version, a ground calcium carbonate-containing structure suitable for forming storage articles can be provided, the structure comprising an extruded ground calcium carbonate containing mixture comprising ground calcium carbonate particles, a bonding agent, and at least one of a natural and synthetic fiber. The ground calcium carbonate-containing structure is shaped, sized and manufactured such that it is capable of being shaped to form the storage article.

[0017] In one version, the composite structure is formed into the shape of a box or carton for retail and/or shipping purposes. The composite structure may also be formed into the shape of a container liner, a shipping mailer, a display or display tray, slip or tear sheets, pallet covers, corrugated structures and interior protective packaging components, and other retail and/or shipping components.

[0018] The present invention is best understood by reference to the following detailed description when read in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] These as well as other features of the present invention will become more apparent upon reference to the drawings wherein:

[0020] FIG. 1a is a schematic side view of a prior art blister card package showing a product held in a blister that is sandwiched between top and bottom card portions;

[0021] FIG. 1b is a schematic side view of the prior art blister card package of FIG. 1a having the top and bottom card portions sealed to one another;

[0022] FIG. 1c is a schematic front view of the prior art blister card package of FIGS. 1a-1b showing the product displayed within the blister portion of the package;

[0023] FIG. 2a is a sectional side view of a composite structure having a fiber-containing layer and a ground calcium carbonate-containing layer covering the fiber-containing layer;

[0024] FIG. 2b is a sectional side view of a composite structure having a fiber-containing layer and first and second ground calcium carbonate-containing layers;

[0025] FIG. 2c is a sectional side view of a ground calcium carbonate-containing structure having an extruded mixture of ground calcium carbonate particles, a bonding agent, and fibers;

[0026] FIG. 2d is a sectional side view of extrusion pellets having a mixture of ground calcium carbonate particles, a bonding agent, and fibers;

[0027] FIGS. 3a-3b are side views of embodiments of composite structures formed into the shape of at least one of a shipping box and retail box;

[0028] FIGS. 4a-4b are side views of embodiments of containers having composite structures formed into the shape of container liners.
FIG. 5 is a front view of a shipping mailer having the composite structure;

FIGS. 6a-6g are front views of embodiments of retail displays and display trays having the composite structure;

FIG. 7a is a sectional side view of a corrugated structure having the composite structure;

FIG. 7b is a sectional top view of the corrugated structure having the composite structure of FIG. 7a;

FIG. 8 is top view of a tear sheet or slip sheet having the composite structure which may optionally be used as a pallet cover;

FIG. 9 is a sectional side view of an interior protective packaging component having the composite structure and containing shock absorbing material;

FIG. 10 is a sectional side view of an interior protective packaging component having the composite structure molded onto a shock absorbing material; and

FIG. 11 is a schematic side view of a vacuum-forming apparatus suitable for molding composite structures into shapes for storage articles.

Common reference numerals are used throughout the drawings and detailed description to indicate like elements.

DETAILED DESCRIPTION OF THE INVENTION

The detailed description set forth below is intended as a description of the presently preferred embodiment of the invention, and is not intended to represent the only form in which the present invention may be constructed or utilized. The description sets forth the functions and sequences of steps for constructing and operating the invention. It is to be understood, however, that the same or equivalent functions and sequences may be accomplished by different embodiments and that they are also intended to be encompassed within the scope of the invention.

It has been discovered that environmentally friendly and attractive storage articles 20, such as for example retail and/or shipping packages, can be constructed at least in part from a composite structure 22 formed from a fiber-containing layer 24 and a ground calcium carbonate-containing layer 26 covering the fiber-containing layer 24, as shown for example in FIG. 2a. The composite structure 22 comprises a ground calcium carbonate-containing layer 26 that is substantially continuously bonded to the fiber-containing layer 24 along a surface 25 of the fiber-containing layer 24 that is at the interface 19 between the two layers 24, 26, thereby forming a unitary composite structure. The manufacture of the composite structure 22, including the shapes, sizes and manufacture of the fiber-containing layer 24 and ground calcium carbonate-containing layer 26, is controlled such that the composite structure 22 formed therefrom has a pleasing and attractive pliability, as well as a tensile strength and other processing-related characteristics that are suitable to allow for the production of the storage article 20. The pliability of the composite structure 22 imparts an attractive tactile feel to the article 20 that is a substantial improvement over prior products. The composite structure 22 can also be readily transformed into desired storage article components 33 by machining the composite structure 22, for example by at least one of scoring, folding, creasing and die-cutting of the pliable composite structure 22, as well as by using vacuum-forming or thermo-forming techniques.

In one version, the composite structure 22 has a pliability that is increased over what the fiber-containing layer 24 would have alone if used apart from the composite structure 22. In other words, the formation of the composite structure 22 provides for a structure having a pliability that is greater than that of the original fiber-containing layer 24 used to form the composite. For example, the pliability of the composite structure 22 may be at least about 20% higher than that of the fiber-containing layer 24 alone, such as even at least about 50% higher, as measured by bendability and pliability standards known to those of ordinary skill in the art, including ASTM D228-02, #10 and ASTM D6125-97 (2002), both of which standards are herein incorporated by reference in their entirety.

As known to those of ordinary skill in the art, a “composite” material is a material comprising two or more substances having different physical characteristics, in which each substance retains its identity while contributing desirable properties to the whole. The term “composite” may especially refer to those materials for which each substance contributes desirable properties to the whole that are greater than the otherwise additive contribution of each substance in the absence of the other, in effect creating a material that has properties greater than the mere sum of its parts. This is in contrast to, for example, the prior art non-composite product shown in FIGS. 1a-1c, as the two layers 24, 26 of the pliable composite structure 22 according to the present invention are bonded along substantially the entire interface between the layers 24, 26, such as substantially continuously along an entire surface 25 of the base layer 24, to form a single composite structure. Also, the characteristics and manufacture of the layers 24, 26 and composite structure 22 are selected such that the combined composite structure 22 has properties including pliability and machinability that go beyond the capabilities of either material alone and that are not achieved by the prior art product.

The composite structure 22 can be formed by controlling the sizes, shapes and manufacture of the ground calcium carbonate-containing layer 26 and fiber-containing layer 24, as well as the composite structure manufacturing process. For example, parameters that can be controlled to achieve the improved composite structure 22 having the desired pliability and aesthetic characteristics, as well as desired durability and machinability, can include at least one of the thickness, the basis weight, the density, the tensile strength, and the chemical content of the layers 24, 26.

In one version, the chemical composition of the ground calcium carbonate-containing layer 26 is controlled to provide the composite structure 22 having the desired characteristics. Suitable ground calcium carbonate-containing layers 26 may comprise from about 50% to about 85% by weight of ground calcium carbonate in the form of particles sized from about 10 microns to about 20 microns. The calcium carbonate of the ground calcium carbonate-containing layer 26 can be derived from a limestone source or other calcium carbonate-containing sources. The ground calcium carbonate-containing layer 26 further comprises a bonding agent mixed with the ground calcium carbonate particles that provides a medium for bonding the particles within the layer 26. In one version, a type and prescribed amount of the bonding agent can be added to the ground
calcium-containing layer 26 that is sufficient to provide a composite structure 22 that has a desired level of pliability, while also being readily machinable. Examples of suitable bonding agents can include at least one bonding agent selected from high density polyethylene (HDPE), biopolymers and polylactic acids. The bonding agents can be provided in an amount of, for example, from about 15% to about 50% by weight of the layer 26, such as about 15% by weight. It is contemplated that higher amounts of bonding agent, such as amounts of at least 30% by weight, can be provided to render the composite structure 22 more readily vacuum or thermoformable. Also, the proportion of branched to linear polymers provided as the bonding agent can be selected to achieve the desired stiffness of the resulting structure, with higher amounts of branched polymers believed to result in stiffer composite structures 22.

[0044] The composition of the fiber-containing layer 24 can also be controlled to provide a composite structure 22 having the desired characteristics, such as the desired pliability and machinability of the structure 22. The fiber-containing layer 24 comprises at least one of natural and synthetic fibers, and has desirable tensile strength and other characteristics that render the layer suitable for machining processes used to form the storage article 20. For example, the fiber-containing layer 24 may be in the form of a fiberboard layer, and even a paperboard layer, such as one of the various different types of paperboard roll and sheet materials that are known in the art. Examples of suitable fiberboard and/or paperboard materials include, for example, recycled folding boxboards (RFB), bleached Kraft board, unbleached Kraft board, such as C1S and C2S solid bleached sulfate boards (SBS), as well as coated recycled boards (CRB) and uncoated recycled boards, clay coated light black boards (CCLB) and triplex and duplex boards. The fiberboards and/or paperboards used for the fiber-containing layer 24 typically contain primarily cellulosic and/or wood pulp-based fibers, although they may also have a synthetic fiber content. The fiber-containing layer 24 also desirably comprises a relatively high level of recycled and/or post-consumer recycled fiber content. For example, the recycled folding boxboard and coated and uncoated recycled boards can contain 100% recycled content, of which up to 35% by weight is post-consumer recycled content. The triplex and duplex boards, which are coated recycled boards having a high content of post-consumer recycled fibers, can contain 100% recycled content and greater than 90% or 95% post-consumer recycled content, respectively.

[0045] The thickness of one or more of the layers 26, 24 can also be controlled to provide more or less pliability in the resulting composite structure 22 as well as machinability, with thinner layers typically being more pliable than thicker layers. The thicknesses of the layers 24, 26 are also selected such that the composite 22 formed therefrom is readily machinable. Furthermore, the thicknesses of the layers 26, 24 are also selected with regard to desired durability requirements, with thicker layers providing more durability in some embodiments over very thin layers. A suitable thickness of the ground calcium carbonate-containing layer 26 that provides good pliability as well as durability and machinability of the composite structure 22 may be, for example, from about 2 to about 30 mils, such as from about 2.6 mils to about 10 mils. A suitable thickness of the fiber-containing layer 24 can vary according to the density and tensile strength of the type of paperboard being used. For example, the thickness of the layer may be from about 14 mils to about 28 mils for paperboard types such as C1S and C2S SBS paperboard, recycled folding boxboard, unbleached Kraft board, coated and uncoated recycled board, and folding box board, and may be from about 12 mils to about 23 mils for paperboard types such as triplex and duplex paperboards.

[0046] The basis weights and densities of the ground calcium carbonate-containing layer 26 and fiber-containing layer 24 are also selected to provide a composite structure 22 having the desired attributes. The basis weight and densities of the fiber-containing layer 24 and ground calcium carbonate layer 26 are selected to allow for ready machinability of the final composite structure 22, as a finished composite structure 22 that is either too light or too heavy may not be suitable for manipulation by standard paper and paperboard machines, such as scoring, folding, die-cutting, gluing and cartoning machines. A suitable basis weight of the ground calcium carbonate containing layer 26 can be, for example, from about 15 lbs/1000 sqft to about 240 lbs/sqft, and a suitable density may be from about 34 g/m² to about 900 g/m². A suitable basis weight of the fiber-containing layer 24 can be from about 40 lbs/1000 sqft to about 130 lbs/1000 sqft, and a suitable density can be from about 210 g/m² to about 450 g/m². For example, for C1S and C2S SBS board, recycled folding boxboard, unbleached Kraft board, coated recycled board, uncoated recycled board and folding box board, a suitable basis weight may be from about 55 lbs/1000 sqft to about 128 lbs/1000 sqft, and a suitable density may be from about 210 g/m² to about 420 g/m². For fiber-containing layers 24 containing triplex and duplex boards, a suitable basis weight may be from about 41 lbs/1000 sqft to about 110 lbs/1000 sqft, and a suitable density may be from about 225 g/m² to about 450 g/m².

[0047] The fiber-containing layer 24 is also selected to have tensile strength characteristics that result in the formation of the composite structure 22 that can be readily machined. The desired tensile strength characteristics can include the tear resistance of the paperboard layer 24 as measured in machine direction (MD) or cross-direction (CD). The cross-direction (CD) is typically defined as the direction across the web of the paperboard, i.e. at a 90 degree direction with respect to the grain of the fiber in the fiberboard layer 24. The machine direction (MD) is typically defined as the direction that runs parallel to the grain of the fibers in the fiberboard layer 24. The MD and CD tensile strengths of paperboard materials can be measured according to the ASTM D 5342-97 Standard (also called the Tensile-Type testing standard), which is herein incorporated by reference in its entirety, as is known to those of ordinary skill in the art. Materials having a tensile strength within a specified range are capable of being processed by paperboard machining equipment, such as automated scoring, folding, die-cutting and forming machines, to provide final storage article shapes. In contrast, materials that are lacking in proper tensile strength characteristics may be too brittle or stiff, or alternatively too elastic, to be machined in standard paperboard machining processes. In one version, a suitable paperboard layer 24, such as the box boards, Kraft boards and recycled boards described above, has a tensile strength as measured by the ASTM D 5342-97 Standard (tensile-type standard) of from about 125 to about 900 MD, and from about 55 to about 400 CD. In another version, a suitable paperboard layer 24, such as a triplex or duplex paperboard
layer 24, has a tensile strength as measured by the ASTM D 5342-97 Standard, of from about 144 to about 685 MD.  

It should be noted that the ground calcium carbonate-containing layer 26 is not typically selected with regards to a CD or MD tensile strength, as the ground calcium carbonate-containing material effectively does not have a CD or MD tear strength value that is measurable by the same standards used for paperboard. The lack of a comparable tensile strength in the ground calcium carbonate-containing material is one of the characteristics that renders the ground calcium carbonate-containing layer 26 unsuitable for the standard machining processes that are typically used to shape and form paperboard materials and other materials into finished storage articles.

The composite structure 22 formed from the continuously bonded ground calcium carbonate-containing layer and paperboard layer has material characteristics that render it suitable for use in the formation of the storage article 20, including machinability and pliability. In one version, the composite structure 22 comprises a paperboard layer 24 bonded to the ground calcium carbonate-containing layer 26 on one or more surfaces 25, 27 of the paperboard, to form either double or triple layer composites suitable for use in, for example, storage boxes or cartons. FIG. 2b shows an example of a triple layer composite structure having first and second ground calcium carbonate-containing layers 26a, 26b, bonded to top and bottom surfaces 25, 27 of the paperboard layer 24. FIG. 2a shows an example of a double layer composite. Such double or triple layer composite structure 22 can have a basis weight of from about 66 lbs/1000 sqft to about 175 lbs/1000 sqft, a density of from about 216 g/m² to about 880 g/m², a tensile strength of about 125 to about 900 MD and about 55 to about 400 CD, as measured by the ASTM D 5342-97 Standard, and a thickness of from about 12 mils to about 32 mils.

In yet another version, the composite structure 22 comprises multiple sheets of paperboard layers 24 bonded to ground calcium carbonate-containing layers 26, as in the formation of slip or tear sheets 44, as shown for example in FIG. 8. Such multi-layer composite structure 22 can have a basis weight of from about 198 lbs/1000 sqft to about 525 lbs/1000 sqft, a density of from about 648 g/m² to about 2,640 g/m², a tensile strength of about 375 to about 2700 MD and about 165 to about 1,200 CD, as measured by the ASTM D 5342-97 Standard, and a thickness of from about 45 mils to about 80 mils. While the multi-layer composite structure 22 that makes up the relatively heavy slip and tear sheets 44 may not be as readily machinable as lighter weight composite structures, the multi-layer composite structure 22 nonetheless has enhanced pliability that renders it aesthetically appealing, and retains sufficient paperboard characteristics that render it suitable for its function.

The composite structure 22 can be fabricated using a variety of different manufacturing techniques. For example, a method of forming the composite structure 22 can comprise a milling step in which paperboard is formed into sheets having the desired characteristics and thickness, and the resulting sheets are gathered onto rolls. The fabrication process can also include the step of extruding the ground calcium carbonate material into sheets having the desired characteristics and thickness, and gathering the resulting sheets into rolls. The fabrication process can further comprise bonding the paperboard layer 24 to the ground calcium carbonate-containing layer 26 to form the improved composite structure 22. The paperboard layer 24 may be at least partially covered with the ground calcium carbonate-containing layer 26 on one or more surfaces of the layer 24, such as on top and bottom surfaces 25, 27, or only on a single surface, as shown in FIG. 2a.

The paperboard layer 24 can be bonded to the ground calcium carbonate-containing layer 26 by adhering the layers 24, 26 to one another, for example by applying heat or pressure to one or more of the materials forming the layers 24, 26, or by optionally applying an adhesive between the layers 24, 26. In one version, the pliable composite structure 22 is formed without the use of added adhesive between the layers 24, 26. In yet another version, an adhesive is applied to a surface of one or more of the layers 24, 26, such as a top surface 25 of the paperboard layer 24, to adhere the layers 24, 26 to one another. In this version, the adhesive may be applied to substantially the entire surface 25 at the interface 19 between the paperboard layer 24 and ground calcium carbonate-containing layer 26 to ensure bonding of the layers 24, 26 across the entire surface 25. The conditions under which bonding of the layers 24, 26 is carried out can be selected to provide optimum adhesion of the layers 24, 26 to one another, as well as a substantially continuous bond between the layers 24, 26 that extends across the entire length and width of the surface 25. For example, in a suitable hot application process for bonding the layers 24, 26, an adhesive having a viscosity of from about 660 cP to about 1,480 cP is applied to one or more of the layers 24, 26 at an elevated temperature of from about 300°F to about 385°F. In an example of a suitable cold application process for bonding the layers 24, 26, an adhesive having a viscosity of from about 1,000 cP to about 2,100 cP is applied at a temperature of from about 27.5°C to about 30°C.

The final composite structure 22 has the improved characteristics as shown in Table 1 below. As can be seen from the table, the effect of forming the composite structure 22 is that the desirable tensile strength and other machine-processing related characteristics of the paperboard layer 24 are maintained, thereby providing a durable composite structure 22 that is capable of being machined by standard paperboard machining processes, while also achieving a pliability of the composite structure 22 that is aesthetically appealing and that is greater than that of the paperboard material alone.

<table>
<thead>
<tr>
<th>Material</th>
<th>Tensile Strength (MD)</th>
<th>Tensile Strength (CD)</th>
<th>Pliability</th>
<th>Machinability</th>
<th>Photo-degradability</th>
</tr>
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<tbody>
<tr>
<td>Paperboard</td>
<td>125-900</td>
<td>55-400</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>GCC layer</td>
<td>None</td>
<td>None</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Composite</td>
<td>125-900</td>
<td>55-400</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Paperboard/GCC structure</td>
<td>125-900</td>
<td>55-400</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

The composite structure 22 also has other benefits over non-composite paperboard materials used for the packaging and storage article 20. For example the composite structure 22 is photodegradable and provides an improved moisture barrier over typical paperboard materials. The composite structure 22 also has a premium printing surface 21 by virtue of the ground calcium carbonate-containing layer 26. Furthermore, the composite structure 22 is esti-
mated to require 25% to 65% less water for manufacture than similar paperboard materials, as the ground calcium carbonate containing layer 26 essentially does not require water usage for its fabrication. Also, the composite structure 22 renders certain non-biodegradable paperboards biodegradable and compostable, such as C1S and C2S SBS paperboard, unbleached kraft board and folding box board. Because the ground calcium carbonate-containing material is an environmentally friendly material, the composite structure 22 is fully recyclable, can have a recycled fiber content or post-consumer recycled fiber content of from about 35% to about 75%, and also has an estimated 25% to 65% reduction in air discharge and formaldehyde over standard paperboard materials.

[0055] Various machining steps can be performed to shape the composite structure 22 formed from the ground calcium carbonate-containing layer 26 and paperboard layer 24 into the desired storage article form. The machining steps can include folding, bending, creasing and otherwise forming or molding the composite structure 22, such as by vacuum forming and thermoforming, as well as cutting steps and gluing steps to form the desired shapes. The machining steps can be carried out at one or more of the point of manufacture and the point of distribution. For example, machining steps can be carried out at the point of manufacture to cut, score and fold the composite structure 22 into a desired shape that may be suitable for shipping and/or storing of the article 20. At the point of distribution of the storage article 20, gluing and forming steps can be performed to achieve the final storage article shape, such as cartoning steps in the case of the manufacture of cartons or boxes.

[0056] In further embodiments, the individual materials and/or pliable composite structure 22 are formed into a desired shape for the storage article 20 by molding under pressure, heat or vacuum. For example, in a vacuum molding process, one or more of the material and composite is forced against a mold under the force of vacuum, such that the material or composite adopts a shape conforming to the mold. As another example, in a thermoforming process, the materials and/or composite are heated while pressed against a mold to deform the material until it adopts a desired shape. Such molding may allow the pliable composite structure 22 to adopt desired shapes, including even rounded or curved shapes. An example of a vacuum molding press 60 is shown in FIG. 11, which shows top and bottom press plates 62a, 62b and a mold 64, with the pliable composite structure 22 being placed between the presses 62a, 62b and mold 64 and then vacuum pressed onto the mold by application of a vacuum between the presses 62a, 62b. The pliability of the structure 22 may also allow various folding and creasing steps to be performed to form the final component shape, without requiring the application of heat or vacuum. A combination of various molding and/or shaping steps may also be performed to form the final storage article 20, as well as various cutting and shaping steps and steps to adhere additional decorative or functional parts. Also, one or more composite structures 22 can be stacked or adhered to one another to form a desired storage article component 33.

[0057] In one embodiment, the composite structure 22 that is used to form a storage article 20 such as at least one of a retail package 20 and shipping package 20 having printing formed on portions thereof, such as printed advertisements or information about the product contained therein. For example, the storage article 20 can have printing on one or both sides of the ground calcium carbonate-containing layer 26, such as on a printing surface 21 and also or alternatively on one or both sides of the paperboard layer 24. The printing can be carried out by well-known printing techniques, such as flexographic and lithographic printing. Storage articles 20 having composite structures 22 with ground calcium carbonate-containing layers 26 can be attractively and brightly printed to increase consumer demand for the product as well as to convey important information about the product and contents to the customer. In this version, a printing step comprises feeding the base material or ground calcium carbonate-containing material through a printer. The printer can print on one or multiple surfaces of the material, and the same material can also be sent through the same or a subsequent printer.

[0058] In one version, the composite structure 22 is formed into the shape of a component 33 comprising a box 28 for at least one of retail and shipping, as shown for example in FIGS. 3a-3b. The box 28 may be in the form of a cube, rectangular or other box shape that is sized to contain a retail or shipping article 16. In one version, the box 28 is formed by preparing the composite structure 22 in the form of a pliable sheet, for example by performing the milling step and other processing steps as described above, cutting the structure into the desired shape, and then folding and/or creasing the sheet, either manually or by machine, such as via an automated cartoning process, to form the final three dimensional box shape. In the version shown in FIG. 3a, the composite structure 22 forms the walls 39 of the box, including bottom and side walls 39a, 39b as well as a fold-over lid portion 39c. The box 28 formed from the composite structure 22 having high pliability has a smooth and flexible tactile feel that is attractive and pleasing to the touch, while also being sturdy and durable enough to allow use in retail on store shelves and displays. In one version, the pliability of the box 28 is such that it can be readily folded and unfolded into the box shape 28, thereby allowing the user to store the box 28 in the unfolded state and then quickly fold the box into shape when needed for use. The box 28 is also desirably sturdy enough to withstand vertical or other stacking of the box 28 with other boxes, such as in pallets for shipping or storage of products, and may also provide substantial theft deterrence. In another embodiment, the attractive feel of the box 28 as well as the enhanced luster and shine of the box imparted by the ground calcium carbonate-containing material makes the box 28 particularly suitable for the retail of high-end and luxury products where the appeal of the overall retail package is important, such as in the retail of perfumes, cosmetics and jewelry.

[0059] In another version, the composite structure 22 is formed into the shape of a container liner 30 for at least one of retail and shipping use, as shown in FIGS. 4a and 4b. The liner 30 is used to line a shipping or retail container 32 to cushion and protect a product being held in the container 32, as well as to impart moisture resistance and deter infiltration of rodents and other pests. In the version shown in FIGS. 4a and 4b, the liner 30 formed of the composite structure 22 is sufficiently flexible and pliable such that it is capable of at least partially conforming to the shape of the container 32. In the version shown in FIG. 4a, the liner 30 is sufficiently flexible to conform to the shape of a rectangular-shaped container 32. In the version shown in FIG. 4b, the liner 30 is sufficiently flexible to conform to the shape of a cylindrically-shaped container 32. The liner 30 containing the
composite structure 22 provides an improvement over for example prior containers formed of unlined corrugated boxes, by reducing dust contamination of the product held therein from the corrugated material, and also provides moisture, heat, pest and rodent resistance that is an improvement over the prior unlined corrugated container materials.

[0060] In yet another version, the composite structure 22 forms a part of a shipping mailer 34, such as an envelope used to ship documents and other objects through UPS, FEDEX, USPS, etc., as shown in FIG. 5. The composite structure 22 may be used to form a part of or even all of the mailer structure, excluding sealing parts such as adhesive or attachment brads that seal the mailer opening for shipping, and may be fabricated by using a series of folding, creasing and adhesive steps to prepare the desired mailer shape. The composite structure 22 is desirably sufficient pliable such that documents and other objects can be readily accommodated in the mailer 34, while also being sufficiently durable to resist tearing, snagging and ripping of the shipping mailer 34. The shipping mailer 34 formed from the composite structure 22 provides numerous advantages over prior mailers 34 not having the improved composite structure 22. For example, the shipping mailer 34 having the composite structure imparts improved moisture resistance while also allowing for highly attractive printing on the packages, so that instructions regarding the content, shipping instructions or advertisements can be printed on the mailer. This is in contrast to prior mailers, such as e.g. paper mailers, which are typically fabricated to be either water resistant or readily printable, but do not typically have a highly attractive and readily printable surface that is also moisture resistant and durable, as is the case for mailers having the ground calcium carbonate-containing composite layer 26.

[0061] Other versions of the storage article 20 having the composite structure 22 include display trays 36 and other sales displays 38, as shown in FIGS. 6a-6g. For example, in the embodiments shown in FIGS. 6a and 6f, the composite structure 22 is cut, shaped and folded into the shape of display trays 36 capable of holding and displaying products for retail. The trays 36 can have walls and a base sized to hold a desired number of objects, and can also contain cutouts, as shown in FIG. 6a, or other display arrangement that holds the objects in the tray 36. FIGS. 6b, 6e-6g and 6e show embodiments of displays 38 that are either formed from or contain the composite structure 22 having the ground calcium containing material. For example, in the embodiments shown in FIGS. 6c-6d, the composite structure 22 is formed or molded to form parts of the display 38. The composite structure 22 can be molded by bending or folding, as well as via thermo or vacuum-forming to form desired parts of the display 38. The embodiments shown in FIGS. 6b, 6d and 6e show display cases formed from portions of printed, folded and glued composite structures 22, optionally with conventionally lithographed parts. The embodiment shown in FIG. 6c shows a display 38 that has been molded into a desired shape by vacuum forming front and back halves of the display that are formed of the composite structure 22. The composite structure 22 is desirably sufficiently flexible such that it can be molded with vacuum or thermforming techniques to form rounded parts 40, such as those shown in the embodiment of FIG. 6c, which may be particularly desirable for attractive displays 38, as well as in other products. FIG. 6g shows an embodiment in which the composite structure 22 has been used to form a display 38 having display trays 36. The display 38 and display trays 36 that are formed from or otherwise contain the composite structure 22 provide highly attractive and moisture resistant displays and trays, that can be brightly and attractively printed for retail and advertisement purposes and are highly scuff resistant. The composite structure 22 is advantageously shapeable into the desired retail form, such as by folding or molding or other machining of the structure 22, and thus provides a highly adaptable material for use in improved retail displays.

[0062] Other uses of the composite structure 22 include its use to form corrugated structures 42, embodiments of which are shown in FIGS. 7a-7b, as well as in the formation of slip or tear sheets or protective top pallet covers 44, an embodiment of which is shown in FIG. 8, as an interior protective packaging component 48, an embodiment of which is shown in FIG. 9, and also molded interior protective packaging components 48, embodiments of which are shown in FIGS. 10a-10b. In the embodiment shown in FIGS. 7a-7b, corrugated flutes 50 are sandwiched in between top and bottom sheets 52a, 52b to form corrugated structures 42 suitable for the formation of corrugated boxes and other similar applications. One or more of the flutes 50 and sheets 52a, 52b, may be formed of the composite structure 22, to form a corrugated structure 42 having enhanced pliability as well as moisture and pest resistance. Additionally and/or alternatively, the composite structure 22 may contain a ground calcium carbonate-containing layer 26 that covers a paperboard layer 24 that is overtop of corrugated parts such as flutes 50. For example, as shown in FIG. 7a, the composite structure 22 may comprise a paperboard layer 24 that corresponds to at least one of an inner top and bottom sheet 51a, 51b, and that is a part of a corrugated material containing flutes 50, with the base layer 24 being covered by at least one of top and bottom sheets 52a, 52b comprising the ground calcium carbonate-containing layer 26.

[0063] In the embodiment shown in FIG. 8, the composite structure 22 is formed into slip sheets or tear sheets 44 for storing or shipping products, which sheets 44 can also be scored or folded for use as protective top pallet covers. As is also shown in FIG. 8, a plurality of composite sheets 44 can be adhered together to form a multi-layer structure 68, such as a multi-layer tear sheet 44.

[0064] In the embodiment shown in FIG. 9, an interior protective packaging component 48 contains upper and lower sheets 54a, 54b that are adhered to one another along the periphery 55 of the component, with one or more of the upper and lower sheets 54a, 54b being formed from the composite structure 22. The interior protective packaging component 48 is filled with shock absorbing material 56 such as EPS, foam, natural starch based form, pulp, fiberboard, and the like, to form a component that can be placed in packages for shipping or retail to protect the product contained in the package.

[0065] In the embodiment shown in FIG. 10, the interior protective packaging component 48 comprises a composite structure 22 that is molded into a shape suitable for conforming to or otherwise holding and protecting an object within a shipping package, to fill voids in a package, to stabilize and protect fragile items for shipping. The composite structure 22 may be molded into a desired shape and then placed overtop of a shock absorbing material 56, such as any of those described above. The composite structure 22 used in these embodiments imparts those advantages as
described above, including increased pliability to allow for the formation of the desired structures as well as to improve the look and feel of the structure. The structure 22 also has improved moisture, theft and pest resistance, while also maintaining good fire and heat resistance. The structure 22 further allows high quality printing thereon to allow for user instructions or advertisements to be printed on the products.

[0066] In yet another version, a storage article 20 can be formed from an improved material structure that comprises a ground calcium carbonate-containing structure 23 having an extruded ground calcium-carbonate containing material comprising a mixture of ground calcium carbonate particles, a bonding agent, and at least one of a natural and synthetic fiber, as shown for example in FIG. 2c. The ground calcium carbonate-containing structure 23 can be formed by co-extrusion of a ground calcium-carbonate containing material, such as the ground calcium carbonate-containing material described above, with fibers such as cellulosic and/or wood pulp fibers, as well as optionally with polymeric fibers. It is believed that the fiber content in the structure 23 can allow ready machining of the structure 23, while retaining pliability and printability of the ground calcium carbonate-containing material. The ground calcium carbonate-containing structure 23 can be used to form storage articles 20 such as those described above, including boxes and cartons, for example by performing the extrusion and machining steps described for the composite structure 22 above.

[0067] In one version, the ground calcium carbonate-containing structure 23 comprises from about 50% to about 60% by weight of ground calcium carbonate particles, from about 15% to about 20% by weight of the bonding agent, and from about 20% to about 50% by weight of fibers, with the particular content being selected according to the desired machinability of the finished extrusion and the type of fibers used in the blend. While the ground calcium carbonate-containing layer 26 used to form the composite structure 22 described above is typically absent any fiber content, the ground calcium carbonate-containing structure 23 having the fiber content can also optionally be used as the ground calcium carbonate-containing layer 26 to form the composite structure 22. For example, the ground calcium carbonate-containing layer 26 may comprise the ground calcium carbonate-containing structure 23 in layer form, and thus comprise a co-extruded blend of ground calcium carbonate particles, bonding agent and fibers. The ground calcium carbonate-containing layer 26 made of the co-extruded material can be adhered and bonded to fiber-containing layers 24 to form the composite structures 22, for example using any of the fiber-containing layers 24, adhesive agents, and methods described above. In these composite structure versions, the fiber-containing layers 24 are themselves typically absent any ground calcium carbonate containing materials, although both the fiber-containing layer 24 and structure 23 can comprise fibers of the same or different variety.

[0068] The structures 23 have characteristics such as pliability and tensile strength that render them suitable for the formation of storage articles, including any of those storage articles described herein. For example, the structure 23 can be shaped, sized and manufactured such that it is pliable and such that it is capable of being shaped to form a storage article, either alone or as a part of a composite structure 22. It should be understood that as the co-extruded ground calcium carbonate-containing material can be used to form the ground calcium carbonate-containing layer 26, any methods or embodiments described for the layer 26 described above also apply to layers 26 formed of the co-extruded ground calcium carbonate and fiber-containing material.

[0069] In one version of a method of making the ground calcium-carbonate containing structure 23 having the co-extruded ground calcium carbonate-containing materials, extrusion pellets 80 may be provided that comprise an extrusion mixture 82 of ground calcium carbonate-containing particles, bonding agent, and fibers, which pellets 80 can be used to extrude the ground calcium-carbonate containing structure 23 therefrom, as shown for example in FIG. 2d. The pellets 80 can comprise a relative content of the ingredients that is the same or similar to that desired for the extruded product. The application of at least one of heat or pressure to the pellets 80, for example in an extruder machine (not shown), results in the partial melting and coalescence of the pellets 80 to form the extruded material. The pellets 80 can be extruded to form a material having a preselected shape corresponding to a desired shape of the ground calcium carbonate-containing structure 23, such as a preselected shape corresponding to a layer 26 of the ground calcium carbonate-containing material.

[0070] Additional modifications and improvements of the present invention may also be apparent to those of ordinary skill in the art. Thus, the particular combination of components and steps described and illustrated herein is intended to represent only certain embodiments of the present invention, and is not intended to serve as limitations of alternative devices and methods within the spirit and scope of the invention. Along these lines, it should be understood that the storage articles 20 having the pliable composite structure 22 may take any of a variety of forms that are known or later developed in the art, and further contemplates that existing or newly formed storage articles 20, such as newly formed retail and/or shipping packages, should fall within the scope of the present invention. Also, it should be understood that the paperboard layer 24 and calcium carbonate-containing layer 26 can comprise various different materials such as other packaging materials and bonding agents that are other than those specifically described.

What is claimed is:

1. A container comprising:
   a composite material comprising
   a fiber containing layer comprising a fiber component and having a first face; and a first mineral containing layer comprising a polymer component and a mineral component, wherein the first mineral containing layer is formed by coextrusion, and wherein the mineral containing layer is bonded to the first face of the fiber containing layer,
   wherein the composite material is at least 20% more pliable than the fiber component alone when measured by ASTM D 228 02, #10 or ASTM D 6125097 (2002) bendability and pliability standards.

2. The container of claim 1, wherein the first mineral containing layer is formed by coextrusion.

3. The container of claim 1, wherein the polymer component comprises 15% to 50% by weight of the first mineral containing layer.

4. The container of claim 1, wherein the fiber component comprises a natural fiber.

5. The container of claim 1, wherein the fiber component comprises a synthetic fiber.
6. The container of claim 1, wherein the mineral component comprises calcium carbonate.

7. The container of claim 1, wherein the mineral containing layer has a thickness of 2 mils to 30 mils.

8. The container of claim 1, wherein the fiber containing layer has a thickness of 12 mils to 28 mils.

9. The container of claim 1, wherein the fiber containing layer comprises at least 90% recycled material.

10. The container of claim 1, wherein the fiber containing layer is characterized by having tensile strengths of 125 to 900 MD, 55 to 400 CD when measured by ASTM 5342-97 standard.

11. The container of claim 1, further comprising a second mineral containing layer on a second face of the fiber containing layer.

12. The container of claim 1, wherein the first mineral containing layer is bonded without an adhesive.

13. The container of claim 1, wherein the mineral containing layer further comprises printing.

14. The container of claim 1, wherein the container is manufactured by a process comprising a step selected from the group consisting of bending, folding, creasing, thermo forming, vacuum forming, and adhesive steps.

15. The container of claim 1, wherein the container is characterized as moisture resistant.

16. The container of claim 1, wherein the container is configured as an open container.

17. The container of claim 1, wherein the container is configured as a closed container.

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