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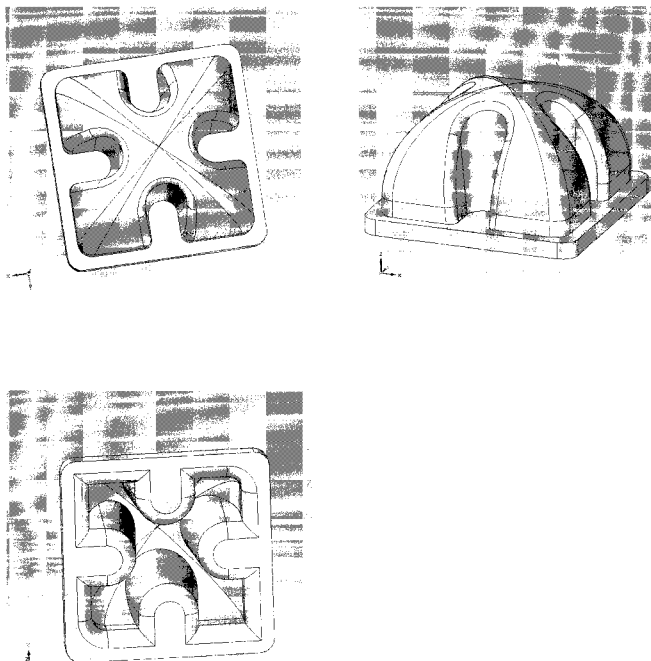
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[Continued on next page]

(54) Title: BIODEGRADABLE BUBBLE-SHAPED WRAP AND VOID FILL BRACES

Figure 1



(57) Abstract: This invention provides packaging materi-
al made from starch and cellulose fiber obtained from re-
cycled paper waste. The process involves drawing a sus-
pension of pulp and starch in water into a mold, and with-
drawing water from the suspension while in the mold. Bubble-shaped wrap and bracing made according to the invention are designed for use as cushioning for the ship-
ment of fragile or irregularly shaped items. The packaging is biodegradable when exposed to water in the environ-
ment.

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Declarations under Rule 4.17:

- *as to the identity of the inventor (Rule 4.17(i))*
- *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*
- *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*
- *of inventorship (Rule 4.17(iv))*

Published:

- *with international search report (Art. 21(3))*
- *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

BIODEGRADABLE BUBBLE-SHAPED WRAP AND VOID FILL BRACESTECHNICAL FIELD

5

This invention provides a molded pulp fiber bubble-shaped wrap and a void-fill brace derived from 100% post consumer paper waste. The wrap and the brace can be used as cushioning devices for the shipment of fragile or irregularly shaped items.

10

BACKGROUND

Plastic bubble sheeting made of high-density polyethylene (HDPE) is a pliable plastic material commonly used for packing fragile items. Regularly spaced, protruding air-filled hemispheres ("bubbles") of about 6 to 26 mm in diameter sizes provide cushioning for precious or breakable items. Multiple layers can be used to provide shock and vibration isolation. A single layer can be used as a surface protective layer.

Bubble Wrap® was created by two engineers, Alfred Fielding and Marc Chavannes, in 1957. The term is a registered trademark of Sealed Air Corporation, Elmwood Park NJ. Bubble Wrap and other products are sold by packaging supply companies, such as U-line® Shipping Supplies, Chicago IL; Geami, Morrisville NC; Robins Paper Bag Co. Ltd., Canterbury, Kent, UK; Nobisco Ltd, Birmingham, UK; PilloPak B.V., Eerbeek, Netherlands; Wholesale Packaging Ltd., Toronto, Canada; Doverco Inc, Montreal, Canada; and Lion Shipping Supplies Canada Inc., Mississauga, Canada.

It is not always possible to ship items in containers that are custom made for their design and shape. Where items are shipped in a larger box, it may be necessary to fill voids to prevent shifting or breakage during transit. Typical void-fill products, like so-called packaging peanuts, take up as much volume before and after shipping as they do in the shipping container. This is an inconvenience to both the shipper and the package recipient.

However, in spite of the wide-spread use of HDPE bubble wrap and Styrofoam® void-fill for packaging, these materials are not easily recyclable according to current technology. Discarded packaging generates a good deal of waste material and adds to landfill. Clearly, there is a need for a less expensive packaging material that is environmentally friendly and 100% biodegradable.

DRAWINGS

FIG. 1 is a drawing of a prototype fiber bubble of this invention. Top left panel is the top view; top right panel is the side view; lower panel is the bottom view.

5 FIG. 2 shows another prototype fiber bubble, having a roughly hemisphere design with solid round support structures on the sides and up the middle.

FIG. 3 shows five other designs for the bubbles.

FIG. 4 shows square bubble shapes packed in an array as they would come from the production line.

10 FIG. 5 shows the manufacturing process for the bubble shaped wrapping. Pulp is drawn into the mold by a vacuum, and then expelled as the drum rotates to the top, whereupon it is glued to the paper backing.

FIG. 6 shows actual fiber bubbles formed according to the manufacturing method.

15 FIG. 7 shows biodegradable stackable bracing for use in packaging for void fill. It stacks tightly for distribution and storage, but separates into units that collectively occupy a much larger volume when the alternating corrugations are no longer aligned.

DESCRIPTION

20 This invention provides packing material suitable for wrapping and protecting packaged items. A bubble shaped wrap is provided, which can be used in the same manner as conventional bubble wrap. A brace with alternating corrugations is provided, which can be used to fill voids in shipping containers.

25 The materials of this invention constitute a substantial advance, by virtue of the fact that they are efficiently biodegradable and environmentally compatible. In particular, the bubble shaped wrap and the braces are made as a combination of fiber and starch by a simple and inexpensive process, placing into the hands of the reader a more environmentally friendly standard for use in the packaging industry.

Starting materials

30 The cellulose fiber and starch used to make the bubble shaped wrap of this invention can be obtained from various sources.

Suitable fibers for the fiber content include polymers of man-made fiber, such as polyamide nylon, polyesters, phenol-formaldehyde, polyvinyl alcohol fiber, polyvinyl chloride fiber, polyolefins, acrylic fiber, carbon fibers, polyurethane and other resin-based fibers. Cellulose fiber is preferred, being
35 the natural structural component of the primary cell wall and connective tissue of green plants. About

33 percent of all plant matter is cellulose. For industrial use, cellulose can be obtained from wood pulp and cotton (the cellulose content of cotton is 90 percent and that of wood is 50 percent).

In particular, cellulose fiber is provided as a starting ingredient for the materials of this invention as pulp. This refers to fibrous material prepared by chemically or mechanically separating fibers from wood or fiber crops. Included are mechanical pulp, chemithermomechanical pulp, chemical pulp made by the Kraft process or by sulfite processing, and pulp recycled from industrial and consumer waste.

The source material of the pulp used for the bubble shaped wrap shown in FIG. 6 was made from recycled paper by beating in warm water bath, and then dispersing the fibers using a blender.

Starch is a polysaccharide carbohydrate consisting of glucose monomers joined together by glycosidic bonds. Starch is produced by all green plants as an energy store. Pure starch is a white, and consists of linear amylose, helical amylose, branched amylopectin, or any of these in combination. Depending on the plant source, starch generally contains 20 to 25% amylose and 75 to 80% amylopectin. Each plant species has a unique starch granular size: rice starch is relatively small (about 2 μm), potato starch have larger granules (up to 100 μm).

A suitable source of starch for use in this invention is industrial corn starch. This can be obtained from National Starch and Chemical Company (NACAN), Brampton, Ontario, now owned by Akzo Nobel N.V. They provide wet-end starch additives to improve strength and productivity in acid, neutral or alkaline paper and board production, and surface starch strength and printability additives for paper and board, such as uncoated office papers, food packaging papers and uncoated book papers.

Some modified starches can also be used. The following list of modified starches is classified by the system established by the International Numbering System for Food Additives (INS):

- 1401 Acid-treated starch
- 1402 Alkaline-treated starch
- 1403 Bleached starch
- 1404 Oxidized starch
- 1405 Starches, enzyme-treated
- 1410 Monostarch phosphate
- 1411 Distarch glycerol
- 1412 Distarch phosphate esterified with sodium trimetaphosphate
- 1413 Phosphated distarch phosphate
- 1414 Acetylated distarch phosphate
- 1420 Starch acetate esterified with acetic anhydride
- 1421 Starch acetate esterified with vinyl acetate
- 1422 Acetylated distarch adipate
- 1423 Acetylated distarch glycerol
- 1440 Hydroxypropyl starch

- 1442 Hydroxypropyl distarch phosphate
- 1443 Hydroxypropyl distarch glycerol
- 1450 Starch sodium octenyl succinate

Other materials can be used in the pulp slurry or during the process as desired: for example,
5 one or more surfactants, strengtheners, binders, dispersants, pro- or anti-microbials, and so on.
However, such ingredients are usually not necessary, in which case they can be left out to promote the
pro-environmental profile of the product.

Manufacture of bubble-shaped wrap

10 FIG. 5 depicts the process by which the bubble shaped wrap of this invention may be
manufactured. A suspension or slurry of cellulose or other fiber and starch is first prepared in a liquid
medium (usually water) at a ratio of between about 2:1 and 10:1, depending on the hardness and
degradability desired, typically about 3:1. The slurry is placed in a bath, and is drawn into a mold having
the outer shape of the bubble.

15 FIG. 1 shows the shape of the bubbles used in a working example of this invention. The
bubbles are domed shaped, and are substantially square. Supporting the dome are arches running
between the diagonal corners. There is also support provided by the four circular indentations, one on
each side. An advantage of the square shape is that it allows close packing of bubbles within a sheet,
as depicted in FIG. 4.

20 FIG. 2 shows another bubble design suitable for use in this invention. Here, the domed
structures are round and have five solid supports supporting each dome: one in the center, and the
others equally spaced around the circumference. FIG. 3 shows five other bubble designs that can be
used either instead, or in combination with either or both of the foregoing shapes. The bubbles may be
solid in their interior, but more usually are thin-walled, allowing an air-space between the bubble shell
25 and the backing.

Once the slurry is drawn into the mold, the vacuum is allowed to continue until essentially all of
the water has been removed. The pressure is then reversed, causing the bubbles to be expelled from
the mold. Samples of the bubbles formed in this way are shown in FIG. 6. The bubbles are then
usually adhered onto a suitable backing of biodegradable material, typically made of paper. The glue
30 applied to the side of the paper where the bubbles are placed is chosen to be environmentally friendly,
exemplified by starch- or milk-based glue.

The cushioning properties, flexibility and the day-to-day durability of the bubble-shaped wrap of
this invention can be adjusted to suit the purpose that the user may have in mind by altering the ratio of
fiber to starch, by changing the plant source of the starch to one having different properties, and by
35 making adjustments to the various components. The design of the bubble, the thickness of the wall, the

nature of the support structures, and the composition of the slurry are chosen so that the bubbles resist crushing but provide the desired degree of cushioning.

Manufacture of void-fill braces

5 FIG. 7 depicts biodegradable stackable braces of this invention that can be used in packaging for void fill. The product is referred to as a "brace", because it is designed to fill voids in packaging spaces by bracing against the item being shipped, a wall of the shipping container, other braces, or other objects in the container. The brace has "corrugated" sections, which means sections in which a strip of pulp and starch board regularly undulates or folds above and below the median plane of the
10 brace. The brace has a plurality two or more corrugated sections situated side by side (three such corrugated sections are shown in each brace in the figure). The corrugations alternate in the sense that where one strip is folded generally upwards, the adjacent strips on either side are folded generally downwards. The brace is "stackable" in the sense that all the braces in a set have essentially the same pattern of folds or undulations, allowing them to sit atop one another in a way that minimizes the volume
15 occupied by the set, but only when they are stacked in this fashion.

 The undulating strips are cross-linked in some fashion to maintain them as a single unit. In FIG. 7, the strips are cross-linked at each end. Alternatively or in addition, they can be cross-linked at the points where the alternating strips cross. The cross-links can be put in place at the time the strips are generated and folded, or at a later time.

20 A stackable brace can be formed by drawing a slurry of fiber and starch into a two-part mold, where the two parts are complementary. This can be done by having a vacuum pull through one or preferably both parts of the mold as it passes through a bath of pulp and starch in water, thereby gathering a coating onto each half. The two parts are then compressed together, leaving enough space for the brace. Water is then withdrawn from the slurry in the mold by way of a vacuum, and the two
25 parts of the mold are then separated to remove the brace.

 An alternative manufacturing process is to make a sheet of pulp and starch by squeezing a slurry of both ingredients through a series of rollers. See Canadian patent disclosure 2,638,232. The sheet is cut into the desired number of corrugation rows, and folded into the final shape while the sheet is still malleable. Final drying occurs after the braces have been molded into the desired shape.

30

Uses

 The bubble-shaped wrap of this invention can be placed into service in the same manner as conventional bubble wrap. Items that are fragile or awkwardly shaped are wrapped in one or more layers of the wrap of this invention, and then placed in a container suitable for shipping. Also
35 contemplated are combined packaging materials that comprise an outer container (such as an envelope or box) lined with bubble wrap.

Once an item has been wrapped for shipment and placed in a shipping container, one or more stackable braces of this invention can be used to fill any void spaces left between the wrapped item and the sides and/or the top of the container. Since the braces are made of pulp and starch, they are easily cut if needed to adjust the size to smaller spaces. A particular benefit of the braces of this invention is that they can be stacked tightly for distribution and storage before use as a void fill, by aligning the corrugations to correspond with each other, as shown in the "stacked" arrangement of FIG. 7. They can then be used singly or in combination to fill voids in a shipping container. By packing the braces so that the corrugations no longer align, each brace will occupy most of the volume defined by the tops and bottoms of its undulating corrugations. Unlike packing peanuts or particles which occupy essentially the same volume in storage or in use, the braces of this invention are stored in a compact aligned form, but used for void fill in unaligned form, thus considerably expanding the volume occupied.

The materials of this invention are designed to be "biodegradable", which means they readily degrade when exposed to a natural environment out-of-doors: particularly water. The water will soon remove the starch, leaving the fiber in a non-compacted form. This can occur within a few days or weeks of water exposure. When the fiber is made of cellulose, it is also a natural product, essentially the same as the cellulose made by plants, and degradable by the same process. Since voids are created by loss of the salt, degradation is rapid. The bubble components of the bubble shaped wrap may disappear into non-visible particulates in as little as one major precipitation event, usually within a month or less. The paper backing may not disappear quite as rapidly, but is biodegradable in a natural environment. The user is cautioned to ensure compatibility at the site where the material is disposed of by checking local regulations and starting with a small test sample, in case there are plants, animals, or other environmental features near by with a special sensitivity to any of the ingredients or byproducts of the degradation.

The materials described in this disclosure can be effectively modified by routine optimization without departing from the spirit of the invention embodied in the claims that follow.

CLAIMS

The invention claimed is:

1. A biodegradable protective wrap for use in packaging, comprising a plurality of domed structures consisting essentially of cellulose fiber and starch, adhered to a backing.
2. The protective wrap of the preceding claim, wherein the cellulose fiber is obtained from pulp made from recycled paper waste.
3. The protective wrap of either preceding claim, wherein the backing is paper.
4. The protective wrap of any preceding claim, wherein the domed structures are adhered to the backing by starch-based glue.
5. The protective wrap of claims 1-6, wherein the domed structures are square shaped, having a circular indentation on each side.
6. The protective wrap of claims 1-6, wherein the domed structures are round and have five solid supports supporting each dome.
7. A method for producing the protective wrap of any preceding claim, comprising:
 - a) drawing a suspension of pulp and starch in water into a mold shaped according to the outer surface of said domed structures;
 - b) withdrawing water from the suspension to dry the while in the mold;
 - c) expelling domed structures from pulp and starch dried in the mold; and
 - d) gluing the expelled domed structures onto a paper backing.
8. A method for protecting an item from possible damage during shipment, comprising wrapping it in protective wrap according to claims 1-6.
9. A method for shipping an item in a manner that decreases risk of damage to the item, comprising shipping it in protective wrap according to claims 1-6.
10. A method for disposing of protective wrap according to claims 1-6, comprising placing it where it will be substantially exposed to moisture.

11. A biodegradable stackable brace for use in packaging for void fill, comprising a plurality of cross-linked alternating corrugations, wherein said alternating corrugations consist essentially of cellulose fiber and starch.
12. The protective wrap of claim 12, wherein the cellulose fiber is obtained from pulp made from recycled paper waste.
13. A method for producing the biodegradable stackable brace of claims 11-12, comprising:
 - a) drawing a slurry of fiber and starch into a two-part mold;
 - b) compressing the two parts of the mold together;
 - c) withdrawing water from the slurry in the mold; and then
 - d) separating the two parts of the mold to remove the brace.
14. A method for protecting an item from possible damage during shipment, comprising packaging it in a shipping container in which a brace according to claims 11-12 has been used to fill one or more spaces.
15. The method of claim 14, further comprising wrapping the item in protective wrap according to claims 1-6.
16. A method for shipping an item in a manner that decreases risk of damage to the item, comprising shipping it in a container in which a brace according to claims 11-14 has been used to fill one or more spaces.
17. A method for disposing of the biodegradable stackable brace of claims 11-12, comprising placing it where it will be substantially exposed to moisture.
18. A kit for preparing one or more items for shipment, comprising the biodegradable protective wrap of claims 1-6; and the biodegradable stackable brace of claims 11-12.

Figure 1

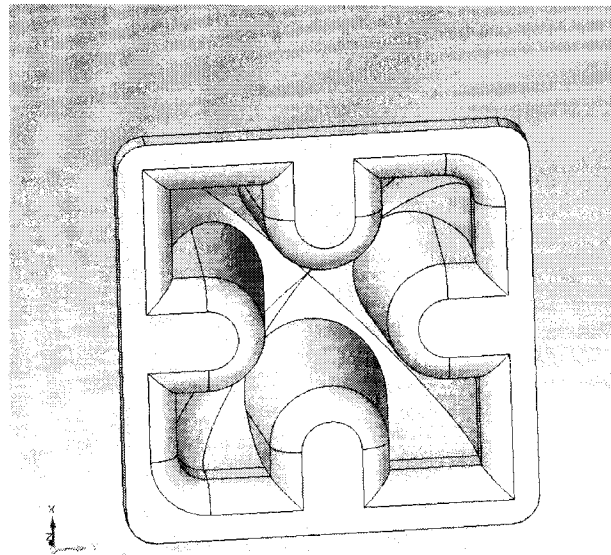
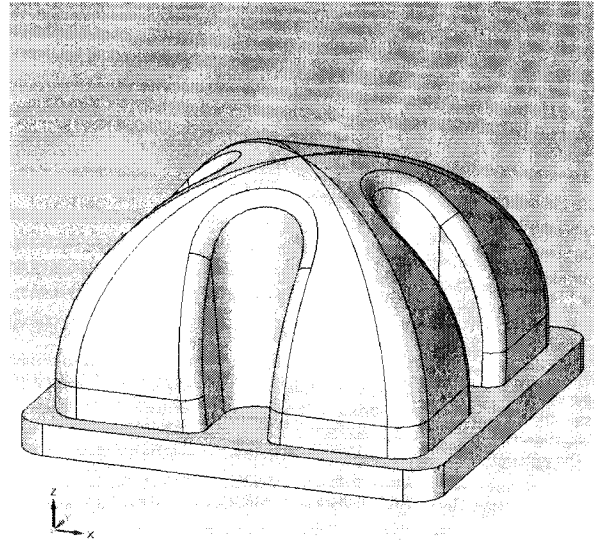
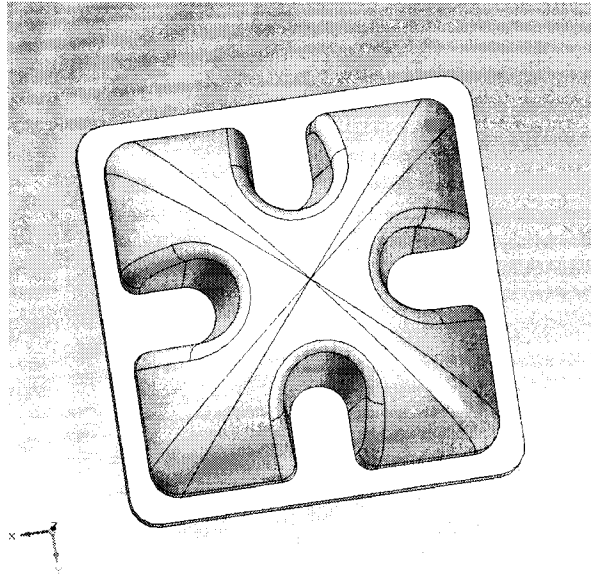


Figure 2

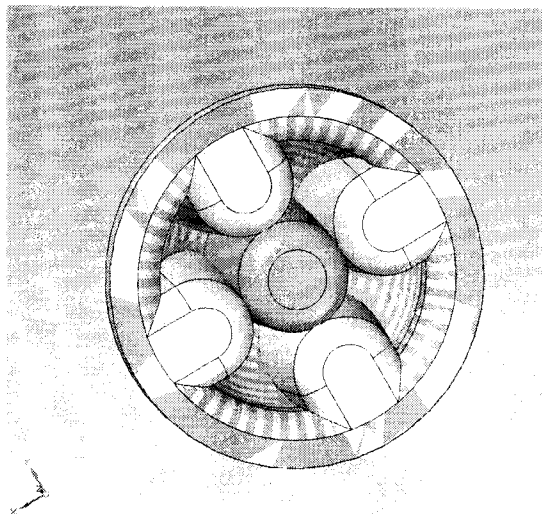
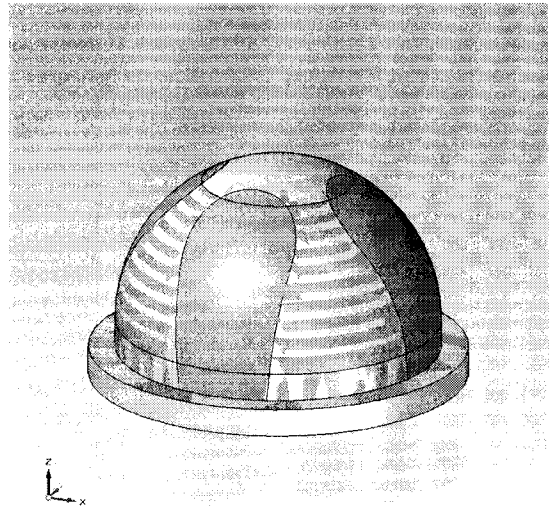
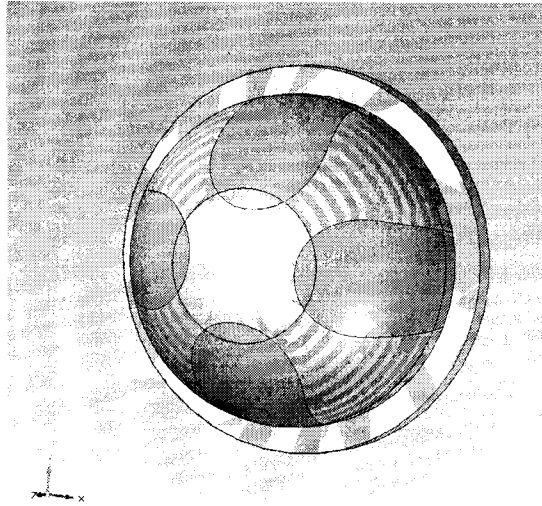


Figure 3

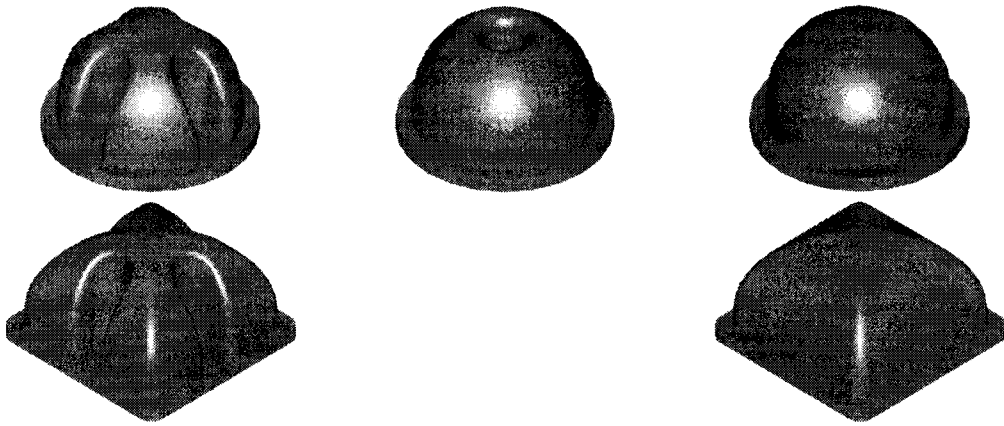


Figure 4

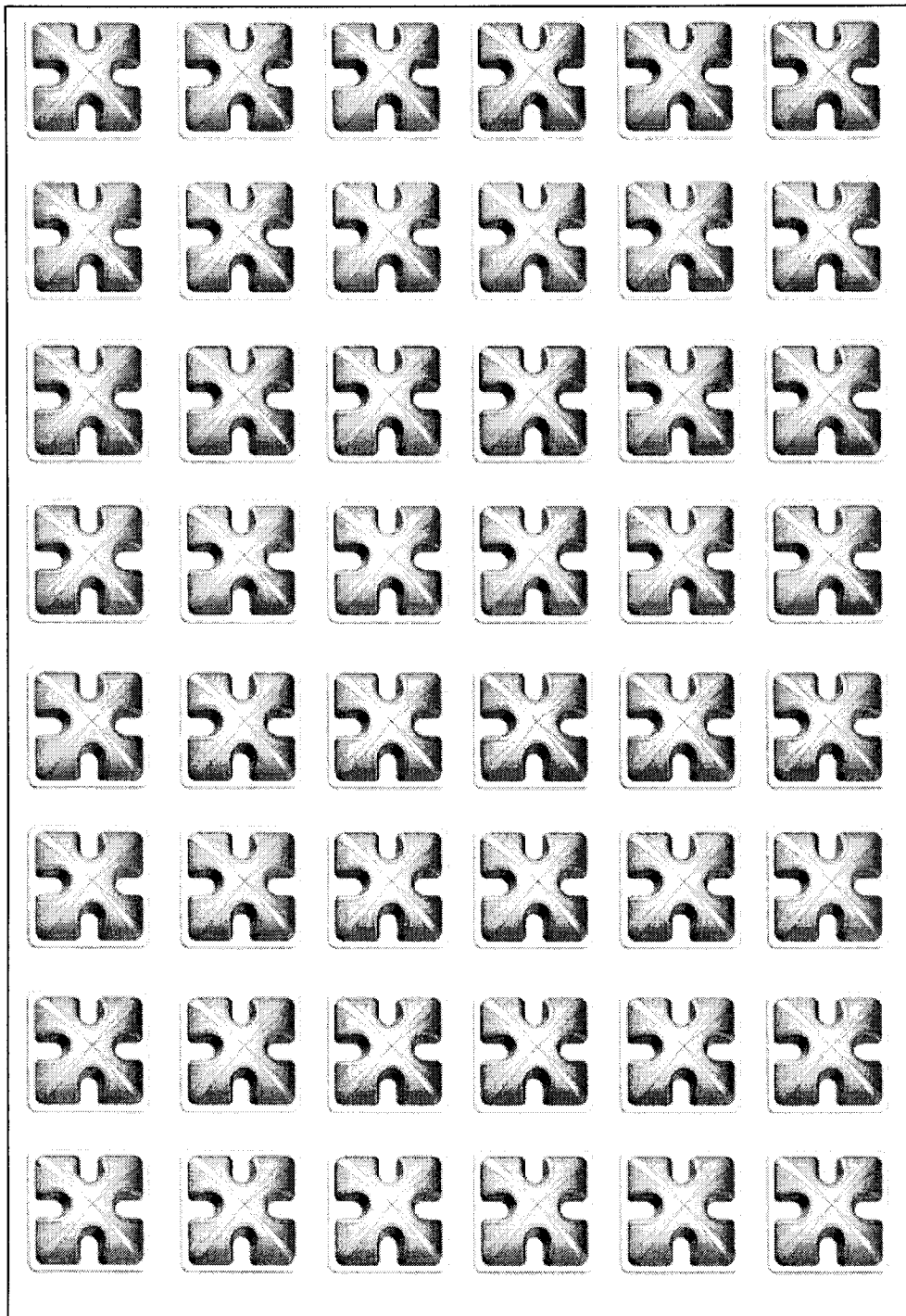


Figure 5

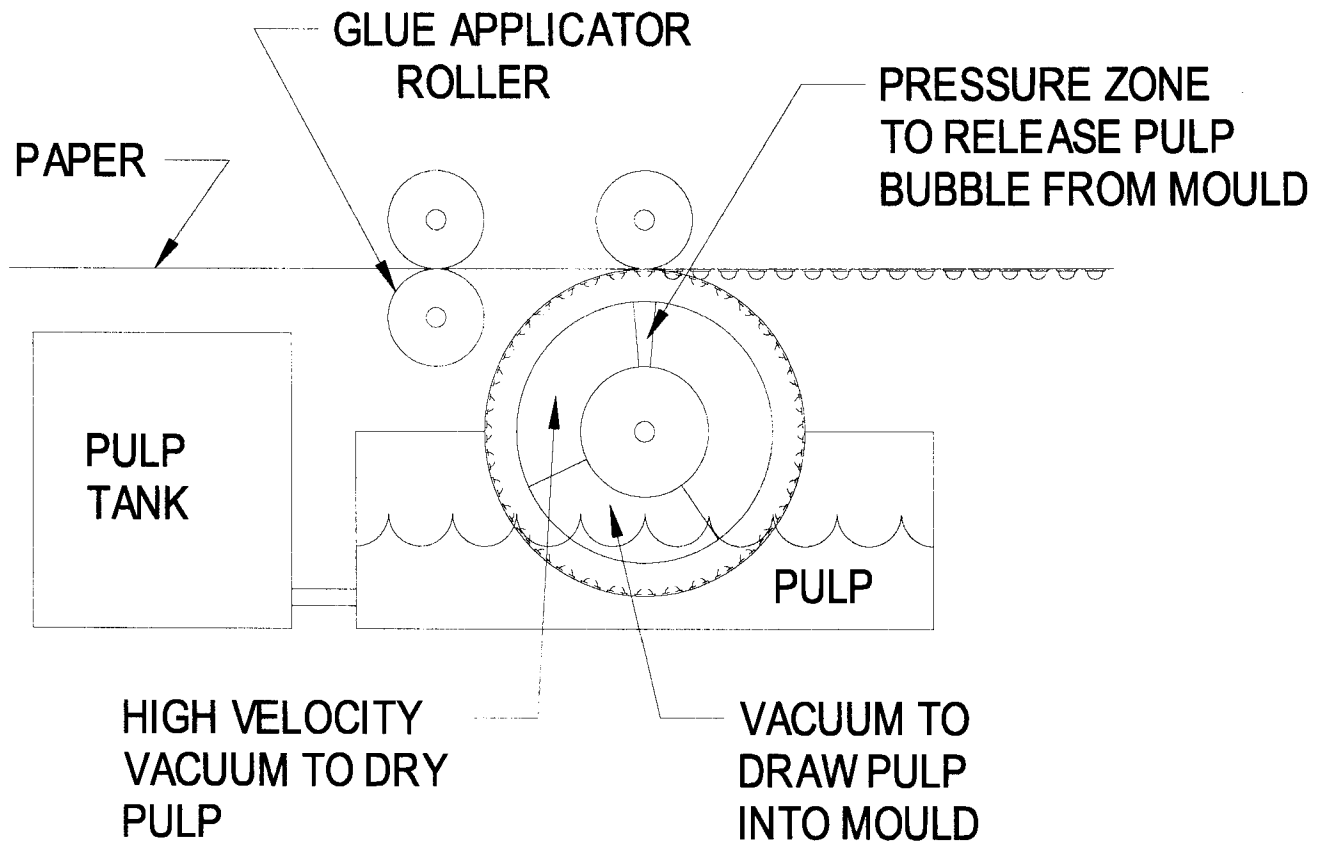


Figure 6

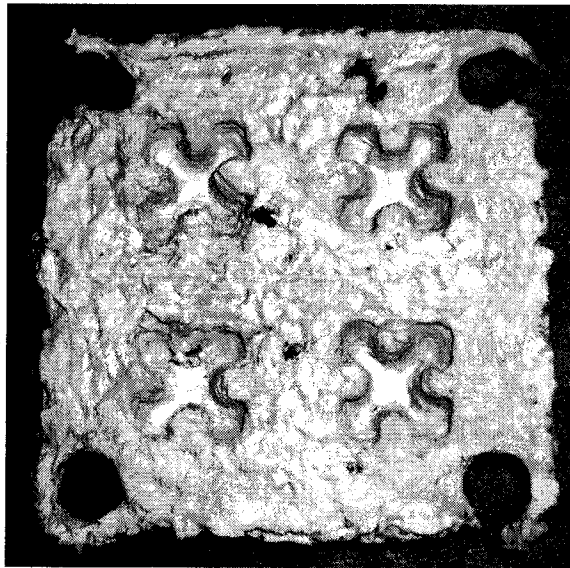
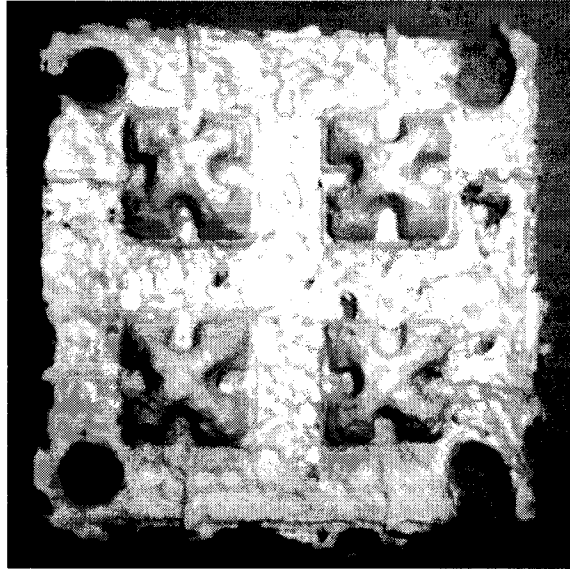
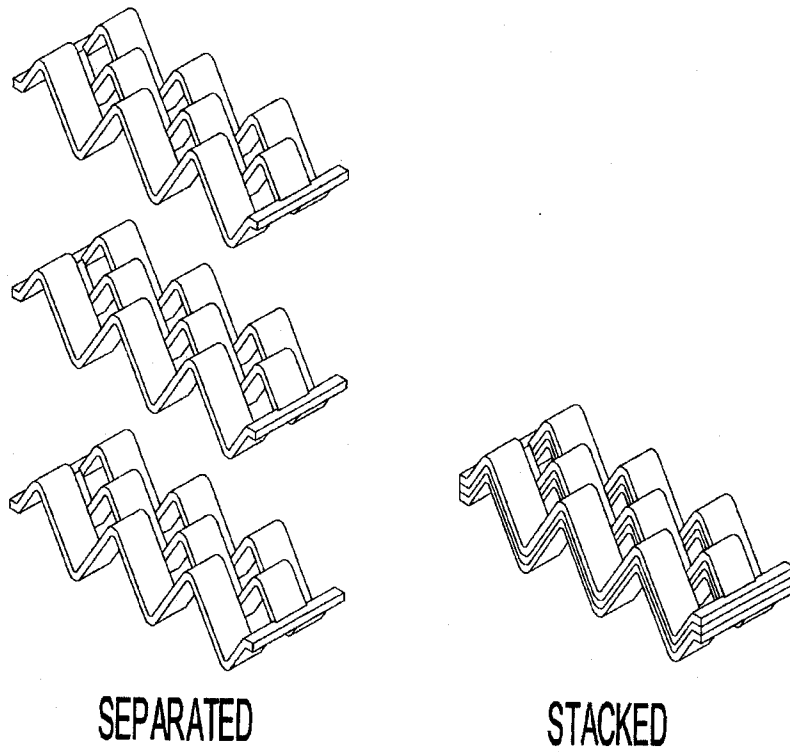


Figure 7



INTERNATIONAL SEARCH REPORT

International application No.
PCT/CA2010/000950

<p>A. CLASSIFICATION OF SUBJECT MATTER IPC: B65D 65/46 (2006.01) , B65D 81/03 (2006.01) , D21H 27/10 (2006.01) , D21J 3/00 (2006.01) According to International Patent Classification (IPC) or to both national classification and IPC</p>																									
<p>B. FIELDS SEARCHED</p> <p>Minimum documentation searched (classification system followed by classification symbols) IPC: B65D 65/46 (2006.01) , B65D 81/03,05,127 (2006.01) , D21H 27/10 (2006.01) , D21J 3/00 (2006.01)</p> <p>Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched</p> <p>Electronic database(s) consulted during the international search (name of database(s) and, where practicable, search terms used) TotalPatent, USPTO</p>																									
<p>C. DOCUMENTS CONSIDERED TO BE RELEVANT</p> <table border="1" style="width:100%; border-collapse: collapse;"> <thead> <tr> <th style="width:10%;">Category*</th> <th style="width:60%;">Citation of document, with indication, where appropriate, of the relevant passages</th> <th style="width:30%;">Relevant to claim No.</th> </tr> </thead> <tbody> <tr> <td align="center">Y</td> <td>US6797119B2 (KOIKE) 28 September 2004 (28-09-2004)</td> <td align="center">1-18</td> </tr> <tr> <td align="center">Y</td> <td>US5849152A (ARNOLD et al.) 15 December 1998 (15-12-1998)</td> <td align="center">1-18</td> </tr> <tr> <td align="center">A</td> <td>US5362776A (BARENBERG et al.) 08 November 1994 (08-11-1994)</td> <td align="center">1-18</td> </tr> <tr> <td align="center">A</td> <td>US2007003719A1 (BALCHIN) 04 January 2007 (04-01-2007)</td> <td align="center">1-18</td> </tr> <tr> <td align="center">A</td> <td>US3416984A (CHAVANNES et al.) 17 December 1968 (17-12-1968)</td> <td align="center">1-18</td> </tr> <tr> <td align="center">A</td> <td>WO03078155A1 (FASCIO) 25 September 2003 (25-09-2003)</td> <td align="center">1-18</td> </tr> <tr> <td align="center">A</td> <td>WO9402377A1 (BERGER) 03 February 1994 (03-02-1994)</td> <td align="center">1-18</td> </tr> </tbody> </table>		Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.	Y	US6797119B2 (KOIKE) 28 September 2004 (28-09-2004)	1-18	Y	US5849152A (ARNOLD et al.) 15 December 1998 (15-12-1998)	1-18	A	US5362776A (BARENBERG et al.) 08 November 1994 (08-11-1994)	1-18	A	US2007003719A1 (BALCHIN) 04 January 2007 (04-01-2007)	1-18	A	US3416984A (CHAVANNES et al.) 17 December 1968 (17-12-1968)	1-18	A	WO03078155A1 (FASCIO) 25 September 2003 (25-09-2003)	1-18	A	WO9402377A1 (BERGER) 03 February 1994 (03-02-1994)	1-18
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<p><input type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex.</p> <table border="1" style="width:100%; border-collapse: collapse;"> <tbody> <tr> <td style="width:50%; vertical-align: top;"> <p>* Special categories of cited documents :</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier application or patent but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> </td> <td style="width:50%; vertical-align: top;"> <p>"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</p> <p>"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</p> <p>"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</p> <p>"&" document member of the same patent family</p> </td> </tr> </tbody> </table>		<p>* Special categories of cited documents :</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier application or patent but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p>	<p>"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</p> <p>"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</p> <p>"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</p> <p>"&" document member of the same patent family</p>																						
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<p>Date of the actual completion of the international search</p> <p>23 November 2010 (23-11-2010)</p>	<p>Date of mailing of the international search report</p> <p>25 November 2010 (25-11-2010)</p>																								
<p>Name and mailing address of the ISA/CA</p> <p>Canadian Intellectual Property Office Place du Portage I, C114 - 1st Floor, Box PCT 50 Victoria Street Gatineau, Quebec K1A 0C9 Facsimile No.: 001-819-953-2476</p>	<p>Authorized officer</p> <p>Alan Jones (819) 934-8531</p>																								

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of the first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons :

1. Claim Nos. :
because they relate to subject matter not required to be searched by this Authority, namely :

2. Claim Nos. :
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically :

3. Claim Nos. :
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows :

The claims are directed to a plurality of inventive concepts as follows:

Group A - Claims 1-10 are directed to a biodegradable packaging protective wrap having a plurality of domed structures adhered to a backing; and
Group B - Claims 11-18 are directed to a biodegradable stackable void-fill brace comprising corrugations.

The claims must be limited to one inventive concept as set out in Rule 13 of the PCT.

1. As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claim Nos. :
4. No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim Nos. :

- Remark on Protest** The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
 The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
 No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CA2010/000950

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