

## TITLE

### CONTAINERS HAVING IMPROVED LOAD-BEARING CAPACITY

#### BACKGROUND

5           **[0001]** The present disclosure generally relates to containers. More specifically, the present disclosure relates to containers having improved load-bearing capacity.

**[0002]** Currently, the market comprises many different shapes and sizes of containers capable of housing consumable products. The shape and size of  
10 containers can depend, among other things, on the amount of product to be housed therein, the type of product to be housed therein, consumer demands, desired aesthetics, cost considerations, or structural requirements. For example, it may be important to provide a consumable product container that is inexpensive to manufacture if the final product is to be available to consumers at a competitive price.

15           **[0003]** Alternatively, it may also be important to provide a consumable product container having a structural integrity that provides improved structural and aesthetic features by preventing compression of the container at pressures typically associated with packaging, shipping, storing and displaying the products. One example of this type of pressure includes top-loading forces. In this regard,  
20 containers may be stacked one on top of another during packaging, shipping and display. Thus, the containers should be manufactured so as to withstand the compressive forces applied by one or more filled containers placed on top of the container without buckling. Accordingly, a need exists for a consumable product container having improved structural features that provide for affordable, structurally  
25 sound containers.

#### SUMMARY

**[0004]** The present disclosure relates to load-bearing containers for housing consumable products. In a general embodiment, the present disclosure provides a  
30 container including at least one beveled portion at a location where a side wall meets

a bottom wall. The container has an axial load compression capacity that is substantially the same as a similar container having a greater wall thickness without the at least one beveled portion.

5       **[0005]** In another embodiment, a container is provided and includes an interior formed by a bottom and a wall, at least one beveled portion at a location where the wall meets the bottom, and an axial load compression capacity that is substantially the same as a similar container having a greater wall thickness without the at least one beveled portion.

10       **[0006]** In yet another embodiment, a container is provided and includes a bottom wall, and at least four side walls. The side walls form corners where adjacent side walls meet, and the corners have a beveled shape at a location where the corners meet the bottom wall.

**[0007]** In an embodiment, the similar container is formed from a sheet having a thickness of about 52 mil.

15       **[0008]** In an embodiment, the axial load capacity is about 50 ft-lbs.

**[0009]** In an embodiment, the container comprises at least 2 beveled portions, or at least 3 beveled portions, or at least 4 beveled portions.

20       **[0010]** In an embodiment, the beveled portion has an angle ranging from about 10° to about 60°, or from about 20° to about 50°, or from about 30° to about 40°, or about 10°, or about 15°, or about 20°, or about 25°, or about 30°, or about 35°, or about 40°, or about 45°, or about 50°, or about 55°, or about 60°.

**[0011]** In an embodiment, the container includes a flange portion that extends in a direction that is substantially perpendicular to the side wall. The flange may have a flat top surface.

25       **[0012]** In an embodiment, the container includes a border portion along a top portion of the container. The border portion may include a textural feature such as, for example, a plurality of ridges. The textural feature can help to improve a consumer's grip of the container or the stackability of the container.

30       **[0013]** In an embodiment, the container further includes a lid. The lid may be made of a material selected from the group consisting of plastic, cardboard, cardstock, paperboard, styrofoam, or combinations thereof.

**[0014]** In an embodiment, the container has a volume ranging from about 1.0 ounce to 10.0 ounces, or from about 2.0 ounces to 9.0 ounces, or from about 3.0

ounces to 8.0 ounces, from about 4.0 ounces to 7.0 ounces, from about 5.0 ounces to 6.0 ounces.

5       **[0015]** In an embodiment, the container is configured to house a consumable product selected from the group consisting of a solid, a semi-solid, a liquid, a gel, or combinations thereof.

**[0016]** In an embodiment, the container is configured to house a consumable product selected from the group consisting of an infant food, a toddler food, or combinations thereof.

10       **[0017]** In an embodiment, the container is manufactured from a material selected from the group consisting of polyethylene, low density polyethylene, high density polyethylene, polypropylene, polystyrene, polyethylene terephthalate, or combinations thereof.

**[0018]** In an embodiment, the container has a shape selected from the group consisting of cube, cuboid, cylindrical, prism, or combinations thereof.

15       **[0019]** In still yet another embodiment, a method for reducing the wall thickness of a container while maintaining an axial compression load capacity of the container is provided. The method includes forming a container having a bottom wall and at least four side walls, the side walls forming corners where adjacent side walls meet, and the corners having a beveled shape at a location where the corners  
20       meet the bottom wall.

**[0020]** In an embodiment, the container is configured to maintain an axial load compression capacity while having a reduced wall thickness when compared to a similar container not having the at least one beveled portion.

25       **[0021]** In another embodiment, a method for reducing the costs for manufacturing a container is provided. The method includes forming a container comprising at least one beveled portion at a location where a side wall meets a bottom wall, the container having an axial load compression capacity that is substantially the same as a similar container having a greater wall thickness without the at least one beveled portion. The costs are reduced by forming the container from  
30       a thinner preform than a preform used to form the similar container.

**[0022]** In yet another embodiment, a method for reducing the amounts of raw materials necessary to manufacture a container is provided. The method includes forming a container comprising at least one beveled portion at a location where a side

wall meets a bottom wall, the container having an axial load compression capacity that is substantially the same as a similar container having a greater wall thickness without the at least one beveled portion. The amounts of raw materials are reduced by forming the container from a thinner preform than a preform used to form the  
5 similar container.

**[0023]** In yet another embodiment, a method for reducing waste material from a container is provided. The method includes forming a container comprising at least one beveled portion at a location where a side wall meets a bottom wall, the container having an axial load compression capacity that is substantially the same as  
10 a similar container having a greater wall thickness without the at least one beveled portion. The waste materials are reduced by forming the container from a thinner preform than a preform used to form the similar container.

**[0024]** An advantage of the present disclosure is to provide an improved container.

15 **[0025]** Another advantage of the present disclosure is to provide a container having improved load-bearing features.

**[0026]** Still another advantage of the present disclosure is to provide a container having a beveled corner to distribute axial compressive loads.

**[0027]** Yet another advantage of the present disclosure is to provide a  
20 container that is so constructed and arranged to prevent buckling at compressive loads typically associated with manufacturing, packaging and retail distribution.

**[0028]** Still yet another advantage of the present disclosure is to provide a container that maintains an axial compressive load-bearing capacity while being manufactured using less raw materials.

25 **[0029]** Additional features and advantages are described herein, and will be apparent from the following Detailed Description and the figures.

## BRIEF DESCRIPTION OF THE FIGURES

**[0030]** FIG. 1 shows a perspective view of a container in accordance with an  
30 embodiment of the present disclosure.

**[0031]** FIG. 2 shows a side view of the container of FIG. 1 in accordance with an embodiment of the present disclosure.

**[0032]** FIG. 3 shows a side view of a container in accordance with an embodiment of the present disclosure.

**[0033]** FIG. 4 shows a control container described in the Examples of the present disclosure.

5       **[0034]** FIG. 5 shows a step bottom container described in the Examples of the present disclosure.

**[0035]** FIG. 6 shows thickness zones of a control container as used in the Finite Element Analysis described in the Examples of the present disclosure.

**[0036]** FIG. 7 shows a graph illustrating the force (N)/displacement (mm) responses of a control container, a step bottom container and a beveled container in accordance with an embodiment of the present disclosure.

**[0037]** FIG. 8 shows thickness zones of a beveled container in accordance with an embodiment of the present disclosure as used in the Finite Element Analysis described in the Examples of the present disclosure.

15       **[0038]** FIG. 9 shows a graph illustrating the force (N)/displacement (mm) responses of beveled containers having varying thicknesses in accordance with an embodiment of the present disclosure.

## DETAILED DESCRIPTION

20       **[0039]** The present disclosure relates to load-bearing containers for providing consumable products. The containers are constructed and arranged to maintain load-bearing properties while limiting the amount of material necessary for production of same.

**[0040]** During packaging, distribution and retail stocking, containers can be exposed to a wide range of forces created by factors such as, for example, temperature and pressure changes, stacking of containers, dropping of containers, etc. Additionally, containers may also be exposed to forces imposed by the consumer including, for example, stacking of containers, gripping pressures, and compressive forces to collapse the container (e.g., for recycling). Accordingly, it would be desirable to produce a consumable product container that is capable of withstanding a  
30       desired amount of force, but which is manufactured using a lesser amount of materials (e.g, for cost and recycling purposes).

[0041] Applicant has surprisingly developed a container that is able to optimize container performance by improving the top load on the container, which provides material downgauging opportunities. The structure of the improved containers includes beveled corners that help to eliminate failure points in currently  
5 marketed containers that occur in the bottom corners of the containers. The structure of the improved containers also, accordingly, allows material to be more evenly distributed throughout the container. Similarly, by providing an improved axial compression load capability, Applicant is able to reduce the occurrence of damaged products that are not sellable and, instead, must be disposed of. By decreasing the  
10 number of containers that are not sellable, and by manufacturing the containers using less raw materials, Applicant is able to dramatically reduce the cost of production of the containers.

[0042] Containers of the present disclosure may be configured to house any type of consumable product therein including solids, semi-solids, liquids, gels, etc.  
15 In an embodiment, the containers are configured to house a solid or semi-solid consumable product such as, for example, an infant or toddler food.

[0043] Suitable materials for manufacturing containers of the present disclosure can include, for example, polymeric materials. Specifically, materials for manufacturing bottles of the present disclosure can include, but are not limited to,  
20 polyethylene ("PE"), low density polyethylene ("LDPE"), high density polyethylene ("HDPE"), polypropylene ("PP"), polystyrene ("PS"), and polyethylene terephthalate ("PET"). Further, the containers of the present disclosure can be manufactured using any suitable manufacturing process such as, for example, thermoforming, conventional extrusion blow molding, stretch blow molding, injection stretch blow  
25 molding, and the like.

[0044] Containers of the present disclosure may be manufactured using a flat sheet of raw materials. The sheet of material may be any thickness including, for example, about 45 mil, or about 46 mil, or about 47 mil, or about 48 mil, or about 49 mil, or about 50 mil, or about 51 mil, or about 52 mil, or about 53 mil, or about 54  
30 mil, or about 55 mil. As understood by the skilled artisan, a "mil" is a unit of length equal to one thousandth (10) of an inch (0.0254 millimeter).

[0045] The containers may be sized to any suitable volume such as, for example, from about 1.0 ounce to about 10 ounces, or from about 2 ounces to about 9

ounces, or from about 3 ounces to about 8 ounces, or from about 4 ounces to about 7 ounces, or from about 5 ounces to about 6 ounces, or about 2.0 ounces, 2.5 ounces, 3.0 ounces, 3.5 ounces, 4.0 ounces, 4.5 ounces, 5.0 ounces and the like.

**[0046]** Similarly, the containers may have any suitable shape that can include  
5 a flat bottom and beveled edges to maintain axial compressive loads but allow for a reduction in the amount of materials used to manufacture the containers. For example, the containers may have a shape that is cube, cuboid, cylindrical, prism, etc. As such, the skilled artisan will appreciate that, although the present figures illustrate a substantially cube or cuboid container, other shapes may be manufactured having  
10 the structural features described herein.

**[0047]** As illustrated in FIGS. 1 and 2, and in an embodiment, the present disclosure provides a container 10 including side walls 12 that meet at corners 14, a bottom wall 16, and a flange 18 at a top portion of container 10. Corners 14 include beveled portions 20 at a lower portion of container 10 where corners 14 meet bottom  
15 wall 16. The skilled artisan will appreciate, however, that in embodiments wherein container 10 has a shape that does not include corners (e.g., cylindrical, oval, etc.), a beveled portion of the container may be located where a side wall meets a bottom wall.

**[0048]** In an embodiment, container 10 also includes a border portion 22  
20 between side walls 12 and flange 18. Border portion 22 may have a slightly lesser or slightly greater perimeter measurement than that formed by side walls 12. Additionally, border portion 22 may have include textural or structural features that aid in improving a consumer's grip of container 10, or stackability of container 10. For example, border portion 22 may include ridges 24 that protrude toward an  
25 interior of container 10 and provide indented portions on an exterior of container 10. Ridges 24 may improve a consumer's grip of container 10, or may aid in stacking empty containers on top of each other.

**[0049]** Flange 18 is located a top portion of container 10 and may extend in a direction that is substantially perpendicular to side walls 12. Flange 18 may extend  
30 past a perimeter defined by side walls 12 and may have a substantially flat top that allows for easy stacking of containers 10 and allows for a cover (not shown) to be placed over top of container 10. Any suitable covers or lids may be used with containers 10 including, for example, thin films, snap-fit lids, friction-fit lids, adhered

lids, etc. Accordingly, any covers or lids used with containers 10 may be manufactured using any suitable material including, but not limited to, plastic, cardboard, cardstock, paperboard, styrofoam, etc.

5       **[0050]** Beveled portions 20 may have any suitable angle of incline with respect to bottom wall 16. For example, beveled portions 20 may have an angle of incline  $\Theta$  ranging from about 10° to about 60°, or from about 20° to about 50°, or from about 30° to about 40°, or about 10°, 15°, 20°, 25°, 30°, 35°, 40°, 45°, 50°, 55°, 60°, or the like. For example, and as shown in FIG. 2, container 10 may have a beveled corner portion 20 of about 20°. In another embodiment, however, and as  
10 shown in FIG. 3, container 10 may have a beveled corner portion 20 of about 45°.

**[0051]** As will be described further in the Examples below, Applicant has surprisingly found that containers 10 having beveled portions 20 provide structural advantages when compared to other similarly shaped containers. To demonstrate the structural advantages of beveled portions 20, Applicant performed several  
15 experiments comparing a beveled container shape, as in FIG. 1, with a control figure shape, as in FIG. 4, and a step-bottom container, as in FIG. 5. As will be described further below, Applicant surprisingly found that beveled containers 10 of the present disclosure were able to be manufactured using less materials, but still maintained the compressive load performance of the containers.

20       **[0052]** As discussed above, when containers 10 are mass produced for retail distribution, they may be packaged, shipped, stored and/or displayed in a stacked position that exposes containers 10 to top-loading. Applicant has surprisingly found, however, that certain structural features (e.g., beveled corners) can help to improve a container's performance when exposed to top-loading or compressive forces.

25       **[0053]** The structural features of the present containers described herein advantageously allow for a preform of less mass to be used. The reduced use of resin in the containers provides the advantage of a lower cost per unit and increased sustainability when compared to a container without such structural features. Further, by manufacturing the containers of the present disclosure using lower  
30 amounts of raw materials, the containers can provide lower environmental and waste impact. Along the same lines, the containers can be constructed to use less disposal volume than other containers designed for similar uses.

**[0054]** Additionally, the containers of the present disclosure can also improve the ease of use and handling by manufacturers, retailers and consumers. In this regard, the structural features described herein provide for improved top-loading, which reduces and special treatment required by the containers for manufacturing,  
5 packaging, shipping, displaying, etc.

**[0055]** By way of example and not limitation, the following examples are illustrative of various embodiments of the present disclosure.

## **[0056] EXAMPLES**

### 10 **[0057] Example 1**

**[0058]** Applicant performed several experiments using finite element analysis (“FEA”) to investigate the load-bearing capacities of various container structures, and to investigate the possibility of material reduction without loss of compressive load performance. The analysis included evaluation of the containers of the present  
15 disclosure and as illustrated in FIG. 1, as well as a control container, as illustrated in FIG. 4, and a step design container, as illustrated in FIG. 5. Unless otherwise indicated, the containers were manufactured using a commercial 52 mil sheet for thermoforming. The experiments were designed to first correlate the base line buckling modes of a control container structure under axial compressive load, and  
20 then to analyze the container structure of the present disclosure using the validated FE model to predict its behavior. Finally, the experiments evaluated the possibility to down gauge material used to make containers having specific structural features without affecting the compressive load performance of the containers.

**[0059]** To construct the model for the FEA, Applicant divided the control  
25 container of FIG. 4 into thirteen (13) different thickness zones, as shown in FIG. 6. Actual thickness measurements of a plurality of manufactured control containers were used to construct the FEA model. Further, the following assumptions were made for purposes of model construction: (i) fixed and moving platens were modeled as rigid bodies; (ii) a displacement profile was provided to the top plate for loading;  
30 (iii) inertia effects were assumed negligible due to lower mass of cup; and (iv) no strain rate effect was considered.

**[0060]** The control container of FIG. 4 and as used in the experiments had a volume of about 93.7 cc, the beveled container of FIG. 1, and as used in the

experiments, had a volume of about 93.6 cc, and the step bottom container of FIG. 5, and as used in the experiments, had a volume of about 93.77 cc. The initial compressive loading of each of these containers indicates that the control container and the step bottom container exhibited buckling in the corners at a lower portion of the corner near a bottom of the container. In contrast, the beveled container structure of the present disclosure moved the buckling location upward along the corner to a middle height location on the corner.

**[0061]** Additionally, and as shown in FIG. 7, the buckling load of the beveled containers of the present disclosure increased from about 116 N to about 142 N (about a 22% increase over the buckling load of the control containers). As is also shown in FIG. 7, the buckling load of the step bottom container was increased from about 116 N to about 131 N (about a 13% increase over the buckling load of the control container). More specifically, Applicant found an average peak top load (ft-lbs) of about 40.3 for a control container, about 40.8 for a step bottom container, and about 57.6 for a beveled container of the present disclosure. Accordingly, Applicant surprisingly found that the beveled edge containers of the present disclosure provide structural advantages over similarly sized, but differently shaped containers.

#### **[0062]** Example 2

**[0063]** To investigate the possibility of manufacturing containers using less materials, but maintaining the compressive load performance of the containers, Applicant performed axial compression load testing using a control thickness beveled container of the present disclosure. Then, Applicant reduced the thickness of a beveled container of the present disclosure by about 5% and performed the same axial compression load test. Finally, Applicant reduced the thickness of a beveled container of the present disclosure by about 10% and performed the same axial compression load test. In other words, the control thickness beveled container was the same as previously described using a commercial 52 mil sheet for thermoforming. To evaluate a 5% reduction in thickness, a commercial sheet of about 49 mil was used, and to evaluate a 10% reduction in thickness, a commercial sheet of about 47 mil was used.

**[0064]** Similar to the initial FEA described, above, to construct the model for the material thickness testing FEA, Applicant divided the beveled container of the

present disclosure into fifteen (15) different thickness zones, as shown in FIG. 8. Actual thickness measurements for a plurality of manufactured containers were used to construct the material thickness testing FEA model.

5       **[0065]** As shown by FIG. 9, a 5% thickness reduction for a beveled container of the present disclosure provides the same, or a similar, buckling load as the control container of FIG. 4 (e.g., about 116 N). A 10% thickness reduction for a beveled container of the present disclosure provides a buckling load of about 103 N, which is about an 11% decrease when compared to the control container of FIG. 4. More specifically, Applicant found an average peak top load (ft-lbs) of about 49.2 for a  
10       beveled container of the present disclosure, and about 32.7 for a control container.

**[0066]** Accordingly, Applicant has surprisingly found that the corner thickness of the beveled containers of the present disclosure plays a significant role in improving and/or maintaining a compressive load performance of the containers. Applicant has also found that optimizing material distribution could further increase  
15       buckling load capacity.

### **[0067]** Example 3

**[0068]** After preliminary tests from Experiment 2 above showed promising  
20       results for the 49 mil sheet used to form a beveled container of the present disclosure, a sample of 30 such containers was measured. Additionally, Applicant performed experiments to compare a 49 mil beveled container of the present disclosure with a 49 mil control container, a 52 mil control container, and a 55 mil control container. The structure of the control containers is illustrated in FIG. 4.

25       **[0069]** After testing about 30 samples of each container, Applicant found an average peak load (ft-lbs) of about 49.2 for the 49 mil beveled container of the present disclosure, about 40.1 for the 52 mil control container, and about 30.6 for the 55 mil control container. Applicant surprisingly found an 80% increase in top load strength when using the same forming process but changing the structure of the  
30       container from the control container to the beveled containers of the present disclosure. Applicant also surprisingly found that the 49 mil beveled container outperformed both the 52 mil and 55 mil control containers.

**[0070]** It should be understood that various changes and modifications to the presently preferred embodiments described herein will be apparent to those skilled in the art. Such changes and modifications can be made without departing from the scope of the appended claims.

## CLAIMS

The invention is claimed as follows:

1. A container (10) comprising:

at least four side walls (12) and a bottom wall (16) and an interior formed by  
5 the bottom wall (16) and the at least four side walls (12); and

at least one beveled portion (20) for increasing an axial load compression capacity of the container (10), wherein each of the at least one beveled portion (20) is provided at a corresponding corner portion being a location where two of the at least four side walls (12) together with the bottom wall (16) meet,

10 wherein the container is made of a sheet of material having a thickness in a range of from about 1.143 millimeters to about 1.397 millimeters, wherein the at least one beveled portion (20) has an angle of incline ranging from about 10° to about 60° with respect to the bottom wall.

2. The container (10) according to Claim 1, further comprising a flange  
15 portion (18) that extends in a direction that is substantially perpendicular to the at least four side walls (12), wherein the flange portion (18) has a flat top surface.

3. The container (10) according to Claim 1, further comprising a border portion (822) along a top portion of the container (10), wherein the border portion (22) comprises a textural feature.

20 4. The container (10) according to Claim 1, wherein the textural feature improves a consumer's grip of the container (10), or wherein the textural feature improves stackability of the container (10).

5. The container (10) according to Claim 1, further comprises a lid.

6. The container (10) according to Claim 1, wherein the container (10)  
25 comprises a volume ranging from about  $2.95735296 \times 10^{-5} \text{ m}^3$  to  $2.95735296 \times 10^{-4} \text{ m}^3$ .

7. The container (10) according to Claim 1, wherein the container (10) is configured to house a consumable product selected from the group consisting of a solid, a semi-solid, a liquid, a gel, and combinations thereof, or

wherein the container (10) is configured to house a consumable product  
5 selected from the group consisting of an infant food, a toddler food, and combinations thereof.

8. The container (10) according to Claim 1, wherein the container (10) has a shape selected from the group consisting of cube, cuboid, cylindrical, prism, and combinations thereof.

10 9. A method for manufacturing a container (10), the method comprising:  
forming the container (10) according to any one of claims 1 to 8.