

**CLOSURE/CONNECTORS FOR LINER-BASED SHIPPING AND  
DISPENSING CONTAINERS AND METHODS FOR FILLING LINER-  
BASED SHIPPING AND DISPENSING CONTAINERS**

**Field of the Invention**

**[001]** The present disclosure relates to novel and advantageous shipping and dispensing systems. Particularly, the present disclosure relates to novel and advantageous closure/connector systems for liner-based systems, and more particularly, closure/connector systems that may advantageously be tailored for use in particular industries, which may include being configured for compatibility with existing dispensing systems. The present disclosure also relates to novel and advantageous methods for filling a liner-based assembly to minimize the potential for damage, leaks, or contamination associated with thermal expansion of the contents of a liner.

**Background of the Invention**

**[002]** Container systems may be used in many industries for storing, shipping and/or dispensing materials. For example, container systems may be used to contain liquid-based contents of any viscosity. Typically, a shipping and dispensing system will include a container of some kind, and/or a liner, a cap that may be used to seal and protect the contents of the storage system when the contents are not being dispensed, and a connector that may be used to dispense the contents from the container. In some industries, one or more predominant dispense systems may exist, such that in order for a container system to be compatible with an end-user's existing dispense system, the container must have compatibly sized and shaped features. However, traditional storage and dispense container systems that may be compatible with such dispense systems may have one or more disadvantages. For example, traditional storage and dispense container systems may not ensure and/or maintain the purity of the contents of the container; may not efficiently use storage and/or shipping space, and therefore may result in unnecessary cost; and/or may not have satisfactory dispense rates, for example.

**[003]** However, because the purchase and/or installation of a dispense system may be a substantial cost, and in some cases potentially a prohibitive cost, an end-user may be stuck using container systems that are compatible with the existing dispense

system, even though there may be other container systems that are more advantageous in one or more ways. Accordingly, there is a need for a storage and dispense system that is better than traditional storage and dispense systems in one or more ways that may also be compatible with existing dispensing systems used in various existing industries.

**[004]** Additionally, many material customers utilizing such container systems desire the ability to ship their material to end users with no or substantially no headspace gas. Presently, there is an elaborate process used by end users to remove headspace gas, as well as whatever gas is trapped in the stored material. Shipping a packaged material with no or substantially no headspace would eliminate the need for such an elaborate end user process and would allow end users to take their product directly from the container system to their final utilization process.

**[005]** Furthermore, many substances that can desirably be stored in a container system may be affected by temperature change. For example, when some substances are subjected to increasing temperatures they may tend to expand and/or when they are subjected to decreasing temperature they may tend to contract. In some cases the thermal expansion of a substance contained in a liner may put a fair to significant amount of stress on the walls of the container, which in some cases may result in the walls of the container being damaged and could lead to the contents of the container becoming contaminated and/or leaking. In some cases, the contents of a container may be expensive or even extremely expensive and the loss of the contents due to contamination and/or leaking may have significant adverse consequences at the least. For example, some materials for use in some high-technology industries may be both very expensive and useable only when the material remains substantially free of contamination. Therefore any contamination caused by leaks or cracks in a container wall for example could render the entire container of very expensive material unusable. To this end, there is a further need for a method of filling a container that can take into account the propensity for a substance to expand when temperatures rise. There is also a need to substantially entirely fill a container with a substance in order to most cost-effectively ship and/or store the material.

### **Brief Summary of the Invention**

**[006]** The present disclosure, in one embodiment, relates to a method for removing headspace gas from a liner-based assembly. The liner-based assembly may generally include an overpack, a liner positioned within the overpack and containing a material and headspace gas, and a closure for sealing the liner. The method may include providing a one-way valve in fluid communication with the interior of the liner and permitting flow in a direction out of the interior of the liner, and applying a vacuum to the one-way valve to evacuate headspace gas from the interior of the liner. In some embodiments, The liner-based assembly may also include a port in fluid communication with an annular space between the overpack and liner, and the method may include capping the port, for example, during application of the vacuum to the one-way valve.

**[007]** The present disclosure, in another embodiment, relates to a liner-based assembly configured for headspace gas removal. The liner-based assembly may include an overpack, a liner positioned within the overpack, a closure configured for removable coupling with the liner for sealing the liner, and a one-way valve in fluid communication with the interior of the liner permitting flow in a direction out of the interior of the liner. In some embodiments, the one-way valve is coupled with the closure while in other embodiments, the one-way valve may be integral with the closure. The liner-based assembly may also include a port in fluid communication with an annular space between the overpack and liner, such that the liner-based assembly is configured, for example, for indirect pressure dispense. The port may be temporarily capped for headspace gas removal.

**[008]** The present disclosure, in a further embodiment, relates to a method for filling a container assembly. The method may include heating a material to a predetermined temperature and filling the container with the material at the predetermined temperature, sealing the container, and subsequent sealing the container, permitting the material in the container to cool. In one embodiment, the material may be heated to between about 40-60 °C. Likewise, the material may be permitted to cool to generally ambient room temperature of the room in which the container is located. The method may include filling the container with the material substantially to the top, such that substantially no excess space is provided for headspace gas. In other embodiments, subsequent sealing of the container, headspace gas may be removed.

**[009]** The present disclosure, in still another embodiment, relates to a liner-based assembly for use with pressure dispense. The liner-based assembly may include an overpack, a liner disposed within the overpack, and a closure assembly securable to the overpack and/or the liner. The closure assembly may include a headspace vent and a reservoir configured to collect an overflow of material stored within the interior of the liner. The closure assembly may be generally configured to form a seal to the liner by curing the overflow of material in the reservoir. In particular embodiments, the material stored in the liner-based assembly is an adhesive. In additional embodiments, the liner-based assembly may also include a cap configured for removably sealing the reservoir.

**[010]** The present disclosure, in yet another embodiment, relates to a method for filling and sealing a container. The method may include filling the container with an adhesive, operably coupling a closure assembly to the container, the closure assembly having a reservoir configured to collect an overflow of the adhesive, permitting or causing a portion of the adhesive in the container to flow into the reservoir of the closure assembly, and curing the overflow of adhesive in the reservoir to form a seal for the container. The method may further include capping the closure assembly to removably seal the reservoir.

**[011]** The present disclosure, in another embodiment, relates to a liner-based assembly for use with pressure dispense. The liner-based assembly may include an overpack, a liner disposed within the overpack, and a cap assembly securable to the overpack and/or the liner, the cap assembly including a closure and a plug member, wherein the closure includes a mouth configured to detachably couple to a dispense connector and to also detachably couple to the plug member, wherein the plug is configured to substantially completely fill the mouth of the closure. In particular embodiments, the liner-based assembly is configured for use in the food industry with existing dispense connectors of that industry, and in this regard, the liner may contain an edible food substance, and the dispense connector may be configured for dispensing food substances.

**[012]** The present disclosure, in still a further embodiment, relates to a method for dispensing the contents of a liner-based assembly. The method may include providing a liner having a desired substance stored therein, the liner being disposed within an overpack and comprising a liner neck with a seal secured thereto, securing a dispense connector to the liner neck, such that a probe on the dispense

connector is initially positioned adjacent to, but not piercing, the seal in the liner neck, but is positioned such that when the substance is dispensed by pressure dispense, the seal flexes upward against the probe, and the probe pierces the seal to permit dispense of the substance. In some embodiments, the substance may be dispensed by indirect pressure dispense, wherein a pressure is applied to the annular space between the liner and overpack.

**[013]** While multiple embodiments are disclosed, still other embodiments of the present disclosure will become apparent to those skilled in the art from the following detailed description, which shows and describes illustrative embodiments of the disclosure. As will be realized, the various embodiments of the present disclosure are capable of modifications in various obvious aspects, all without departing from the spirit and scope of the present disclosure. Accordingly, the drawings and detailed description are to be regarded as illustrative in nature and not restrictive.

### **Brief Description of the Drawings**

**[014]** While the specification concludes with claims particularly pointing out and distinctly claiming the subject matter that is regarded as forming the various embodiments of the present disclosure, it is believed that the disclosure will be better understood from the following description taken in conjunction with the accompanying Figures, in which:

**[015]** FIG. 1A is a cross-sectional view of a shipping and dispensing system according to one embodiment of the present disclosure.

**[016]** FIG. 1B is an exploded view of a shipping and dispensing system including a closure/connector assembly according to another embodiment of the present disclosure.

**[017]** FIG. 2 is an exploded view of a shipping and dispensing system including a closure/connector assembly according to one embodiment of the present disclosure.

**[018]** FIG. 3A is a cross-sectional view of the shipping and dispensing system of Figure 2 with the closure/connector assembly coupled to the shipping and dispensing system according to one embodiment of the present disclosure.

**[019]** FIG. 3B is a cross-sectional view of a liner based system of the present disclosure according to one embodiment.

[020] FIG. 3C is a cross-sectional view of a liner based system of the present disclosure according to one embodiment where the liner is being compressed.

[021] FIG. 3D is a perspective view of a connector and seal according to one embodiment of the present disclosure.

[022] FIG. 3E is a cut-away view of a liner-based system according to one embodiment of the present disclosure.

[023] FIG. 4 is a cross-sectional view of a closure/connector assembly coupled to a shipping and dispensing system according to another embodiment of the present disclosure.

[024] FIG. 5 is a perspective view of a dispensing connector for use with a shipping and dispensing system according to another embodiment of the present disclosure.

[025] FIG. 6 shows a shipping and storage system for use with indirect pressure dispense according to one embodiment of the present disclosure.

[026] FIG. 7 shows statistics related to the indirect pressure dispense method shown in FIG. 6 provided in graphical form in accordance with one embodiment of the present disclosure.

[027] FIG. 8 is a cross-sectional view of a shipping and dispensing system including a packaging element according to one embodiment of the present disclosure that.

[028] FIG. 9 is a flow diagram of a method for filling a liner-based assembly according to one embodiment of the present disclosure.

[029] FIG. 10 is a perspective view of a liner-based shipping and dispensing system having a one-way valve for headspace removal according to one embodiment of the present disclosure.

### **Detailed Description**

[030] The present disclosure relates to novel and advantageous shipping and dispensing systems. More particularly, one aspect of the present disclosure relates to novel and advantageous closure/connector systems for liner-based shipping and dispensing systems. In another aspect, the present disclosure relates to novel and advantageous methods for filling a liner-based assembly with a desired substance, such that there is a reduced risk of causing damage to the liner and/or contents of the liner resulting from thermal expansion of the substance. In some embodiments, the

liner-based shipping and dispensing systems and/or the closure and connectors for a liner-based shipping and dispensing system disclosed herein may be configured for particular use in the food industry or for use where the stored material is an adhesive, including, but not limited to epoxies, adhesive epoxies, epoxy and polyurethane coloring pigments, polyurethane cast resins, UV light and/or moisture curable silicone based adhesives, UV light and/or heat curable acrylic based adhesives, cyanoacrylate and anaerobic adhesives, reactive synthetic adhesives including, but not limited to, resorcinol, polyurethane, epoxy and/or cyanoacrylate, which cure primarily by chemical reactions rather than by evaporation of a carrier or solvent. It will be understood, however, that the liner-based shipping and dispensing systems and/or the closure and connectors for a liner-based shipping and dispensing system disclosed herein may also be used for a wide variety of other applications. Examples of some of the types of materials that may also be used with embodiments of the present disclosure include, but are not limited to: ultrapure liquids, such as acids, solvents, bases, photoresists, slurries, detergents, cleaning formulations, dopants, inorganic, organic, metalorganics, TEOS, and biological solutions, DNA and RNA solvents and reagents, pharmaceuticals, printable electronics inorganic and organic materials, lithium ion or other battery type electrolytes, nanomaterials (including for example, fullerenes, inorganic nanoparticles, sol-gels, and other ceramics), and radioactive chemicals; pesticides/fertilizers; paints/glosses/solvents/coating-materials etc.; power washing fluids; lubricants for use in the automobile or aviation industry, for example; food products, such as but not limited to, condiments, cooking oils, and soft drinks, for example; reagents or other materials for use in the biomedical or research industry; hazardous materials used by the military, for example; polyurethanes; agrochemicals; industrial chemicals; cosmetic chemicals; petroleum and lubricants; sealants; health and oral hygiene products and toiletry products; or any other material that may be dispensed by pressure dispense, for example. Materials that may be used with embodiments of the present disclosure may have any viscosity, including high viscosity and low viscosity fluids. Those skilled in the art will recognize the benefits of the disclosed embodiments, and therefore will recognize the suitability of the disclosed embodiments to various industries and for the transportation and dispense of various products.

**[031]** The liner-based systems of the present disclosure may hold up to approximately 200 liters, in some embodiments. Alternatively, the liner-based

systems may hold up to approximately 20 liters. Alternatively, the liner-based systems may hold approximately 1 to 5 liters, or less. It will be appreciated that the referenced container sizes are examples only and that the liner-based systems of the present disclosure may be readily adapted for use with a wide variety of sized and shaped shipping and dispensing containers. The entire liner-based system of the present disclosure may be used a single-time and then disposed of, in some embodiments. In other embodiments, the overpack, for example, may be reused while the liner and/or any closures or connectors may be used only a single time. In still other embodiments, some portion of the closure and/or connector may be configured for a one-time use while other portions of the closure and/or connector may be configured for repeated use.

**[032]** Figure 1A illustrates one embodiment of a liner-based shipping and dispense system 100 of the present disclosure. In some embodiments, the shipping and dispense system 100 may include an overpack 102, a liner 104, and one or more closures and/or connectors, which may be referred to herein as closure/connector assemblies 122. A closure/connector assembly may comprise in some embodiments, a filling connector and/or a dispensing connector and/or a closure or cap, as will be described in further detail below.

**[033]** The overpack 102 may include an overpack wall 106, an interior cavity 108, and a mouth 110. The overpack 102 may be comprised of any suitable material or combination of materials, for example but not limited to, one or more polymers, including plastics, nylons, EVOH, polyolefins, or other natural or synthetic polymers. In further embodiments, the overpack 102 may be manufactured using polyethylene terephthalate (PET), polyethylene naphthalate (PEN), poly(butylene 2,6-naphthalate) (PBN), polyethylene (PE), linear low-density polyethylene (LLDPE), low-density polyethylene (LDPE), medium-density polyethylene (MDPE), high-density polyethylene (HDPE), polypropylene (PP), and/or a fluoropolymer, such as but not limited to, polychlorotrifluoroethylene (PCTFE), polytetrafluoroethylene (PTFE), fluorinated ethylene propylene (FEP), and perfluoroalkoxy (PFA). The overpack 102 may be of any suitable shape or configuration, such as, but not limited to, a bottle, a can, a drum, etc.

**[034]** As described above, the shipping and dispense system 100 may include a liner 104, which may be disposed within the overpack 102. The liner 104 may include a liner wall 112, an interior cavity 114, and a mouth 116. The mouth 116 of

the liner 104 may include a fitment portion 118. The fitment portion 118 may be made of a different material than the rest of the liner 104 and may be harder, more resilient, and/or less flexible than the rest of the liner. The fitment portion 118 may couple with a closure, connector or closure/connector assembly 122 (discussed more fully below) by any suitable means, such as but not limited to, complementary threading, snap-fit or friction-fit means, bayonet means, or any other suitable mechanism or combination of mechanisms for coupling, as will be appreciated by those skilled in the art. In some embodiments, a connector or closure/connector assembly 122 may couple to, or may also couple to, the mouth 110 of the overpack 102.

**[035]** In some embodiments, the liner 104 may be a collapsible liner that is substantially flexible, while in other embodiments the liner may be somewhat rigid but still collapsible, e.g., a rigid collapsible liner or substantially rigid collapsible liner. As used herein, the terms “rigid” or “substantially rigid,” in addition to any standard dictionary definitions, are meant to also include the characteristic of an object or material to substantially hold its shape and/or volume when in an environment of a first pressure, but wherein the shape and/or volume may be altered in an environment of increased or decreased pressure. The amount of increased or decreased pressure needed to alter the shape and/or volume of the object or material may depend on the application desired for the material or object and may vary from application to application. In addition, the term “substantially rigid” is meant to include the characteristic of an object or material to substantially hold its shape and/or volume, but upon application of such increased or decreased pressure, tend to give, such as by but not limited to, flexing, bending, etc., rather than breaking.

**[036]** The liner 104 may be manufactured using any suitable material or combination of materials, such as but not limited to, any of the materials or combination of materials listed above with respect to the overpack 102. However, the overpack 102 and liner 104 need not be manufactured from the same materials. In some embodiments, the material or materials selected and the thickness of that material or those materials may determine the rigidity of the liner 104. The liner 104 may have one or more layers and may have any desirable thickness. A liner 104 may have a thickness of, for example, from about 0.05 mm to about 3 mm, or any other suitable thickness.

**[037]** The liner 104 may be configured to comprise any desirable shape that is appealing to the user, and/or assists in the collapse of the liner. The liner 104, in some embodiments, may be dimensioned and shaped to substantially conform to the interior of the overpack 102. As such, the liner 102 may have a relatively simplistic design with a generally smooth outer surface, or the liner may have a relatively complicated design including, for example but not limited to, indentations and/or protrusions. In some embodiments, the liner wall 112 may include a generally textured surface in order to minimize leaching and/or adhesion. For example, in some embodiments, the surface may include a plurality of bumps, scales, or projections, which may each have any appropriate size, for example, but not limited to, from about 0.5 – 100  $\mu\text{m}$ . Texturizing features may be spaced any suitable distance from one another. In some embodiments, the texturizing may comprise a framework, such as a lattice or scaffold, for example. Examples of some suitable texturizing features are described in greater detail in U.S. Provisional Patent Appln. No. 61/334,006, titled, “Fluid Processing Components with Textured Surface for Decreased Adhesion and Related Methods,” filed May 12, 2010, which is hereby incorporated by reference herein in its entirety. The liner 104 may have a relatively thin liner wall 112, as compared to the thickness of the overpack wall 106. In some embodiments, the liner 102 may be flexible such that the liner wall 112 may be readily collapsed, such as by vacuum through the mouth 116 or by pressure between the liner wall 112 and overpack wall 106, referred to herein as the annular space therebetween.

**[038]** The liner 104, in a further embodiment, may have a shape, when inflated or filled, that is different from, but complimentary with, the shape of the overpack 102 such that it may be disposed therein. In some embodiments, the liner 104 may be removably attached to the interior of the overpack wall 102. The liner 104 may provide a barrier, such as a gas barrier, against drive gas migration from the annular space between the liner wall 112 and the overpack wall 106. In some embodiments, the material from which the liner 104 is manufactured may provide gas barrier properties. In other embodiments, the gas barrier may be provided by a component added to the material from which the liner wall is manufactured, may be an additional layer added to the liner wall 112, or may be any other suitable structure for providing a gas barrier between the annular space and the interior of the liner. Accordingly, the liner 104 may generally ensure and/or maintain the purity of the contents within the liner.

**[039]** In some embodiments, particularly where sterility of the contents of the liner must be substantially maintained, the liner 102 may be comprised of a material that may help ensure or maintain a sterile environment for the contents disposed in the liner. For example, in some embodiments the liner may be comprised of TK8 manufactured by ATMI of Danbury, Connecticut, or any other suitable material. In additional or alternative embodiments, the liner and/or liner-based shipping and dispensing system may be a liner and/or liner-based shipping and dispensing system particularly configured for the substantially sterile storage, shipment, and dispense of materials, such as those disclosed in International PCT Appl. No. PCT/US2012/59865, titled "Liner-Based Shipping and Dispensing Containers for the Substantially Sterile Storage, Shipment, and Dispense of Materials," filed October 12, 2012, and which is hereby incorporated by reference herein in its entirety.

**[040]** As noted above, in some embodiments, the liner 104 may comprise multiple layers. The multiple layers may comprise one or more different polymers or other suitable materials. In some embodiments, the thickness, ply, and/or the composition of the liner and/or the layers of the liner may allow for the secure and substantially uncontaminated shipment of the contents of the liner-based system of the present disclosure by limiting or eliminating typical weaknesses or problems associated with traditional liners or packages, such as, for example weld tears, pin holes, gas entrainment, and/or any other means of contamination. Similarly, or in addition, the liner 104 may also contribute to the secure and substantially uncontaminated shipment of the contents of the shipping and dispense system 100 of the present disclosure by configuring the liner to substantially conform to the shape of the overpack when the liner is filled, thereby reducing the amount of movement of the contents during shipping.

**[041]** The overpack 102 and liner 104 may each be manufactured using any suitable manufacturing process, such as but not limited to, injection blow molding, injection stretch blow molding, extrusion, etc., and may each be manufactured as a single component or may be a combination of multiple components. In some embodiments, the overpack 102 and liner 104 may be blow molded in a nested fashion, also referred to herein as co-blow molded. Examples of liner-based systems and methods utilizing co-blow molding techniques have been described in greater detail in Examples of liner-based systems and methods utilizing co-blow molding

techniques have been described in greater detail in International PCT Appl. No. PCT/US11/55560, titled “Nested Blow Molded Liner and Overpack and Methods of Making Same,” filed October 10, 2011, which is hereby incorporated herein by reference in its entirety. In some embodiments, a liner may be blow molded into an already formed overpack, whereby the overpack may function as the mold for the liner, sometimes referred to herein as “dual blow molding.” In such embodiments, the overpack may be manufactured by any suitable process.

**[042]** Examples of the type of liners and overpacks that may be used are disclosed in more detail in: International PCT Appl. No. PCT/US11/55558, titled, “Substantially Rigid Collapsible Liner, Container and/or Liner for Replacing Glass Bottles, and Enhanced Flexible Liners,” filed October 10, 2011; International PCT Appl. No. PCT/US11/55560, titled, “Nested Blow Molded Liner and Overpack and Methods of Making Same,” filed October 10, 2011; International PCT Appl. No. PCT/US11/64141, titled “Generally Cylindrically-Shaped Liner for Use in Pressure Dispense Systems and Methods of Manufacturing the Same,” filed December 9, 2011; U.S. Prov. Appl. No. 61/703,996, titled “Liner-Based Shipping and Dispensing Systems,” filed September 21, 2012; U.S. Prov. Appl. No. 61/468,832, titled “Liner-Based Dispenser,” filed March 29, 2011 and related International PCT Appln. No. PCT/US2011/061764, filed November 22, 2011; U.S. Prov. Appl. No. 61/525,540, titled “Liner-Based Dispensing Systems,” filed August 19, 2011 and related International PCT Appln. No. PCT/US2011/061771, filed November 22, 2011; U.S. Pat. Appl. No. 13/149,844, titled “Fluid Storage and Dispensing Systems and Processes,” filed May 31, 2000 U.S. Pat. Appl. No. 11/915,996, titled “Fluid Storage and Dispensing Systems and Processes,” filed June 5, 2006; International PCT Appl. No. PCT/US10/51786, titled “Material Storage and Dispensing System and Method With Degassing Assembly,” filed October 7, 2010; International PCT Appl. No. PCT/US10/41629; U.S. Pat. No. 7,335,721; U.S. Pat. Appl. No. 11/912,629; U.S. Pat. Appl. No. 12/302,287; International PCT Appl. No. PCT/US08/85264; U.S. Pat. Appl. No. 12/745,605, filed February 15, 2011; U.S. Prov. Appln. No. 61/605,011, titled “Liner-Based Shipping and Dispensing System,” filed February 29, 2012; and U.S. Prov. Appln. No. 61/561,493, titled “Closure/Connectors for Liner-Based Shipping and Dispensing Containers,” filed November 18, 2011, each of which is hereby incorporated by reference herein in its entirety. The overpack 102 and liner 104 for use with the shipping and dispense system 100 of the present disclosure may

include any of the embodiments, features, and/or enhancements disclosed in any of the above noted applications, including, but not limited to, flexible, rigid collapsible, 2-dimensional, 3-dimensional, welded, molded, gusseted, and/or non-gusseted liners, and/or liners that contain folds and/or liners that comprise methods for limiting or eliminating choke-off and liners sold under the brand name NOWpak® by ATMI, Inc. for example. Various features of dispensing systems disclosed in embodiments described herein may be used in combination with one or more other features described with regard to other embodiments.

**[043]** In one particular embodiment, as illustrated in Figure 1B, a storage and dispense system of the present disclosure may include a liner-based system having a liner 130 positioned within an overpack 132. The overpack 132 may include a top portion 134 and a bottom portion 136. The bottom portion 136 may also be referred to as a chime. In other embodiments, however, the overpack may be a unitary piece, or in still other embodiments the overpack may comprise more than two pieces. The liner and overpack may be formed by any suitable method described herein and may be comprised of any suitable material described herein. For example, in embodiments having a single-piece overpack, the liner and overpack may be co-blow molded, for example. The liner 130 and/or overpack 132 may include surface features, and in some embodiments, such as where nested co-blow molding is used to manufacture the liner and overpack, co-extensive surface features that may help minimize or eliminate dimpling in the liner and/or overpack that may result from temperature changes, for example. Particularly, in one embodiment, the liner 130 may contain surface features, such as but not limited to, one or more indented or protruding panels 138 that may be positioned around the circumference of the liner. In some embodiments the overpack 132 may also have similar or co-extensive surface features. Such surface features may include any desired or suitable dimensions, geometry, or pattern, as is further described in U.S. Prov. Appln. No. 61/605,011 and International PCT Appl. No. PCT/US11/55558, which were previously incorporated by reference herein in their entirety. Generally, surface features such as one or more panels may add strength and/or rigidity to the liner and/or overpack. However, in some embodiments, more shallow edging may also keep the liner from sticking to the overpack.

**[044]** In other embodiments, the liner-based shipping and dispensing systems of the present disclosure may include baffles, baffling features, or other

discontinuities in the interior surface(s) thereof to retard settling of the suspended solids contained therein during storage and/or transportation.

**[045]** The liner-based shipping and dispensing systems described herein may be configured as any suitable shape, including but not limited to square, rectangular, triangular or pyramidal, cylindrical, or any other suitable polygon or other shape. Differently shaped dispensers can improve packing density during storage and/or transportation, and may reduce overall transportation costs. Additionally, differently shaped dispensers can be used to differentiate dispensers from one another, such as to provide an indicator of the contents provided within the dispensers or to identify for which application or applications the contents are to be used, etc. In still further embodiments, the dispensers described herein may be configured as any suitable shape in order to “retrofit” the dispensers with existing dispense assemblies or dispense systems.

**[046]** Embodiments of the liner-based assemblies of the present disclosure may include additional features that may help minimize stiction (e.g. by including an overcoat or slip agent in the material of the liner and/or overpack); may help reduce the risk of contamination (e.g. by including a colorant to the overpack to reduce penetration of ultraviolet light); may make it easier to package, ship, carry, and/or move the liner-based assembly (e.g. by including one or more handles, or additional packaging elements); may allow the liner and overpack to be compatible with one or more caps, connectors, or dispensing assemblies, and/or make the liner-based assembly more secure and/or keep the contents of the liner free of contaminants, such as rings, collars, seals, connectors, caps, etc.; and/or any other feature such as those more fully described in U.S. Prov. Appln. No. 61/605,011, U.S. Prov. Appln. No. 61/561,493, and International PCT Appl. No. PCT/US11/55558, each of which was previously incorporated by reference herein in its entirety.

**[047]** Generally, in use, a liner-based system may be used in the following way: first the liner-based system may be shipped to a fill site; the liner-based system may be filled with a desired substance and then shipped to an end-user, for example; the end-user may then store and/or dispense the contents of the container; finally, after dispense, the end-user may dispose of the liner-based system, and/or recycle or reuse some or all of the liner-based system, including some or all of the closure/connector assembly. The closure/connector assembly may be suitably configured to be used at one or more points in the cycle of use described above for a liner-based system. For

example, a fill connector may be secured to the fitment 118 of the liner, the mouth 110 of the overpack, or both during filling of the liner. The fill connector, in some embodiments, may be configured to limit or substantially eliminate contaminants being introduced into the liner or the substance being introduced therein, during filling; and/or to increase the speed at which filling may occur, for example. Once the liner has been filled at a fill site, a shipping cap or closure may be detachably secured to the liner-based system. In some embodiments, the cap or closure may couple to the fitment 118 of the liner, the mouth 110 of the overpack, or both. In some cases, the fill connector may be removed prior to connecting the closure, while in other cases, the closure may couple to the fill connector and the fill connector may remain on the container during storage and/or transport. The purpose of the closure is generally to keep contaminants out and the desired material in the liner during storage and/or transportation. Once the filled liner or liner-based system arrives at an end destination, where some or all of the dispense will occur, in some cases the closure (or closure and fill connector in some embodiments) may be removed and a dispense connector may be secured to the fitment 118 of the liner, the mouth 110 of the overpack, or both. In some embodiments, the fill connector may also be configured as a dispense connector. Accordingly, in some cases a closure or cap may be incorporated into a connector, such that a single connector may be used for filling, shipping, and dispensing, while in other cases, the dispense connector may be a separate connector from the connector used for filling.

**[048]** The dispense connector may be configured to be compatible with particular dispense systems used by an end-user. Existing dispense systems may vary from industry to industry. In some cases, a variety of dispense systems may be used in a particular industry, depending on, for example, the configuration of the shipping and dispense containers that may typically be used in that industry and/or any other standards or norms that may have developed in a particular industry for any other reason.

**[049]** The various embodiments of storage and dispense systems described herein may be utilized in any suitable dispense processes. For example, the various embodiments of storage and dispense system described herein may be utilized in pressure dispense processes, including direct and indirect pressure dispense, pump dispense, and pressure-assisted pump dispense, including various embodiments of inverted dispense methods disclosed in Korean patent registration no. 10-0973707,

titled "Apparatus for Supplying Fluid," which is hereby incorporated by reference herein in its entirety. Similarly, the various embodiments of storage and dispense system described herein may be utilized in traditional manual or automatic pour methods, or any other suitable means of dispensing the contents of a container consistent with the intended use of the material, or application involved. The dispense connector may include features used to dispense the contents of the liner. In some embodiments, the dispense connector features may allow for dispense using existing pressure-dispense systems, for example. Generally, such pressure-dispense dispense connector features may include a pressurizing gas inlet that generally permits a gas pressure in-line to be inserted through or coupled with the dispense connector and be in fluid communication with the annular space between the liner 104 and the overpack 102. In such a system, a pressurizing fluid, gas, or other suitable substance may be introduced into the annular space, causing the liner to collapse away from the overpack wall, thereby pushing the contents of the liner out through a liquid outlet. In one embodiment, for example, to dispense liquid stored in the liner, the annular space between the liner and the overpack may be pressurized, as is further described in International PCT Appl. No. PCT/US11/55558, which was previously incorporated by reference.

**[050]** The use of indirect pressure dispense may be advantageous over other dispense methods in some cases. For example, the use of pumps to dispense the contents of a liner can disadvantageously cause bubbling and/or may put stress on the material and the system, which may be undesirable because the purity of the contents of the liner may be crucial. The use of pressure dispense may help avoid or eliminate these problems. Further, in some cases a higher rate of dispense may be achieved by pressure dispense as opposed to pump dispense. Direct pressure dispense methods, however, can cause gas to be introduced directly into the contents of the liner and can reduce the purity of the contents of the liner. The use of indirect pressure dispense may help avoid or eliminate these problems.

**[051]** Although not limited as such, one embodiment of a closure/connector assembly may be configured to be particularly useful with liner-based assemblies containing materials used in the food industry. As may be seen in Figure 2, a closure/connector assembly 240 for use in a liner-based system 200 may include a closure 250 and a plug 260, in some embodiments. As described above, the container system 220 in some embodiments may include a liner disposed in an overpack. It will

be understood, however, that any of the liners and/or overpacks as described herein are contemplated and are within the spirit and scope of the present disclosure.

**[052]** The closure 250 of the closure/connector assembly 240 may advantageously be configured to be compatible with existing dispensing systems used by end-users, and/or other existing technology or machinery that may be used, in the food industry, for example. As such, by using the closure/connector assembly 240 of the present disclosure, the advantages described herein related to the container system (including a liner and/or overpack) may be realized without requiring a change in end-user technology or machinery, for example.

**[053]** The closure 250 may include a mouth 252 and connecting features 254, in some embodiments. The mouth 252 may be configured to allow for easy and/or controlled dispense, in some embodiments. The mouth 252 of the closure 250 may, or may also, be suitably sized and shaped so as to be compatible with one or more dispense systems.

**[054]** Figure 3A shows a cut-away view of a closure 250 of the present disclosure according to some embodiments, wherein the closure 250 is coupled to a liner-based container 220. The closure 250 may be coupled to the liner-based container 220 by connecting features 254, in some embodiments. As may be seen, the mouth 310 of the overpack may be coupled to the fitment 318 of the liner, in some embodiments. In one embodiment, as shown, the mouth 310 of the overpack and the fitment 318 of the liner may be coupled by complementary threading, though other means of coupling are possible. In other embodiments, the mouth 310 of the overpack may be adjacent to, but not coupled to, the fitment 318 of the liner. The closure 250 may or may also detachably secure to the liner-based container 220, by connecting features 254 that may be present on the closure 250 and/or the liner and/or the overpack. For example, in one embodiment, the connecting features 254 may comprise internal threading that may be complementary with external threading on the fitment 318 of the liner and/or external threading on the mouth 310 of the overpack, for example. It will be recognized that any other suitable means of detachably securing the closure 250 to the liner-based container 220 are possible, such as snap-fit, friction fit, or any other suitable means, or combination of means.

**[055]** The closure 250 may be comprised of any suitable material, such as metal, plastic, or any other material or combination of materials. In some embodiments, the closure 250 may be comprised of a material that may be suitable for

use in a sterile environment, such as those listed above, or any other suitable material, or combination of materials.

**[056]** With reference back to Figure 2, in some embodiments a fitment plug 260 may also be included in the closure/connector assembly. The fitment plug 260 may be inserted into an opening 252 in the closure 250. In some embodiments the plug 260 may substantially securely couple with the closure 250 through any suitable method, or combination of methods, at one or more points. For example, the plug 260 may have threading that mates with complementary threading on the interior of the closure mouth 252, for example. In other embodiments, the plug 260 may have, or may also have snap-fit and/or friction fit features that may allow the plug to securely couple to the mouth 252 of the closure 250. In some embodiments, the plug 260 may generally tightly couple, or be coupled in generally air tight fashion, to the closure 250 for storage and/or shipping, but may still be detachable when removal is desired.

**[057]** The fitment plug may be used for storage and/or shipping, in some embodiments, such that contaminants, for example, cannot get into the container 220, and the contents of the liner cannot get out of the container 220 until desired. The plug 260 may be comprised of any suitable material, such as metal, plastic, or any other material or combination of materials. In some embodiments, the plug 260 may be comprised of a material that may be suitable for use in a sterile environment, such as those listed above, or any other suitable material, or combination of materials. The plug 260 may be comprised of the same or different material as the closure 250. In some embodiments, the plug 260 may be an existing plug used in the food industry, for example, such as but not limited to those made by Scholle Packaging, Inc. of Northlake, Illinois or E. I. du Pont de Nemours and Company. In this regard, the mouth 252 of the closure 250 may be particularly configured so as to receive such plug 260. While the foregoing embodiments have been described as being particularly advantageous for applications in the food industry, it will be understood that the closure/connector assembly 240 may be used in conjunction with a shipping and dispensing container for any desired application and/or in any desired industry.

**[058]** In another embodiment, the closure/connector described above or any other closure/connector assembly may include a seal that may help keep the contents of a liner free of contaminants, particularly when, in some cases, a cap or connector may be removed and another one may be put on for dispense, for example, and the contents of the liner might otherwise be exposed during that time, if not for the seal.

The seal 320 shown in Figure 3D may be a flexible seal in some embodiments and may be punctured by the probe of a connector during dispense, such that substantially no air is introduced into the material contained in the liner prior to dispense. For example, a liner 340 may be filled with a material M, as shown in Figure 3B. In some cases, the fill volume may be predetermined and controlled. For example, the fill volume may be determined by measuring and controlling the rate of flow during fill and the amount of time the material is permitted to fill the liner. Alternately, the fill volume may be determined by measuring the weight of the liner based system during the fill process and stopping the fill process when the predetermined and desired fill weight has been achieved. Still other methods of predetermining and controlling the fill volume are contemplated and within the spirit and scope of the present disclosure. In some embodiments, once the liner has been filled, a pressurized fluid or gas may be introduced into the annular space between the outer walls of the liner 340 and the inner walls of the overpack 342. The pressure introduced into the annular space may work to compress the wall of the liner 340 as shown in Figure 3C, thereby pushing the material M in the liner 340 up to the top of the liner, removing substantially all of the undesirable headspace. "Headspace" refers to the amount of gas, such as air for example, that remains at the top of the liner after the liner has been filled with a desired substance. Headspace may be undesirable because the gas may cause foaming, bubbling, stress, protein damage, and/or gas contamination of the material, for example, which can be highly undesirable where maintaining the purity of the contents of the system is important.

**[059]** In one embodiment of the present disclosure shown in Figure 9, a fill process 900 may be utilized that may generally de-gas the contents of a filled liner at the fill site while also removing generally all of the headspace in the filled liner prior to sealing or securing the filled liner for shipping and/or storage. As discussed above, limiting or substantially eliminating headspace in a filled liner may be advantageous because it may limit or substantially eliminate the risk of headspace gas contaminating the contents of the liner, when for example, the liner-based assembly is moved during shipping.

**[060]** As may be understood in the art, some substances may take up more or less volume, that is to say they may expand or contract, as a result of a change in temperature. For example, if the contents of the liner are filled and generally sealed in the liner at one temperature, and are then subjected to a change in temperature

during storage or shipping, for example, the substance in the liner may either expand (with an increase in temperature) or contract (with a decrease in temperature) as a result. For substances that may tend to expand with an increasing change in temperature, a risk exists that the thermal expansion of the substance may put stress on the liner walls, potentially causing leaks in the liner. This risk may be even more acute in cases where the headspace is removed, because in such cases there is no space in the liner not already taken up with the substance, and so if the substance expands even a relatively small amount, the pressure may cause damage to the liner walls and result in a leak. The present disclosure advantageously provides a solution to this problem, thereby allowing substantially all headspace to be removed while also eliminating or substantially minimizing the risk of leaks occurring in the event of thermal expansion of the substance contained in the liner.

**[061]** In one embodiment of the present disclosure, the liner may be filled with the desired substance wherein the substance is heated and gas-equilibrated as the liner is being filled with the substance 902. For example, the substance may be heated when it is introduced into the liner. In some embodiments the substance may be heated to the maximum temperature the substance is expected to be subjected to prior to dispense, including during storage and shipment. In other embodiments the substance may be heated to any suitable and desired temperature. In some embodiments, for example, the substance may be heated to about 40-60 °C during the fill process. In other cases, the substance may be heated to between about 50-55 °C. In still other embodiments, any suitable fill temperature may be selected. The liner may be filled to the top of the liner in some embodiments, leaving generally no excess space for headspace gas, while in other embodiments there may be some relatively small amount of space left at the top of the liner. Once the liner has been filled, the liner may be sealed, secured, and/or capped in any suitable manner that keeps the substance within the liner and minimizes or substantially eliminates exposure of the substance to contaminants outside of the liner 904. The one or more seals, caps, or other securing mechanism may be gas impermeable. In some embodiments, some or any headspace may be removed after a cap or connector is secured to the liner 906. In such embodiments, the annular space between the liner and the overpack may be pressurized so as to compress the walls of the liner inward, thereby forcing any headspace out of the liner and into a holding area in a cap and/or connector, for example, as described in further detail below. It will be understood, however, that

any suitable method of removing headspace is contemplated and within the spirit and scope of the present disclosure. The substance in the liner may then be allowed to cool to ambient room temperature 908. As the substance cools, the substance will generally become under-saturated with respect to room temperature, i.e. the substance will be substantially degassed. Further, as the substance cools to room temperature after the liner has been sealed, the substance may tend to contract. The contracting substance may provide a small amount of void space in the filled and secured liner.

**[062]** As discussed above, during shipping and/or storage, the substance in the liner may be subjected to higher temperatures than the temperature that the substance was cooled to after hot-fill of the liner. For example the liner-based assembly may be shipped through a part of the country with relatively higher temperatures, such as the desert, for example, that may be higher than room temperature at the fill site. Accordingly, the substance in the liner may generally expand as the temperature increases. In some embodiments, features of the liner and/or overpack may help reduce or eliminate any stress on the liner resulting from the substance expanding. For example, in some embodiments, the liner and/or overpack may have surface features such as panels described above that may allow the liner to expand when pressure is applied. The panels 138 may be concave, as shown in Figure 1B for example, until pressure is exerted on them from the inside of the liner, e.g. by thermal expansion of the contents of the liner. While panels have been specifically described above, it will be understood that any suitable surface feature that may generally allow the liner to expand as the substance in the liner expands, is contemplated and within the spirit and scope of the present disclosure. Further, as described above, when the substance is cooled after being hot-filled and sealed, the substance contracting may also provide some additional space in the liner that may allow the substance to later thermally expand without putting stress on the liner walls. The fill method described herein may advantageously allow the liner to be substantially completely filled, remain free of headspace gas, while still allowing for a degree of thermal expansion of the substance, thereby significantly reducing or eliminating the potential for thermal expansion related damage, contamination, or leaks.

**[063]** In some embodiments of headspace removal, particularly with respect to more delicate container systems, such as those with thin liner walls, any non-conformal fit between the inner liner 104 and the overpack 102 could result in a

potential product failure during shipping simulation. That is, pressurizing the annular space in order to remove the headspace, as described herein, generally causes an intentional deformation in the liner away from the overpack, which could, but does not always, lead to container failure or failure of the container to meet required specifications, during, for example, shipping. Thus, in some embodiments, additional or alternative steps may be taken in the headspace removal process to avoid such deformation, or reduce the resulting effect of such deformation.

[064] For example, in some embodiments, during the headspace removal process, both the liner and overpack may be collapsed in general uniformity. To accomplish this, in one embodiment, illustrated in Figure 10, which illustrates a liner-based storage and dispensing system 1000 having a liner (not visible) positioned within an overpack 1002 and chime 1004 and including a closure 1006 operably coupled with the liner and/or overpack, a one-way valve or check valve 1008 may be provided through which headspace removal may be effected. In one embodiment, the one-way valve 1008 may be operably or integrally included with the closure 1006. The one-way valve 1008 may be configured or provided such that it is in fluid communication with the interior of the liner and permits gas flow in the direction from the interior of the liner to an external side of the closure 1006. As may be appreciated, the closure 1006 may also include a port 1010 in communication with the annular space between the liner and overpack, which may be used to dispense the contents of the liner via indirect pressure dispense, as described herein. In order to effect headspace removal, upon filling of the liner and capping of the liner with closure 1006, the annular space port 1010 (if provided) may first be capped such that no gas may enter the annular space between the liner and overpack. After capping the annular space port 1010, a vacuum may be applied, such as by connecting a vacuum source, to the one-way valve, which is in communication with the interior of the liner, to evacuate any headspace within the interior of the liner. This may cause substantially uniform collapsing, albeit typically minimal, of both the liner and overpack 1002, which can avoid or reduce deformation in the liner away from the overpack, which may be disadvantage in some cases, as described above. When the desired amount, often all or substantially all, of headspace is evacuated from the interior of the liner, the vacuum source may be removed from the one-way valve 1008. The one-way valve 1008 may be removed, if desired in some embodiments. However, the one-way valve 1008 could be left with the closure 1006 and by nature

of its one-way characteristics should otherwise keep any air from migrating back into the liner. In further embodiments, the one-way valve may be capped for added protection. In other embodiments, in addition to the vacuum source or as an alternative thereto, the headspace may be removed by applying a pressure to the overpack. Because the annular space port 1010 is capped, the pressure on the overpack may cause a pressure to be applied to the liner and the headspace may therefore be forced out via the one-way valve 1008. The package may then be ready for transporting to an end user, and upon arrival at the end user site, the material contained inside the liner should maintain the evacuated level of headspace. While discussed herein as a check valve, the valve could be any suitable one-way valve, including but not limited to, a bleeder valve or the like.

**[065]** In still other embodiments, the annular space need not be pressurized and the headspace need not be removed. Indeed, many embodiments may not require such processing. Whether or not headspace is removed, a seal, and in some embodiments a flexible seal may be applied to the outlet of the liner, including applying the seal to the interior space of the fitment of the liner, such that when the seal is applied, the contents of the liner may not escape. The seal may be comprised of any suitable material or combination of materials, including but not limited to plastic, rubber, elastomeric or any other suitable material. The seal may be any suitable type of seal, including but not limited to, what may be referred to as a flat seal in some embodiments, or what may be referred to as a blabber seal in other embodiments that may be placed further down the neck of the fitment of the liner. The seal may be form fit to the interior of the neck of the liner, may be heat sealed, adhered, or otherwise fitted to the interior of the neck of the liner. In other embodiments, the seal may be fitted to the top of the neck of the liner. Once the seal has been applied, any pressure applied to the annular space from the above described optional headspace removal steps may be removed from the annular space, and a shipping and/or storage cap or other closure/connector assembly described herein may be coupled to the liner and/or overpack for storage and/or shipping. The end-user may then store and/or dispense the contents of the container. When it is desired to dispense the contents of the liner, the contents may be removed through the mouth of the liner using any suitable dispense method, such as by pressure dispense, including direct and indirect pressure dispense, pump dispense, pressure-assisted pump dispense, inverted dispense, pouring, or any other suitable means of dispensing the

contents of a container consistent with the intended use of the material, or application involved, as described above. In some embodiments, a dispense connector, configured for a particular dispense method, may be affixed to the liner-based system in preparation for removal of the contents of the liner. The dispense connector may be configured to be compatible with particular dispense systems used by an end-user, which may vary from industry to industry. For example, when dispense of the contents of the liner is desired, dispense connector 326 may be coupled to the liner and/or overpack. Depending on the embodiment used, the shipping/storage cap may also serve as a dispense connector; the dispense connector may be secured to the shipping/storage cap; or the shipping/storage cap may be removed and the dispense connector may be secured to the liner and/or overpack. The seal may be so positioned that when the dispense connector 326 is coupled to the liner and/or overpack, a connector probe 328 may generally rest very near or gently against the surface of the seal, but may not puncture the seal, as shown in Figure 3D. The probe 328 tip may be sharp and in some cases may be generally very sharp. When pressure dispense begins, such as by introducing a gas into the annular space between the liner and overpack, the pressure introduced into the annular space may compress the liner walls and force the material in the liner upward generally pushing the flexible seal up toward the sharp tip of the connector probe 328, thereby puncturing the seal and allowing the contents of the liner to be dispensed. Advantageously, this embodiment may help keep substantially any air from being introduced into the material of the liner prior to actual dispense.

**[066]** One particular embodiment of the present disclosure is shown in Figure 3E. The liner-based system may include some or all of an overpack 346, a liner 348, positioning device 378, cap 354, holding cap 352, dispense connector 356, and an absorbent 374. The overpack 346 may be comprised of any suitable material or combination of materials including those described herein. For example, the overpack may be comprised of metal or may be blow molded from PE. The mouth of the overpack 346 may be large enough to allow a liner 348 to be inserted therethrough when the liner is in a collapsed state. The liner 348 may be any suitable liner comprised of any suitable material described herein. In one embodiment, the liner may be a liner with pre-folds, for example, that may allow the liner to collapse, inflate, and re-collapse in a predetermined manner, as described in International PCT Appl. No. PCT/US11/55558, previously incorporated herein in its entirety. The liner

348 may include a septum seal 366. The septum seal may be comprised of any suitable material, including but not limited to a silicone septum. In some embodiments, the seal may further include a foil barrier 368. The foil barrier 368 may help lower permeation across the septum so as to maintain the purity and/or sterility of the material in the liner. The cap 354 may include a fill inlet, a pressure port 364, and/or a vent, and may generally hold the liner 348 in place inside of the overpack 346. One or more additional closures and/or holders may couple with the cap 354 for filling and/or dispensing material from the liner. For example, a holding cap 352 may be secured to the cap 354. A fill and/or dispense connector 356 may then be coupled to the cap 354 and/or the holding cap 352, in some embodiments. In other embodiments, the cap 354 may not need a holding cap 352 and may itself be directly compatible with a connector 356. The connector 356 may include a plunger 360. The plunger may include a piercing “needle”-tipped probe that may penetrate the septum seal 366. When the tip is piercing the septum seal, the plunger may be lowered with the “needle” tip in order to prevent bubbles from entering the dispensing connector. The plunger may then be withdrawn from the tip area to allow flow after insertion of the tip into the liner.

**[067]** An absorbent, desiccant or getter 374 may be positioned in the annular space between the liner 346 and the overpack 348. The getter 374 may generally absorb moisture and/or oxygen and thereby prevent the moisture from seeping into the liner and contaminating the contents of the liner. One or more getters and/or absorbents may be used.

**[068]** The liner-based system 344 may also include one or more positioning devices 378 that may help stabilize the liner within the overpack 346. The positioning devices 378 may be comprised of any suitable material including, but not limited to plastic, metal, rubber, wood, or any other suitable material. The device 378 may take any suitable shape and/or configuration such that the device may help position and in some cases vertically position and/or stabilize the liner within the overpack. For example, in some embodiments the bottom of the liner may be rounded, or have another geometry that may be generally different than the bottom of the overpack. Accordingly, a positioning device may be shaped and placed in such a manner as to fill any void area in the overpack that is not taken up by the liner, for example. Other embodiments of liner-based systems disclosed herein may include one or more of the features discussed with reference to the embodiment shown in Figure 3E.

**[069]** In another embodiment, a closure/connector assembly may include a closure 400, as shown in Figure 4 and/or a dispense connector 500, as shown in Figure 5. The closure 400, shown in Figure 4, may include a vent 412, a reservoir 416, and a cap 422, in some embodiments. Accordingly, in some embodiments, the closure 400 may be used as a fill connector for filling as well as a closure or cap that may be used during storage and/or shipping. The closure 400 may be comprised of any suitable material, such as metal, plastic, or any other material or combination of materials. In some embodiments, the closure 400 may be comprised of a material that may be suitable for use in a sterile environment, such as those listed above, or any other suitable material, or combination of materials.

**[070]** As was described above, the typical use cycle for a liner-based system may include filling a liner with material, typically by using a fill connector coupled to the liner and/or an overpack; sealing the liner-based system with a closure or cap for storage and/or transport, by either integrating the closure with the fill connector, or by removing the fill connector and securing a separate closure; transporting the secured filled container to an end-user for dispense, whereby the end-user may, in some cases, remove the fill connector and/or closure and affix a dispense connector prior to dispense.

**[071]** As previously stated, the closure 400 may be used as a fill connector that may also include advantageous features for storage and/or transport. In some embodiments the closure 400 may include a vent 412, for example and integrated vent as shown, that may allow a gas, for example air, or nitrogen (N<sub>2</sub>) to escape during and/or after the filling process. As discussed above, gas that may become trapped in a filled container may generally be referred to as headspace. Headspace may be undesirable because the gas may cause foaming, bubbling, stress, protein damage, and/or gas contamination of the material, for example, which can be highly undesirable where maintaining the purity of the contents of the system is important. The negative consequences of headspace may be increased when the filled container is transported, as a result of the movement of the contents of the container during transport, which may further agitate the gas, and consequently contaminate the contents of the liner. Accordingly, removing headspace may be advantageous or highly advantageous. The headspace may be removed by introducing a suitable gas or fluid into the annular space between the liner and the overpack once the liner has been filled. The increased pressure in the annular space may push the liner in upon

itself, thereby forcing out any excess gas in the liner. In some embodiments, the excess gas in the liner may escape through the vent 412.

**[072]** In some embodiments, once the headspace is removed via the vent as described above, overflow of the contents of the container may collect in the reservoir 416. Overflow may be described as the portion of the contents of a filled liner that may not fit within the liner as a result of excess material or folds in the liner, for example. Alternately, or in addition, overflow may occur as a result of the process to remove headspace as discussed above. Typically, overflow is undesirable because the overflow material is not usable. However, in some embodiments and applications, overflow may advantageously be used to help seal the system for storage and/or transport. For example, where the contents of the liner are an adhesive, for example, and particularly a reactive adhesive that requires curing, for example by ultraviolet light, the overflow that flows into the reservoir 416 as a result of the headspace removal process may be cured. Curing the overflow adhesive may result in a seal being created that may secure the contents of the liner for storage and/or shipping. Once such a seal has been created, in some embodiments, a cap 422 may be secured to the closure for storage and/or transport. The cap 422 may couple to the closure 400 by any suitable means, including by snap fit, complementary threading, or any other suitable method or combination of methods.

**[073]** Once the headspace gas has been removed via the vent 412, the seal has been created in the reservoir 416 in some embodiments, and the cap 422 has been secured, the filled container may be transported to the end user. When the end user is ready to dispense some or all of the contents of the liner, the closure 400 may be removed, and replaced with a dispense connector 500 as shown in Figure 5.

**[074]** The dispense connector 500 may be any suitable dispense connector 500 that may be compatible for use with the desired method of dispense including, for example, pressure dispense, pressure-assisted pump dispense, pump dispense, inverted dispense, pouring, or any other method of dispense, as described previously herein. For example, as may be seen in Figure 5, in some embodiments, a dispense connector configured for pressure dispense may be coupled to the container for dispense. Such a pressure dispense connector may include dispense features that allow for pressure dispense as were described earlier with regard to the previous embodiment. In some embodiments the dispense connector may be disposable and

configured for a one-time use; however, in other embodiments the dispense connector is typically configured for repeated use.

**[075]** The dispense connector may be comprised of any suitable material, such as metal, plastic, or any other material or combination of materials. In some embodiments, the dispense connector may be comprised of a material that may be suitable for use in a sterile environment, such as those listed above, or any other suitable material, or combination of materials.

**[076]** Embodiments of liners of the present disclosure, in some cases, may be dispensed at pressures less than about 100 psi, or more preferably at pressures less than about 50 psi, and still more preferably at pressures less than about 20 psi. In some cases, the contents of the liners of some embodiments, however, may be dispensed at significantly lower pressures, as may be desirable, depending on the intended use or application involved.

**[077]** In additional embodiments, a dispense assembly, including the connector, may also include control components to control the incoming gas and outgoing liquid. For example, a controller can be operably coupled to control components to control the dispense of the liquid from the liner. One or more transducers may also be included in some embodiments to sense the inlet and/or outlet pressure. In this regard, such control components may be utilized to detect when the liner is near empty. Means for controlling such dispense of fluid from the liner and determining when a liner nears empty are described for example in U.S. Patent Number 7,172,096, entitled "Liquid Dispensing System," issued February 6, 2007 and PCT Application Number PCT/US07/70911, entitled "Liquid Dispensing Systems Encompassing Gas Removal," with an international filing date of June 11, 2007, each of which is hereby incorporated herein by reference in its entirety, and International Patent Application No. PCT/US2011/055558, hereby incorporated herein in its entirety.

**[078]** In an additional or alternative embodiment, shown in Figure 6, an empty detect mechanism may include a liner and overpack system 602 that may be operably connected to an indirect pressure dispensing assembly 604. The dispense assembly 604 may include a pressure transducer or sensor 606, a pressure solenoid or other control valve 608, and a vent solenoid or other control valve 610. A microcontroller may be used to control the pressure solenoid 608 and/or the vent solenoid 610. The outlet liquid pressure may be read and measured by the pressure

transducer 606. If the pressure is too low, i.e. lower than a set value, the pressure solenoid 608 may be turned on for a period of time ( $P_{on}$ ), thereby causing more pressurizing gas or other substance to be introduced into the annular space between the overpack and liner and raising the outlet liquid pressure. If the pressure is too high, i.e. higher than a predetermined value, the vent solenoid 610 may be turned on for a period of time ( $P_{vent}$ ), somewhat relieving the pressure in the annular space between the overpack and liner, and thus the outlet liquid pressure. As may be seen in Figure 7, as the contents of the liner near empty, the liquid pressure drops 710. The drop in liquid pressure triggers the pressure solenoid to turn on for a longer period of time. The increase in the time that the pressure solenoid is turned on ( $P_{on}$ ) rises rapidly as the liner nears empty 712. Accordingly, the amount of time that the pressure valve is on ( $P_{on}$ ) may be used to determine when the endpoint of the dispense has been reached.

**[079]** Alternatively or additionally, the frequency of the on/off switching of the inlet pressure solenoid may be monitored. As indicated above, as the liner approaches empty, the inlet pressure will need to increase in order to maintain the constant liquid outlet pressure. The inlet pressure solenoid may thus switch on/off at a higher frequency as the liner nears empty to permit the required amount of pressurized gas into the annular space between the liner and the container. This frequency of the on/off switching can be a useful empty detect indicator. Empty detect mechanisms such as those disclosed herein, may help save time and energy, and consequently money.

**[080]** After dispense is completed or substantially completed and the liner is empty or substantially empty, the end-user may dispose of the liner-based system, and/or recycle or reuse some or all of the liner-based system, including some or all of the closure/connector assembly. In order to assist in making the dispensers described herein more sustainable, the dispensers or one or more components thereof, including any overpack, liner(s), handles, etc., may be manufactured from biodegradable materials or biodegradable polymers, including but not limited to: polyhydroxyalkanoates (PHAs), like poly-3-hydroxybutyrate (PHB), polyhydroxyvalerate (PHV), and polyhydroxyhexanoate (PHH); polylactic acid (PLA); polybutylene succinate (PBS); polycaprolactone (PCL); polyanhydrides; polyvinyl alcohol; starch derivatives; cellulose esters, like cellulose acetate and nitrocellulose and their derivatives (celluloid); etc. Similarly, in some embodiments,

and if suitable for the industry application, the dispensers or one or more components thereof may be manufactured from materials that can be recycled or recovered, and in some embodiments, used in another process by the same or a different end user, thereby allowing such end user(s) to lessen their impact on the environment or lower their overall emissions. For example, in one embodiment, the dispensers or one or more components thereof may be manufactured from materials that may be incinerated, such that the heat generated therefrom may be captured and incorporated or used in another process by the same or different end user. In general the dispensers or one or more components thereof may be manufactured from materials that can be recycled, or that may be converted into raw materials that may be used again.

**[081]** In one embodiment of the present disclosure a storage and dispense system 800 may include an additional optional packaging element 820, in which the liner and overpack 802 may be positioned. The packaging element 820 may be used to store, transport, and/or carry the liner and overpack 802, in some cases relatively easily. The packaging element 820 may generally be a box configured from a corrugated material, such as but not limited to cardboard. However, in other embodiments, the packaging element 820 may be comprised of any suitable material or combination of materials including paper, wood, metal, glass, or plastic, for example. The packaging element 820 may include one or more reinforcing elements 830 that may provide support and/or stability for the liner and overpack 802 disposed therein. A reinforcing element 830 may be positioned at any appropriate or desired height in the packaging element 820. For example, as may be seen in Figure 8, one reinforcing element 830 may be provided near the top of the body of the overpack and liner 802. However, in other embodiments, one or more reinforcing elements may be positioned at other areas of the overpack, for example at the bottom of the overpack, or the middle of the overpack. In still another embodiment, the reinforcing element may generally fill substantially all of, or some portion of the space not taken up by the liner and overpack. The reinforcing element(s) 830 may be comprised of any suitable material or combination of materials, such as but not limited to the materials listed above for the packaging element. In some embodiments, the reinforcing element(s) 830 may be comprised of the same material as the remainder of the packaging element 820, although use of the same materials is not necessary. The packaging element 820 may also have one or more handles or handle slots/openings 840 that may make the packaging element 820 relatively easy to move and/or carry. The

packaging element 820 may be any desired shape, and in some cases may be a generally rectangular box, as shown. A plurality of systems, such as those shown in Figure 8, may be easily and conveniently packed for storage and/or shipping due to the rectangular box shape of the packaging element. Additionally, the packaging element may further protect the liner and overpack disposed therein from exposure, such as exposure to potentially harmful UV rays.

**[082]** In some embodiments including a packaging element 820, the liner and overpack system may not include a handle or chime because the storage unit 820 may provide handle slots/openings and the support otherwise provided by the chime. Accordingly, a cost associated with the liner and overpack related to the handle and/or chime may be reduced or eliminated in such embodiments. Nonetheless, in other embodiments, the liner and overpack may still include a handle and/or chime in embodiments including a packaging element.

**[083]** To aid in dispense, such as but not limited to, in pump dispense applications, any of the liner-based systems of the present disclosure may include an embodiment that has a dip tube extending any suitable distance into the liner. In other embodiments, the liner-based systems of the present disclosure may not include a dip tube, such as for some pressure dispense or inverted dispense applications. In alternative embodiments, each embodiment of a potentially self-supporting liner described herein, may be shipped without an overpack and placed in a pressurizing vessel at the receiving facility in order to dispense the contents of the liner.

**[084]** In some embodiments, the liner-based systems described above may also include features for helping prevent or limit choke-off. Generally speaking, choke-off may be described as what occurs when a liner ultimately collapses on itself, or a structure internal to the liner, to form a choke point disposed above a substantial amount of liquid. When choke-off occurs, it may preclude complete utilization of the liquid disposed within the liner, which can be a significant problem, as many materials used in the biotechnology and/or pharmaceutical industry, for example, can be very expensive. A variety of ways of preventing or handling choke-off are described in PCT Application Number PCT/US08/52506, entitled, "Prevention Of Liner Choke-off In Liner-based Pressure Dispensation System," with an international filing date of January 30, 2008, which is hereby incorporated herein by reference in its entirety. Additional ways of preventing or handling choke-off are described in International PCT Appl. No. PCT/US11/55558, titled, "Substantially Rigid

Collapsible Liner, Container and/or Liner for Replacing Glass Bottles, and Enhanced Flexible Liners,” filed October 10, 2011, which was previously incorporated herein by reference in its entirety.

**[085]** In some embodiments, the controlled and varied introduction of pressurized gas or liquid into the annular space between the inside of the container wall and the outside of the liner wall may be used to mix the contents of the liner. For example, a controlled cycle of pressurization and depressurization resulting in compression and relaxation of the liner may cause the contents of the liner to mix. In use, this embodiment would allow for the sterile mixing of the contents of the liner without the need for impellers or paddles. Because introducing objects into the interior of the liner may increase the risk of contamination, not needing to introduce impellers or paddles into the liner may advantageously help minimize the risk of contamination.

**[086]** In some embodiments, the dispensers described herein may include symbols and/or writing that is molded into the dispensers or one or more components thereof. Such symbols and/or writing may include, but is not limited to names, logos, instructions, warnings, etc. Such molding may be done during or after the manufacturing process of the dispensers or one or more components thereof. In one embodiment, such molding may be readily accomplished during the fabrication process by, for example, embossing the mold for the dispensers or one or more components thereof. The molded symbols and/or writing may be used, for example, to differentiate products.

**[087]** In some embodiments, one or more colors and/or absorbant materials may be added to the materials of the dispensers or one or more components thereof during or after the manufacturing process to help protect the contents of the dispensers from the external environment, to decorate the dispensers, or to use as an indicator or identifier of the contents within the dispensers or otherwise to differentiate multiple dispensers, etc. Colors may be added using, for example, dyes, pigments, nanoparticles, or any other suitable mechanism. Absorbant materials may include materials that absorb ultraviolet light, infrared light, and/or radio frequency signals, etc.

**[088]** Similarly, in some embodiments, the dispensers or one or more components thereof may be provided with different textures or finishes. As with color and molded symbols and/or writing, the different textures or finishes may be

used to differentiate products, to provide an indicator of the contents provided within the dispensers, or to identify for which application or applications the contents are to be used, etc. In one embodiment, the texture or finish may be designed to be a substantially non-slip texture or finish or the like, and including or adding such a texture or finish to the dispensers or one or more components thereof may help improve graspability or handling of the packaging system, and thereby reduce or minimize the risk of dropping of the dispensers. The texture or finish may be readily accomplished during the fabrication process by, for example, providing a mold for the dispensers or one or more components thereof with the appropriate surface features. In other embodiments, the molded dispensers may be coated with the texture or finish. In some embodiments, the texture or finish may be provided on substantially the entire dispenser or substantially the entirety of one or more components thereof. However, in other embodiments, the texture or finish may be provided on only a portion of the dispenser or a portion of one or more components thereof.

**[089]** Similarly, in some embodiments, the exterior and/or interior walls of the dispensers or one or more components thereof may have any suitable coating provided thereon. The coating may increase material compatibility, decrease permeability, increase strength, increase pinhole resistance, increase stability, provide anti-static capabilities or otherwise reduce static, etc. Such coatings can include coatings of polymers or plastic, metal, glass, adhesives, etc. and may be applied during the manufacturing process by, for example coating a preform used in blow-molding, or may be applied post manufacturing, such as by spraying, dipping, filling, etc.

**[090]** In some embodiments, the liner-based system may include one or more handles, which may be operably or integrally attached with the liner and/or overpack. The one or more handles can be of any shape or size, and may be located at any suitable position on the dispensers. Types of handles can include, but are not limited to, handles that are located at the top and/or sides; are ergonomic; are removable or detachable; are molded into the dispensers or are provided after fabrication of the dispensers (such as by, for example, snap fit, adhesive, riveting, screwed on, bayonet-fit, etc.); etc. Different handles and/or handling options can be provided and may depend on, for example but not limited to, the anticipated contents of the dispenser, the application for the dispensers, the size and shape of the dispensers, the anticipated

dispensing system for the dispensers, etc. A handle may provide means for more easily lifting or transporting the overpack and/or liner.

**[091]** In order to assist in making the dispensers described herein more sustainable, the dispensers or one or more components thereof, including any overpack, liner(s), handles, etc., may be manufactured from biodegradable materials or biodegradable polymers, including but not limited to: polyhydroxyalkanoates (PHAs), like poly-3-hydroxybutyrate (PHB), polyhydroxyvalerate (PHV), and polyhydroxyhexanoate (PHH); polylactic acid (PLA); polybutylene succinate (PBS); polycaprolactone (PCL); polyanhydrides; polyvinyl alcohol; starch derivatives; cellulose esters, like cellulose acetate and nitrocellulose and their derivatives (celluloid); etc.

**[092]** In some embodiments, the dispensers may include two or more layers, such as an overpack and a liner, multiple overpacks, or multiple liners. In further embodiments, a dispenser may include at least three layers, which may help ensure enhanced containment of the contents therein, increase structural strength, and/or decrease permeability, etc. Any of the layers may be made from the same or different materials, such as but not limited to, the materials previously discussed herein.

**[093]** In some embodiments, and if suitable for the industry application, the dispensers or one or more components thereof may be manufactured from materials that can be recycled or recovered, and in some embodiments, used in another process by the same or a different end user, thereby allowing such end user(s) to lessen their impact on the environment or lower their overall emissions. For example, in one embodiment, the dispensers or one or more components thereof may be manufactured from materials that may be incinerated, such that the heat generated therefrom may be captured and incorporated or used in another process by the same or different end user. In general the dispensers or one or more components thereof may be manufactured from materials that can be recycled, or that may be converted into raw materials that may be used again.

**[094]** In some embodiments, structural features may be designed into the dispensers that add strength and integrity to the dispensers or one or more components thereof. For example, the base (or chime in some embodiments), top, and sides of the dispensers may all be areas that experience increased shake and external forces during filling, transportation, installation, and use (e.g., dispensing). Accordingly, in one embodiment, added thickness or structural edifices (e.g., bridge tressel design) may be

added to support stressed regions of the dispensers, which can add strength and integrity to the dispensers. Furthermore, any connection region in the dispensers may also experience increased stress during use. Accordingly, any of these such regions may include structural features that add strength through, for example, increased thickness and/or specifically tailored designs. In further embodiments, the use of triangular shapes could be used to add increased strength to any of the above described structures; however, other designs or mechanical support features may be used.

**[095]** In some embodiments, the dispensers or one or more components thereof, including any overpack or liner(s), may include reinforcement features, such as but not limited to, a mesh, fiber(s), epoxy, or resin, etc. that may be integrated or added to the dispensers or one or more components thereof, or portions thereof, in order to add reinforcement or strength. Such reinforcement may assist in high pressure dispense applications, or in applications for dispensing high viscosity contents or corrosive contents.

**[096]** In some embodiments, the dispensers may include level sensing features or sensors. Such level sensing features or sensors may use visual, electronic, ultrasonic, or other suitable mechanisms for identifying, indicating, or determining the level of the contents stored in the dispensers. For example, in one embodiment, the dispensers or a portion thereof may be made from a substantially translucent or transparent material that may be used to view the level of the contents stored therein.

**[097]** In further embodiments, flow metering technology may be integrated into or operably coupled with the connectors for a direct measurement of material being delivered from the packaging system to a downstream process. A direct measurement of the material being delivered could provide the end user with data which may help ensure process repeatability or reproducibility. In one embodiment, the flow meter may provide an analog or digital readout of the material flow. The flow meter, or other component of the system, can take the characteristics of the material (including but not limited to viscosity and concentration) and other flow parameters into consideration to provide an accurate flow measurement. Additionally, or alternatively, the flow meter can be configured to work with, and accurately measure, a specific material stored and dispensed from the dispenser. In one embodiment, the inlet pressure can be cycled, or adjusted, to maintain a substantially constant outlet pressure or flow rate.

**[0098]** The various shipping and dispensing system embodiments of the present disclosure have several advantages over traditional packaging systems. Many of the advantages have been noted throughout the application and include, but are not limited to the above advantages of the disclosed liner-based system coupled with a closure/connector that may allow for compatibility with existing dispense systems in particular industries, for example, the adhesives industry or food industry. Other advantages will be recognized by those skilled in the art and may vary from industry application to industry application.

**[0099]** Some embodiments of the features described above are described in further detail in International PCT Appl. No. PCT/US11/55558, titled, “Substantially Rigid Collapsible Liner, Container and/or Liner for Replacing Glass Bottles, and Enhanced Flexible Liners,” filed October 10, 2011, which was previously incorporated herein by reference in its entirety.

**[0100]** In the foregoing description various embodiments of the invention have been presented for the purpose of illustration and description. They are not intended to be exhaustive or to limit the invention to the precise form disclosed. Obvious modifications or variations are possible in light of the above teachings. The embodiments were chosen and described to provide the best illustration of the principals of the invention and its practical application, and to enable one of ordinary skill in the art to utilize the invention in various embodiments and with various modifications as are suited to the particular use contemplated. All such modifications and variations are within the scope of the invention as determined by the appended claims when interpreted in accordance with the breadth they are fairly, legally, and equitably entitled.

### Claims

What is claimed is:

1. A method for removing headspace gas from a liner-based assembly comprising an overpack, a liner positioned within the overpack and containing a material and headspace gas, and a closure for sealing the liner, the method comprising:
  - providing a one-way valve in fluid communication with the interior of the liner and permitting flow in a direction out of the interior of the liner;
  - applying a vacuum to the one-way valve to evacuate headspace gas from the interior of the liner.
2. The method of claim 1, wherein the liner-based assembly further comprises a port in fluid communication with an annular space between the overpack and liner, and further comprising capping the port.
3. A liner-based assembly configured for headspace gas removal, the liner-based assembly comprising:
  - an overpack;
  - a liner positioned within the overpack;
  - a closure configured for removable coupling with the liner for sealing the liner; and
  - a one-way valve in fluid communication with the interior of the liner permitting flow in a direction out of the interior of the liner.
4. The liner-based assembly of claim 3, wherein the one-way valve is coupled with the closure.
5. The liner-based assembly of claim 4, further comprising a port in fluid communication with an annular space between the overpack and liner.

6. The liner-based assembly of claim 5, wherein the port is temporarily capped for headspace gas removal.
7. A method for filling a container assembly, the method comprising:
  - heating a material to a predetermined temperature and filling the container with the material at the predetermined temperature;
  - sealing the container; and
  - subsequent sealing the container, permitting the material in the container to cool.
8. The method of claim 7, wherein the predetermined temperature is between about 40-60 °C.
9. The method of claim 8, wherein the material is permitted to cool to generally ambient room temperature of a room in which the container is located.
10. The method of claim 7, further comprising filling the container with the material substantially to the top, such that substantially no excess space is provided for headspace gas.
11. The method of claim 7, further comprising, subsequent sealing of the container, removing headspace gas.
12. A liner-based assembly for use with pressure dispense comprising:
  - an overpack;
  - a liner disposed within the overpack; and
  - a closure assembly securable to at least one of the overpack and the liner, the closure assembly including a headspace vent and a reservoir, the reservoir configured to collect an overflow of material stored within the interior of the liner;wherein the closure assembly is configured to form a seal to the liner by curing the overflow of material in the reservoir.

13. The liner-based assembly of claim 12, wherein the material is an adhesive.
14. The liner-based assembly of claim 13, further comprising a cap configured for removably sealing the reservoir.
15. A method for filling and sealing a container comprising:
  - filling the container with an adhesive;
  - operably coupling a closure assembly to the container, the closure assembly comprising a reservoir configured to collect an overflow of the adhesive;
  - at least one of permitting or causing a portion of the adhesive in the container to flow into the reservoir of the closure assembly; and
  - curing the overflow of adhesive in the reservoir to form a seal for the container.
16. The method of claim 15, further comprising capping the closure assembly to removably seal the reservoir.
17. A liner-based assembly for use with pressure dispense comprising:
  - an overpack;
  - a liner disposed within the overpack; and
  - a cap assembly securable to at least one of the overpack and the liner, the cap assembly comprising a closure and a plug member, wherein the closure includes a mouth configured to detachably couple to a dispense connector and to also detachably couple to the plug member, wherein the plug is configured to substantially completely fill the mouth of the closure.
18. The liner-based assembly of claim 17, wherein the liner contains an edible food substance, and the dispense connector is configured for dispensing food substances.
19. A method for dispensing the contents of a liner-based assembly, the method comprising:

providing a liner having a desired substance stored therein, the liner being disposed within an overpack and comprising a liner neck with a seal secured thereto;

securing a dispense connector to the liner neck, such that a probe on the dispense connector is initially positioned adjacent to, but not piercing, the seal in the liner neck, but is positioned such that when the substance is dispensed by pressure dispense, the seal flexes upward against the probe, and the probe pierces the seal to permit dispense of the substance.

20. The method of claim 19, wherein the substance is dispensed by indirect pressure dispense, wherein a pressure is applied to the annular space between the liner and overpack.