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Container End Closure Sealing Liner and Methods of Preparing the Same

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CONTAINER END CLOSURE SEALING LINER AND METHODS OF PREPARING THE SAME

TECHNICAL FIELD

[0001] The present disclosure relates to metalworking generally and more specifically to laminating metal strips and preparing metal end closures therefrom. The present disclosure also relates to metal containers and non-metal containers, such as glass bottles or plastic bottles.

BACKGROUND

[0002] Certain container products, such as beverage containers, may require a seal between a body of the container and a cap of the container. The seal can prevent beverages from leaking from the container and can avoid undesirable effects to the beverage, such as discoloration or change in taste. Traditionally, methods of providing a liner have included inserting a plastic or multi-layered material over an opening of the body of a container that is separate from the cap and the body. Problems of current methods include cost, liner placement (e.g., product spoilage due to misaligned liners over the opening), additional processing (e.g., insertion and bonding of the liner), equipment maintenance, and high energy consumption.

SUMMARY

[0003] Covered embodiments of the invention are defined by the claims, not this summary. This summary is a high-level overview of various aspects of the invention and introduces some of the concepts that are further described in the Detailed Description section below. This summary is not intended to identify key or essential features of the claimed subject matter, nor is it intended to be used in isolation to determine the scope of the claimed subject matter. The subject matter should be understood by reference to appropriate portions of the entire specification, any or all drawings, and each claim.

[0004] Disclosed herein is a container, including a body having a sealable opening, a body inner surface, and a body outer surface. The container also includes an end closure having a closure inner surface and a closure outer surface, where the sealable opening is configured to receive the end closure. In certain embodiments, when the end closure is assembled with the body, at least a

portion of the end closure inner surface covers and/or contacts at least a portion of the body outer surface. In some embodiments, the closure inner surface of the end closure includes a liner, which may be a polymer film that contacts the body outer surface to form a body seal between the end closure and the body. In some cases, the container can be a beverage bottle and the end closure can be a beverage closure such as a cap or other suitable closure.

[0005] In certain aspects, the polymer film may be provided on an entirety of the closure inner surface of the end closure, although in other embodiments, the polymer film may be provided on less than the entire closure inner surface. In some embodiments, the polymer film may optionally be provided on those portions of the end closure that contact the body when the end closure is assembled with the body. In some examples, the end closure may optionally engage a portion of the body proximate to the sealable opening. In some cases, the polymer film may be up to 200 microns thick, such as from 30 to 200 microns thick or from 30 to 125 microns thick. In some non-limiting embodiments, the polymer film may be a polyethylene terephthalate (PET) film or a polypropylene (PP) film.

[0006] Also described herein is a method for preparing a container having a body and an end closure with a liner. The method may include providing a body having a sealable opening, a body inner surface, and a body outer surface. The method also includes providing an end closure having a closure inner surface, and a closure outer surface, and laminating the closure inner surface of the end closure with the liner, which may be a polymer film. The method may include sealing the body with the end closure to provide a sealed container by contacting the polymer film on the closure inner surface to the body outer surface of the body.

[0007] In some cases, the polymer film of the liner is optionally a PET film or a PP film. Laminating the closure inner surface of the end closure with the polymer film may include a hot-melt lamination process. In some cases, the polymer film contacts an entirety of the closure inner surface of the end closure, although it need not in other embodiments. In certain examples, the container may be a beverage bottle, and the end closure includes a beverage closure. In some examples, the end closure includes an aluminum alloy. In some cases, the polymer film is up to 200 microns thick, such as from 30 to 200 microns thick or from 30 to 125 microns thick.

[0008] In certain aspects, contacting the polymer film on the product-facing side to the body outer surface of the body optionally provides an air-tight closure.

[0009] Also described herein is an end closure for a container that includes a closure inner surface, a closure outer surface, and a liner including a polymer film on the closure inner surface. The end closure is configured to cover a sealable opening of the container, and the polymer film on the closure inner surface is configured to contact a body outer surface of the container to form a body seal.

DETAILED DESCRIPTION

[0010] Described herein are containers with improved end closures and methods for preparing the same. The end closures described herein address the problems associated with existing containers and their preparation methods. For example, end closures for containers described herein can be prepared at a lower cost with lower energy consumption than existing containers. The end closures provided herein may also have improved recyclability. In addition, the end closure can include a liner along an inner surface of the end closure to provide a seal for the container. The liner can reduce a need for any additional material to be added over a sealable opening of a body of the container, thus reducing material usage and cost.

[0011] A body of the container includes a sealable opening, a body inner surface (e.g., an inside), and a body outer surface (e.g., an outside). The end closure includes a closure inner surface and a closure outer surface. The end closure may selectively engage the body proximate to the sealable opening such that the sealable opening is selectively sealed.

[0012] The container may be constructed from various materials as desired including, but not limited to, various metals, glass, various plastics, etc. In some embodiments, the container may be constructed from metals including, but not limited to, aluminum, an aluminum alloy, magnesium, a magnesium-based material, titanium, a titanium-based material, copper, a copper-based material, steel, a steel-based material, bronze, a bronze-based material, brass, a brass-based material, combinations thereof, or other metals as desired. In some cases, the container is an aluminum alloy, such as a 1xxx series aluminum alloy, a 3xxx series aluminum alloy, or a 5xxx series aluminum alloy. In other embodiments, the container may be constructed from a non-metallic material such as glass, plastic, composites, or any other material or combination of materials as desired.

[0013] In various non-limiting examples, the container includes an opening to an internal cavity or chamber. The container can have any suitable body shape, including, but not limited to, a cylinder, a cube, a cuboid, a sphere, a cone, a tetrahedron, a pyramid, any other suitable three-dimensional (3-D) shape, or any combination thereof. Accordingly, the container closure can be

formed into any shape suitable to form a closure for the container body. For example, the closure for the container body can be a disc (e.g., to seal a cylinder), a square (e.g., to seal a cube), a rectangle (e.g., to seal a cuboid), a hemisphere (e.g., to seal a sphere), a cone top (e.g., to seal a cone), a tetrahedron top (e.g., to seal a tetrahedron), a pyramid top (e.g., to seal a pyramid), any suitable closure that is complementary to a body (e.g., a closure that completes the shape of the body when joined together), or any combination thereof.

[0014] The container can be containers for various types of products as desired, including, but not limited to, a beverage can (e.g., a soda can, a water can, an alcoholic beverage can, any pressurized beverage can, or any non-pressurized beverage can), a glass bottle (e.g., a water bottle, a soda bottle, an alcoholic beverage bottle, a chemical storage bottle, or the like), a food storage can (e.g., a canned vegetable can, a canned meat can, a sardine can, a pet food can, or an emergency provisions can), an aerosol can (e.g., a cooking spray can, a hairspray can, a lubricant can, or a whipped product can), a chemical storage can (e.g., a weak acid storage can, a weak base storage can, a solvent storage can, or any chemical suitable for use with a polymer film liner, such as a chemical that does not degrade the polymer film), any suitable metal container, any suitable glass container, any suitable plastic container, containers formed from other materials, or any combination thereof.

[0015] In some non-limiting examples, the end closure described herein is a closure for the sealable opening of the container such that any product stored within the container can be retrieved as desired through the opening. In various cases, the closure is a resealable closure. For example, the resealable closure can be a threaded closure (e.g., a twist-off cap), a bottle rolled-on pilfer proof closure, a clamp closure, a hinged closure, a snap-on closure, or any combination thereof. As mentioned, the closure inner surface of the end closure includes a polymer film liner that is laminated thereon. When the container is assembled, the end closure engages the container body and covers the opening of the container body, and the polymer film liner contacts the container body.

[0016] FIG. 1 illustrates an embodiment of an end closure 100. As illustrated in FIG. 1, the end closure 100 includes a closure inner surface 102 and a closure outer surface 104. Optionally, the end closure 100 includes engagement features 101 that may engage corresponding portions or features on a container body. In one non-limiting example, the engagement features 101 may be

threading, although other engagement features 101 may be utilized as desired. The particular shape or profile of the end closure 100 should not be considered limiting.

[0017] A polymer film 106 is provided as a liner on the closure inner surface 102. In certain embodiments, the polymer film 106 is provided on an entirety of the closure inner surface 102. In other embodiments, the polymer film 106 need not be provided on the entire closure inner surface 102, and portions of the closure inner surface 102 may not be covered by the polymer film 106. In certain aspects, the polymer film 106 is optionally provided on at least those portions of the end closure 100 that are configured to contact the body of the container.

[0018] The polymer film 106 may be various suitable materials as desired. In certain embodiments, the polymer film 106 may be materials suitable for selectively forming a seal between the end closure 100 and the body of the container when the end closure 100 is assembled on the body of the container. Thus, sealing the container with the end closure 100 having the polymer film 106 on the closure inner surface 102 of the end closure 100 further provides a body seal.

[0019] In some examples, the polymer film 106 may include a natural polymer or a synthetic polymer. In some non-limiting examples, the polymer film 106 can be prepared from a homopolymer or a copolymer. Suitable homopolymers include, but are not limited to, polyesters (e.g., PET), polypropylenes, epoxies, polyurethanes, polyvinyls, polyacrylics, polyamides, polyolefins, and silicones. In some cases, the polyesters optionally may be hot melt polyesters. In some cases, the polymer film 106 may include copolymers. Suitable copolymers as described herein include, but are not limited to, block copolymers, random copolymers, graft copolymers, copolymer blends, statistical copolymers, periodic copolymers, alternating copolymers, star copolymers, starblock copolymers, and/or any combinations thereof. The copolymers may optionally be configured as head-to-head copolymers and/or as head-to-tail copolymers. The copolymers may have any suitable structure, or be any suitable isomer thereof (e.g., cis isomers or trans isomers).

[0020] Optionally, the polymer film 106 may be a polyester film. In certain embodiments, the polyester film optionally may be a hot melt polyester film. Optionally, the polymer film 106 can be a PET film or a PP film. In some examples, the polymer film 106 is optionally a PET film includes a polymer derived from ethylene glycol, terephthalic acid, or a terephthalate-containing compound, and optionally one or more additional comonomers. The one or more additional

comonomers can be used to tailor the properties of the film, such as the melting temperature. Exemplary comonomers for use as the additional comonomers can include isophthalic acid, butylene diol, 2-methyl-1,3-propanediol, phthalate, 1,8-naphthalenedicarboxylate, and 1,8-anthracenedicarboxylate, to name a few. Optionally, the polymer film 106 includes a polyethylene naphthalate film.

[0021] In certain aspects, polymers for use as the polymer film 106 can have a weight average molecular weight (M_w) of the copolymers between about 10,000 grams per mole (g/mol) and about 500,000 g/mol. For example, the M_w can be from about 20,000 g/mol to about 400,000 g/mol; from about 30,000 g/mol to about 300,000 g/mol; or from about 40,000 g/mol to about 100,000 g/mol, or any value in between. For example, the M_w can be 10,000 g/mol, 20,000 g/mol, 30,000 g/mol, 40,000 g/mol, 50,000 g/mol, 60,000 g/mol, 70,000 g/mol, 80,000 g/mol, 90,000 g/mol, 100,000 g/mol, 110,000 g/mol, 120,000 g/mol, 130,000 g/mol, 140,000 g/mol, 150,000 g/mol, 160,000 g/mol, 170,000 g/mol, 180,000 g/mol, 190,000 g/mol, 200,000 g/mol, 210,000 g/mol, 220,000 g/mol, 230,000 g/mol, 240,000 g/mol, 250,000 g/mol, 260,000 g/mol, 270,000 g/mol, 280,000 g/mol, 290,000 g/mol, 300,000 g/mol, 310,000 g/mol, 320,000 g/mol, 330,000 g/mol, 340,000 g/mol, 350,000 g/mol, 360,000 g/mol, 370,000 g/mol, 380,000 g/mol, 390,000 g/mol, 400,000 g/mol, 410,000 g/mol, 420,000 g/mol, 430,000 g/mol, 440,000 g/mol, 450,000 g/mol, 460,000 g/mol, 470,000 g/mol, 480,000 g/mol, 490,000 g/mol, or 500,000 g/mol. In other embodiments, polymers for the polymer film 106 may have other weight average molecular weights as desired.

[0022] In certain aspects, the polymer film 106 can have a thickness up to about 200 microns (μm) (e.g., from about 1 μm to about 200 μm, from about 2 μm to about 100 μm, from about 3 μm to about 50 μm, from about 4 μm to about 35 μm, from about 6 μm to about 22 μm, from about 9 μm to about 18 μm, from about 12 μm to about 15 μm, from about 7 μm to about 21 μm, from about 8 μm to about 20 μm, from about 9 μm to about 19 μm, from about 10 μm to about 18 μm, from about 11 μm to about 17 μm, from about 12 μm to about 16 μm, from about 13 μm to about 15 μm, from about 30 μm to about 200 μm, or from about 30 μm to about 125 μm). For example, the polymer film can have a thickness of about 0.5 μm, about 1 μm, about 2 μm, about 3 μm, about 4 μm, about 5 μm, about 6 μm, about 7 μm, about 8 μm, about 9 μm, about 10 μm, about 11 μm, about 12 μm, about 13 μm, about 14 μm, about 15 μm, about 16 μm, about 17 μm, about 18 μm, about 19 μm, about 20 μm, about 21 μm, about 22 μm, about 23 μm, about 24 μm,

about 25 μm, about 26 μm, about 27 μm, about 28 μm, about 29 μm, about 30 μm, about 31 μm, about 32 μm, about 33 μm, about 34 μm, about 35 μm, about 36 μm, about 37 μm, about 38 μm, about 39 μm, about 40 μm, about 41 μm, about 42 μm, about 43 μm, about 44 μm, about 45 μm, about 46 μm, about 47 μm, about 48 μm, about 49 μm, about 50 μm, about 51 μm, about 52 μm, about 53 μm, about 54 μm, about 55 μm, about 56 μm, about 57 μm, about 58 μm, about 59 μm, about 60 μm, about 61 μm, about 62 μm, about 63 μm, about 64 μm, about 65 μm, about 66 μm, about 67 μm, about 68 μm, about 69 μm, about 70 μm, about 71 μm, about 72 μm, about 73 μm, about 74 μm, about 75 μm, about 76 μm, about 77 μm, about 78 μm, about 79 μm, about 80 μm, about 81 μm, about 82 μm, about 83 μm, about 84 μm, about 85 μm, about 86 μm, about 87 μm, about 88 μm, about 89 μm, about 90 μm, about 91 μm, about 92 μm, about 93 μm, about 94 μm, about 95 μm, about 96 μm, about 97 μm, about 98 μm, about 99 μm, about 100 μm, about 101 μm, about 102 μm, about 103 μm, about 104 μm, about 105 μm, about 106 μm, about 107 μm, about 108 μm, about 109 μm, about 110 μm, about 111 μm, about 112 μm, about 113 μm, about 114 μm, about 115 μm, about 116 μm, about 117 μm, about 118 μm, about 119 μm, about 120 μm, about 121 μm, about 122 μm, about 123 μm, about 124 μm, about 125 μm, about 126 μm, about 127 μm, about 128 μm, about 129 μm, about 130 μm, about 131 μm, about 132 μm, about 133 μm, about 134 μm, about 135 μm, about 136 μm, about 137 μm, about 138 μm, about 139 μm, about 140 μm, about 141 μm, about 142 μm, about 143 μm, about 144 μm, about 145 μm, about 146 μm, about 147 μm, about 148 μm, about 149 μm, about 150 μm, about 151 μm, about 152 μm, about 153 μm, about 154 μm, about 155 μm, about 156 μm, about 157 μm, about 158 μm, about 159 μm, about 160 μm, about 161 μm, about 162 μm, about 163 μm, about 164 μm, about 165 μm, about 166 μm, about 167 μm, about 168 μm, about 169 μm, about 170 μm, about 171 μm, about 172 μm, about 173 μm, about 174 μm, about 175 μm, about 176 μm, about 177 μm, about 178 μm, about 179 μm, about 180 μm, about 181 μm, about 182 μm, about 183 μm, about 184 μm, about 185 μm, about 186 μm, about 187 μm, about 188 μm, about 189 μm, about 190 μm, about 191 μm, about 192 μm, about 193 μm, about 194 μm, about 195 μm, about 196 μm, about 197 μm, about 198 μm, about 199 μm, about 200 μm, or anywhere in between. In other embodiments, polymers for the polymer film 106 may have other thicknesses as desired.

[0023] In some non-limiting examples, the polymer film 106 may be resistant to (e.g., does not degrade and/or has a reduced degradation in the presence of) nitrogen gas, carbon dioxide, acidic materials, alkaline materials, solvents, corrosive materials, or materials having a pH of from about

1 to about 14 (e.g., from about 2 to about 13, from about 3 to about 12, from about 4 to about 11, from about 5 to about 10, from about 6 to about 9, or from about 7 to about 8). For example, the polymer film 106 is resistant to materials having a pH of about 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, or anywhere in between. In some cases, the polymer film 106 may be resistant to alcoholic liquids (e.g., alcoholic beverages, solvents, or the like). For example, the polymer film 106 may optionally be resistant to alcoholic liquids containing up to about 50 percent by volume (vol. %) alcohol (e.g., from about to about 4 vol. % to about 40 vol. %, from about 6 vol. % to about 50 vol. %, from about 8 vol. % to about 40 vol. %, from about 10 vol. % to about 35 vol. %, from about 12 vol. % to about 25 vol. %, or from about 15 vol. % to about 20 vol. %). For example, the polymer film 106 may be resistant to alcoholic liquids containing an amount of alcohol of about 1 vol. %, 2 vol. %, 3 vol. %, 4 vol. %, 5 vol. %, 6 vol. %, 7 vol. %, 8 vol. %, 9 vol. %, 10 vol. %, 11 vol. %, 12 vol. %, 13 vol. %, 14 vol. %, 15 vol. %, 16 vol. %, 17 vol. %, 18 vol. %, 19 vol. %, 20 vol. %, 21 vol. %, 22 vol. %, 23 vol. %, 24 vol. %, 25 vol. %, 26 vol. %, 27 vol. %, 28 vol. %, 29 vol. %, 30 vol. %, 31 vol. %, 32 vol. %, 33 vol. %, 34 vol. %, 35 vol. %, 36 vol. %, 37 vol. %, 38 vol. %, 39 vol. %, 40 vol. %, 41 vol. %, 42 vol. %, 43 vol. %, 44 vol. %, 45 vol. %, 46 vol. %, 47 vol. %, 48 vol. %, 49 vol. %, or 50 vol. %.

[0024] In certain aspects, the polymer film 106 may provide a product shelf life of up to about four years (e.g., up to about 6 months, up to about 12 months, up to about 18 months, up to about 24 months, up to about 36 months, or up to about 48 months). For example, the polymer film 106 described herein provides a product shelf life of up to about 1 month, 2 months, 3 months, 4 months, 5 months, 6 months, 7 months, 8 months, 9 months, 10 months, 11 months, 12 months, 13 months, 14 months, 15 months, 16 months, 17 months, 18 months, 19 months, 20 months, 21 months, 22 months, 23 months, 24 months, 25 months, 26 months, 27 months, 28 months, 29 months, 30 months, 31 months, 32 months, 33 months, 34 months, 35 months, 36 months, 37 months, 38 months, 39 months, 40 months, 41 months, 42 months, 43 months, 44 months, 45 months, 46 months, 47 months, or 48 months. In some cases, the polymer film 106 is suitable for products that are consumed as soon as accessible or shortly thereafter (e.g., products having a shelf life of less than 1 month, such as 0 months). In other embodiments, the polymer film 106 may be provided for other durations as desired.

[0025] FIG. 2 illustrates a container 201 having a container body 210 and the end closure 100. In the embodiment of FIG. 2, the container body 210 includes a body inner surface 214 and a body

outer surface 216. The body inner surface 214 may define a receiving area 215 in which a product may be provided. The container body 210 includes an end 213 that defines a sealable opening 212 providing access to the receiving area 215. In certain embodiments, the container body 210 optionally includes engagement features 211 that are configured to selectively engage the engagement features 101 of the end closure 100. The shape, profile, and other features of the container body 210 in FIG. 2 should not be considered limiting, and the container body 210 may have other shapes, profiles, and/or features as desired.

[0026] As illustrated in FIG. 2, the end closure 100 may be assembled with the container body 210. In certain embodiments, the end closure 200 can be removable from and resealable with the container body 210. Optionally, the engagement features 101, 211 may facilitate removal and reattachment of the end closure 200 with the container body 210 as desired. As illustrated in FIG. 2, when the end closure 100 is assembled with the container body 210, the end closure 100 overlaps at least a portion of the container body 210, and the polymer film 106 on a closure inner surface 202 of the end closure 200 contacts at least a portion of the container body 210. Contact of the polymer film 106 with the container body 210 may seal the receiving area 215. In certain embodiments, the polymer film 106 may contact the end 213 of the container body 210 and/or at least a portion of the body outer surface 216. Optionally, the polymer film 106 may contact the engagement features 211 of the container body 210.

[0027] A method of producing the container 201 with end closure 100 having the polymer film liner 106 is also provided herein. The process can be performed on one or more sides of the end closure 100 to result in an end closure 100 that is advantageously laminated on at least a portion of the closure inner surface 102. As described herein, in some cases the closure inner surface 102 may be laminated using the process disclosed herein and the closure outer surface 104 may be produced as desired. As one non-limiting example, the closure outer surface 104 may be lacquered using standard lacquering techniques. In some embodiments, the process of producing the end closure 100 can include the steps of (1) providing the container body 210, (2) providing a blank for the end closure 100, (3) laminating a surface of the blank corresponding to the closure inner surface 102 with the polymer film 106, (4) forming or shaping the laminated blank into the end closure 100, and (5) assembling the end closure 100 with the container body 210 such that the polymer film 106 contacts the container body 210 and forms a seal between the end closure 100 and the container body 210. In certain examples, the process may provide an air-tight closure for

the container 201 (e.g., a closure having an air leak rate of less than about 10^{-6} millibar-liters per second (mbar l/s), less than about 10^{-5} mbar l/s, less than about 10^{-4} mbar l/s, less than about 10^{-3} mbar l/s, less than about 10^{-2} mbar l/s, less than about 10^{-1} mbar l/s, or anywhere in between).

[0028] Optionally, the process can include pre-treating the blank for the end closure 100 with a conversion layer. In some cases, this conversion layer can include compounds of trivalent chromium (Cr(III)) and phosphates. In some cases, this conversion layer can include compounds of titanium and zirconium (Ti/Zr). This optional conversion layer can provide enhanced adhesion, low blushing after pasteurization, and resistance to corrosion when exposed to acids, such as acetic acid or citric acid. In some cases, the end closure can include one or more optional conversion layers located on the product side (e.g., an interior-facing side) and/or the consumer side (e.g., an exterior-facing side).

[0029] Optionally, the process can further include applying an adhesion promoter to the end closure. The adhesion promoter can provide enhanced adhesion in optional downstream coating steps. Adhesion promoters suitable for use in this process include silane-based chemistries, titanium/zirconium (Ti/Zr) based chemistries, and polymer-based chemistries. The adhesion promoter can be applied by dip coating, bar coating, roll coating, spin coating, spray coating, screen coating, drop coating, or using any other suitable coating technique. If the end closure is pre-treated with a conversion layer, the end closure pre-treated with the conversion layer can be further coated with the adhesion promoter as described above.

[0030] In some examples, laminating polymer film 106 may include various lamination techniques as desired. As one non-limiting example, the laminating step can include hot-melt lamination, which can include heating the polymer film 106 to a temperature such that the polymer film 106 is soft and tacky, applying the heated polymer film 106 to at least a portion of the surface of the blank corresponding to the closure inner surface 102, and heating the combined end closure blank and polymer film 106, optionally to an annealing temperature, such that the polymer film 106 can be at least partially viscous and wet at least a portion of the surface of the blank corresponding to the closure inner surface 102.

[0031] In some cases, the end closure blank and/or polymer film 106 can optionally be heated to a temperature such that the polymer film 106 can be at least partially viscous and coat at least a portion of the surface of the blank corresponding to the closure inner surface 102, which can improve film adhesion sufficiently to provide increased performance. As a non-limiting example,

the end closure blank can be heated such that when the polymer film 106 contacts the end closure blank, heat is transferred to the polymer film 106, thus heating the polymer film. In some cases, the polymer film 106 is heated prior to contacting the end closure blank such that it is at least partially viscous prior to contacting the end closure blank. In certain aspects, the end closure blank and polymer film 106 are both heated prior to contacting the polymer film 106 to the end closure blank.

[0032] In certain embodiments, laminating may be performed at temperatures near or above the melting temperature of the polymer film 106, which may allow the film to flow into the topography of the end closure blank, including any optional conversion layer(s) and/or optional adhesion promoters. Thus, adhesion between the end closure blank and the polymer film 106 is improved through mechanical bonding, van der Waals forces, polar-polar interactions, or any suitable mechanism initiated by intimate contact between the end closure blank, optional conversion layer and/or optional adhesion promoter layer, and the polymer film 106 to be laminated onto the end closure blank. In some examples, the end closure blank and/or polymer film 106 may optionally be heated to a temperature of at least 150 °C to 200 °C after the polymer film is applied, although other temperatures may be utilized in other embodiments. In some non-limiting examples, the end closure blank can be heated to a temperature of about 150 °C, about 160 °C, about 170 °C, about 180 °C, about 190 °C, and/or about 200 °C. In other embodiments, the end closure bank can be heated to a temperature less than 150 °C and/or greater than 200 °C.

[0033] After heating, the end closure blank and/or polymer film 106 optionally may be maintained at the temperature of at least 150 °C to about 200 °C (or at any other temperature as desired) for about 1 second to about 30 seconds (e.g., from about 5 seconds to about 25 seconds, from about 10 seconds to about 20 seconds, from about 5 seconds to about 30 seconds, or from about 10 seconds to about 30 seconds). For example, the end closure blank and/or polymer film 106 can be maintained at the temperature of at least 200 °C to about 280 °C for about 1 second, about 2 seconds, about 3 seconds, about 4 seconds, about 5 seconds, about 6 seconds, about 7 seconds, about 8 seconds, about 9 seconds, about 10 seconds, about 11 seconds, about 12 seconds, about 13 seconds, about 14 seconds, about 15 seconds, about 16 seconds, about 17 seconds, about 18 seconds, about 19 seconds, about 20 seconds, about 21 seconds, about 22 seconds, about 23 seconds, about 24 seconds, about 25 seconds, about 26 seconds, about 27 seconds, about 28

seconds, about 29 seconds, or about 30 seconds. In other embodiments, the end closure blank and/or polymer film 106 may be maintained at the desired temperature for any duration as desired.

[0034] In some non-limiting examples, the laminated end closure blank is optionally passed directly from a lamination process into an annealing process (e.g., into an annealing furnace). In some cases, the laminated end closure blank is passed directly from a lamination process into a lacquer application system and then into an annealing process (e.g., into an annealing furnace). In some cases, annealing is not performed.

[0035] The end closure blank can be formed into any suitable shape closure 100 as desired. As a non-limiting example, the end closure blank can be formed into an easy open closure (e.g., a ring pull closure), a peel off closure (e.g., a thin foil closure), a beverage closure, a penny lever closure (e.g., a drum closure, or a paint can closure), a sanitary closure (e.g., a closure opened by cutting with, for example, a can opener), an aerosol valve cap closure, a resealable closure, a bottle rolled-on pilfer proof closure, any suitable container end closure, or any combination thereof, providing a laminated end closure.

[0036] In some examples, the laminated end closure 100 is attached to a previously prepared container body 210. Attaching the end closure 100 encloses the product within the container body 210, and the polymer film 106 provides a body seal between the end closure 200 and the container body 210.

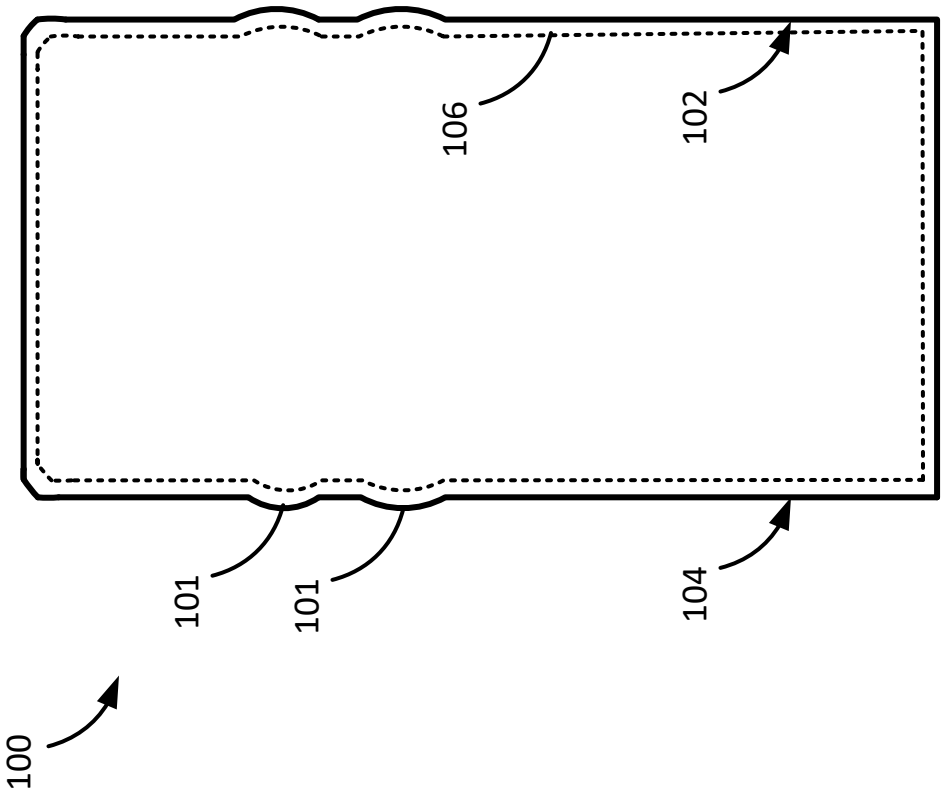

FIG. 1

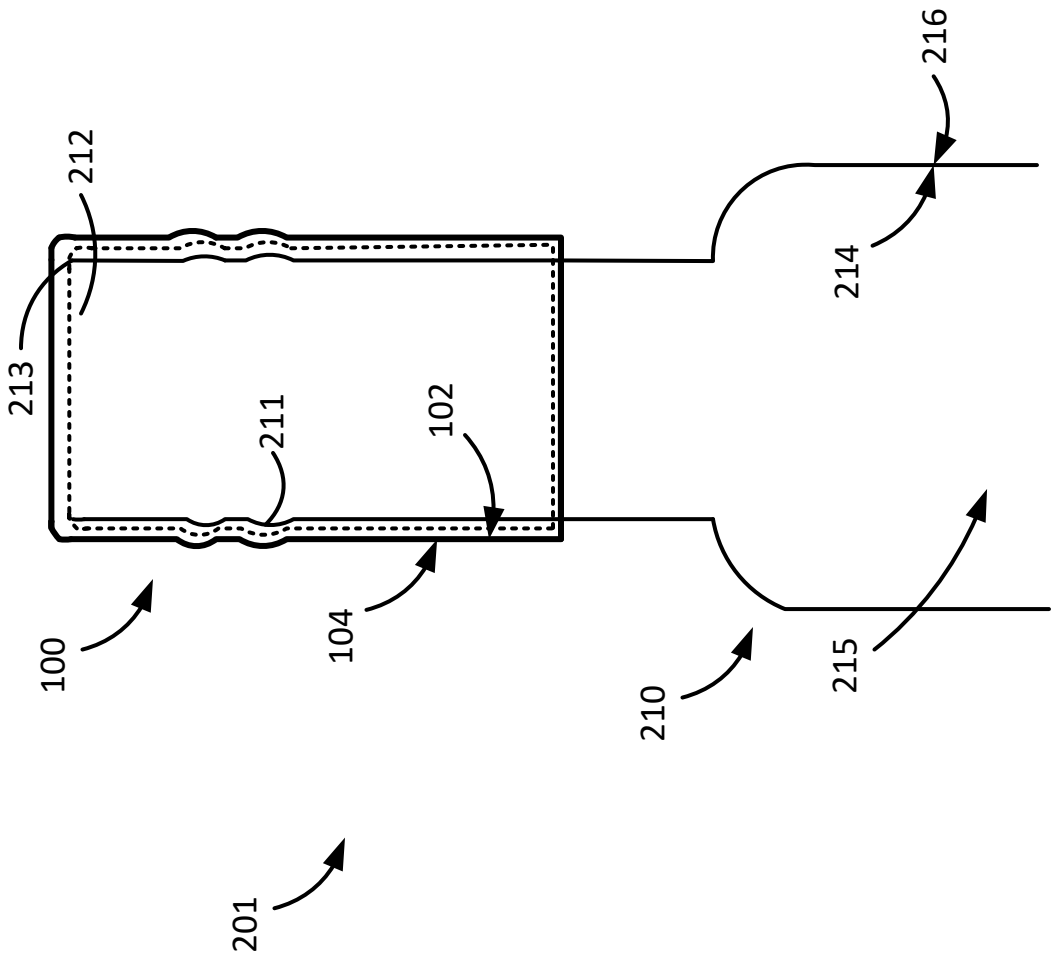

FIG. 2