



(51) International Patent Classification:

B65D 5/50 (2006.01) *B65D 81/107* (2006.01)
B65D 81/03 (2006.01) *B65D 81/113* (2006.01)
B65D 81/05 (2006.01)

(21) International Application Number:

PCT/US2017/068466

(22) International Filing Date:

27 December 2017 (27.12.2017)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

15/393,489 29 December 2016 (29.12.2016) US

(71) Applicant: **DOW GLOBAL TECHNOLOGIES LLC**
[US/US]; 2040 Dow Center, Midland, MI 48674 (US).

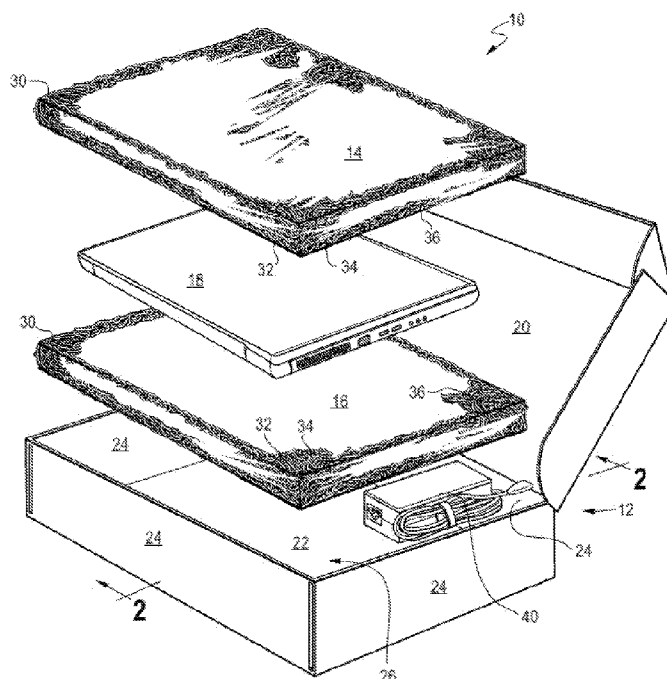
(72) Inventors: **MARTIN, Jill, M.**; 2301 N. Brazosport Blvd., Freeport, TX 77541 (US). **BLACK, Marc, S.**; Washington Street, Bldg. 1616, Midland, MI 48667 (US). **JONES, Joshua, M.**; 715 E. Main Street, Midland, MA 48674 (US). **BURKE, Justin, D.**; 715 E. Main Street, Midland, MI 48674 (US). **MEYERS, Michael, Edwin**; 9330 Zionsville Road, Indianapolis, IN 46268 (US). **WOODMAN, Daniel, S.**; Washington Street, Bldg. 1616, Midland, MI 48667 (US).

(74) Agent: **BARTHEL, Ted, J.**; Husch Blackwell LLP, 555 East Wells Street, Suite 1900, Milwaukee, WI 53202 (US).

(81) Designated States (*unless otherwise indicated, for every kind of national protection available*): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP,

(54) Title: PACKAGING WITH THREE-DIMENSIONAL LOOP MATERIAL

Fig. 1



(57) Abstract: The present disclosure provides a packaging article (10). In an embodiment, the packaging article includes (A) a container (12) having (i) a top wall (20) and a bottom wall (22) and (ii) a plurality of sidewalls (24) extending between the top wall and bottom wall. The walls define a compartment (26). The packaging article includes (B) an upper sheet (14) in the compartment, the upper sheet composed of 3-dimensional random loop material (3DRLM). The upper sheet extends between and contacts two opposing sidewalls of the container. The packaging article includes (C) a lower sheet (16) in the compartment, the lower sheet composed of 3DRLM. The lower sheet extends between and contacts two opposing sidewalls of the container. The two sheets are in opposing relation to each other. The packaging article includes (D) a product (18) disposed between the upper sheet and the lower sheet.

KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME,
MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ,
OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA,
SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN,
TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— with international search report (Art. 21(3))

PACKAGING WITH THREE-DIMENSIONAL LOOP MATERIAL

FIELD

[0001] The present disclosure relates to protective packaging, and more particularly, to an economical reusable protective packaging article for packing and shipping delicate product susceptible to damage by impact and/or vibration

BACKGROUND

[0002] Packaging is a fundamental item in supply chain management. Packaging serves to protect valuable product during shipping and storage. Packaging requires sturdy construction and a cushioning feature in order to fulfill its primary function of product protection from physical shock during shipping and storage. As a result, packaging must withstand many stresses such as falls, drops, tips, puncture, vibration and environmental stresses such as extreme temperatures and water. Known are common packaging materials such as corrugated cardboard, packing peanuts, bubble-out bags, air pillow, bubble wrap, and foam sheets.

[0003] Overly expensive packaging can reduce an entity's return on investment. Excess packaging material has an undue environmental impact and creates a disposal problem for the customer. Excess packaging material also impacts logistics by increasing the amount of pallet space that each package consumes and the dimensional weight of each package. On the other hand, poor or improper packaging can expose product to undue risk of damage.

[0004] Packaging success is the safe arrival of packaged product to a customer. Safe arrival depends upon adequate exterior strength to allow stacking of packages during shipping and adequate interior strength to keep the packaged product from harm in the event of excessive accelerations, such as dropping of the package. Damaged product as a result of defective packaging, impedes the supply chain, is costly, and is deleterious to customer relations.

[0005] Consequently, the art recognizes the need for versatile packaging materials that are sturdy, lightweight, and shock absorbing to meet the demand needs of supply chain management. Also needed is packaging material that is economical, convenient to use and handle, and packaging that is re-usable and/or recyclable.

SUMMARY

[0006] The present disclosure provides a packaging article. In an embodiment, the packaging article includes (A) a container having (i) a top wall and a bottom wall and (ii) a plurality sidewalls extending between the top wall and bottom wall. The walls define a compartment. The packaging article includes (B) an upper sheet in the compartment, the upper sheet composed of 3-dimensional random loop material (3DRLM). The upper sheet extends between and contacts two opposing sidewalls of the container. The packaging article includes (C) a lower sheet in the compartment, the lower sheet composed of 3DRLM. The lower sheet extends between and contacts two opposing sidewalls of the container. The two sheets are in opposing relation to each other. The packaging article includes (D) a product disposed between the upper sheet and the lower sheet.

[0007] The present disclosure provides another packaging article. In an embodiment, the packaging article includes (A) a container having (i) a top wall and a bottom wall, and (ii) an optional sidewall extending between the top wall and the bottom wall. The walls define a compartment with four corners. (B) The packaging article includes a first set of mated strips and a second set of mated strips in the compartment. Each set comprises an upper strip and a lower strip. The upper strip and the lower strip are in opposing relation to each other. Each strip is composed of 3-dimensional random loop material (3DRLM). Each set extends between two opposing corners of the compartment. The sets are spaced apart and in parallel relation to each other. The packaging article includes (D) a product extending across the two sets. The product is disposed between the upper strips and the lower strips.

DEFINITIONS AND TEST METHODS

[0008] All references to the Periodic Table of the Elements herein shall refer to the Periodic Table of the Elements, published and copyrighted by CRC Press, Inc., 2003. Also, any references to a Group or Groups shall be to the Groups or Groups reflected in this Periodic Table of the Elements using the IUPAC system for numbering groups. Unless stated to the contrary, implicit from the context, or customary in the art, all components and percents are based on weight. For purposes of United States patent practice, the contents

of any patent, patent application, or publication referenced herein are hereby incorporated by reference in their entirety (or the equivalent US version thereof is so incorporated by reference).

[0009] The numerical ranges disclosed herein include all values from, and including, the lower value and the upper value. For ranges containing explicit values (e.g., 1, or 2, or 3 to 5, or 6, or 7) any subrange between any two explicit values is included (e.g., 1 to 2; 2 to 6; 5 to 7; 3 to 7; 5 to 6; etc.).

[0010] Unless stated to the contrary, implicit from the context, or customary in the art, all components and percents are based on weight, and all test methods are current as of the filing date of this disclosure.

[0011] Apparent density. A sample material is cut into a square piece of 38 cm × 38 cm (15in x 15 in) in size. The volume of this piece is calculated from the thickness measured at four points. The division of the weight by the volume gives the apparent density (an average of four measurements is taken) with values reported in grams per cubic centimeter, g/cc.

[0012] Bending Stiffness. The bending stiffness is measured in accordance with DIN 53121 standard, with compression molded plaques of 550 μm thickness, using a Frank-PTI Bending Tester. The samples are prepared by compression molding of resin granules per ISO 293 standard. Conditions for compression molding are chosen per ISO 1872 – 2007 standard. The average cooling rate of the melt is 15° C/min. Bending stiffness is measured in 2-point bending configuration at room temperature with a span of 20 mm, a sample width of 15 mm, and a bending angle of 40°. Bending is applied at 6°/second (s) and the force readings are obtained from 6 to 600 s, after the bending is complete. Each material is evaluated four times with results reported in Newton millimeters (“Nmm”).

[0013] “Blend,” “polymer blend” and like terms is a composition of two or more polymers. Such a blend may or may not be miscible. Such a blend may or may not be phase separated. Such a blend may or may not contain one or more domain configurations, as determined from transmission electron spectroscopy, light scattering, x-ray scattering, and

any other method known in the art. Blends are not laminates, but one or more layers of a laminate can comprise a blend.

[0014] ¹³C Nuclear Magnetic Resonance (NMR)

[0015] Sample Preparation

[0016] The samples are prepared by adding approximately 2.7 g of a 50/50 mixture of tetrachloroethane-d₂/orthodichlorobenzene that is 0.025M in chromium acetylacetonate (relaxation agent) to 0.21 g sample in a 10 mm NMR tube. The samples are dissolved and homogenized by heating the tube and its contents to 150°C.

[0017] Data Acquisition Parameters

[0018] The data is collected using a Bruker 400 MHz spectrometer equipped with a Bruker Dual DUL high-temperature CryoProbe. The data is acquired using 320 transients per data file, a 7.3 sec pulse repetition delay (6 sec delay+1.3 sec acq. time), 90 degree flip angles, and inverse gated decoupling with a sample temperature of 125°C. All measurements are made on non-spinning samples in locked mode. Samples are homogenized immediately prior to insertion into the heated (130°C) NMR Sample changer, and are allowed to thermally equilibrate in the probe for 15 minutes prior to data acquisition.

[0019] "Composition" and like terms is a mixture of two or more materials. Included in compositions are pre-reaction, reaction and post-reaction mixtures, the latter of which will include reaction products and by-products as well as unreacted components of the reaction mixture and decomposition products, if any, formed from the one or more components of the pre-reaction or reaction mixture.

[0020] The terms "comprising," "including," "having," and their derivatives, are not intended to exclude the presence of any additional component, step or procedure, whether or not the same is specifically disclosed. In order to avoid any doubt, all compositions claimed through use of the term "comprising" may include any additional additive, adjuvant, or compound, whether polymeric or otherwise, unless stated to the contrary. In contrast, the term, "consisting essentially of" excludes from the scope of any succeeding recitation any other component, step or procedure, excepting those that are not essential

to operability. The term “consisting of” excludes any component, step or procedure not specifically delineated or listed.

[0021] Crystallization Elution Fractionation (CEF) Method

[0022] Comonomer distribution analysis is performed with Crystallization Elution Fractionation (CEF) (PolymerChar in Spain) (B Monrabal et al, Macromol. Symp. 257, 71-79 (2007)). Ortho-dichlorobenzene (ODCB) with 600 ppm antioxidant butylated hydroxytoluene (BHT) is used as solvent. Sample preparation is done with autosampler at 160°C for 2 hours under shaking at 4 mg/ml (unless otherwise specified). The injection volume is 300 µm. The temperature profile of CEF is: crystallization at 3°C/min from 110°C to 30°C, the thermal equilibrium at 30°C for 5 minutes, elution at 3°C/min from 30°C to 140°C. The flow rate during crystallization is at 0.052 ml/min. The flow rate during elution is at 0.50 ml/min. The data is collected at one data point/second. CEF column is packed by the Dow Chemical Company with glass beads at 125 µm + 6% (MO-SCI Specialty Products) with 1/8 inch stainless tubing. Glass beads are acid washed by MO-SCI Specialty with the request from The Dow Chemical Company. Column volume is 2.06 ml. Column temperature calibration is performed by using a mixture of NIST Standard Reference Material Linear polyethylene 1475a (1.0 mg/ml) and Eicosane (2 mg/ml) in ODCB. Temperature is calibrated by adjusting elution heating rate so that NIST linear polyethylene 1475a has a peak temperature at 101.0°C, and Eicosane has a peak temperature of 30.0°C. The CEF column resolution is calculated with a mixture of NIST linear polyethylene 1475a (1.0 mg/ml) and hexacontane (Fluka, purum, >97.0 , 1 mg/ml). A baseline separation of hexacontane and NIST polyethylene 1475a is achieved. The area of hexacontane (from 35.0 to 67.0°C) to the area of NIST 1475a from 67.0 to 110.0°C is 50 to 50, the amount of soluble fraction below 35.0°C is <1.8 wt%. The CEF column resolution is defined in the following equation:

Resolution

$$= \frac{\text{Peak temperature of NIST 1475a} - \text{Peak Temperature of Hexacontane}}{\text{Half - height Width of NIST 1475a} + \text{Half - height Width of Hexacontane}}$$

[0023] where the column resolution is 6.0.

[0024] Density is measured in accordance with ASTM D 792 with values reported in grams per cubic centimeter, g/cc.

[0025] Differential Scanning Calorimetry (DSC). Differential Scanning Calorimetry (DSC) is used to measure the melting and crystallization behavior of a polymer over a wide range of temperatures. For example, the TA Instruments Q1000 DSC, equipped with an RCS (refrigerated cooling system) and an autosampler is used to perform this analysis. During testing, a nitrogen purge gas flow of 50 ml/min is used. Each sample is melt pressed into a thin film at about 175°C; the melted sample is then air-cooled to room temperature (approx. 25°C). The film sample is formed by pressing a "0.1 to 0.2 gram" sample at 175°C at 1,500 psi, and 30 seconds, to form a "0.1 to 0.2 mil thick" film. A 3-10 mg, 6 mm diameter specimen is extracted from the cooled polymer, weighed, placed in a light aluminum pan (ca 50 mg), and crimped shut. Analysis is then performed to determine its thermal properties. The thermal behavior of the sample is determined by ramping the sample temperature up and down to create a heat flow versus temperature profile. First, the sample is rapidly heated to 180°C, and held isothermal for five minutes, in order to remove its thermal history. Next, the sample is cooled to -40°C, at a 10 °C/minute cooling rate, and held isothermal at -40°C for five minutes. The sample is then heated to 150°C (this is the "second heat" ramp) at a 10°C/minute heating rate. The cooling and second heating curves are recorded. The cool curve is analyzed by setting baseline endpoints from the beginning of crystallization to -20°C. The heat curve is analyzed by setting baseline endpoints from -20°C to the end of melt. The values determined are peak melting temperature (T_m), peak crystallization temperature (T_c), onset crystallization temperature (T_c onset), heat of fusion (H_f) (in Joules per gram), the calculated % crystallinity for polyethylene samples using: $\% \text{ Crystallinity for PE} = ((H_f)/(292 \text{ J/g})) \times 100$, and the calculated % crystallinity for polypropylene samples using: $\% \text{ Crystallinity for PP} = ((H_f)/165 \text{ J/g}) \times 100$. The heat of fusion (H_f) and the peak melting temperature are reported from the second heat curve. Peak crystallization temperature and onset crystallization temperature are determined from the cooling curve

[0026] Elastic Recovery. Resin pellets are compression molded following ASTM D4703, Annex A1, Method C to a thickness of approximately 5-10 mil. Microtensile test specimens of geometry as detailed in ASTM D1708 are punched out from the molded sheet. The test specimens are conditioned for 40 hours prior to testing in accordance with Procedure A of Practice D618.

[0027] The samples are tested in a screw-driven or hydraulically-driven tensile tester using flat, rubber faced grips. The grip separation is set at 22 mm, equal to the gauge length of the microtensile specimens. The sample is extended to a strain of 100% at a rate of 100%/min and held for 30s. The crosshead is then returned to the original grip separation at the same rate and held for 60s. The sample is then strained to 100% at the same 100%/min strain rate.

[0028] Elastic recovery may be calculated as follows:

$$\text{Elastic Recovery} = \frac{(\text{Initial Applied Strain} - \text{Permanent Set})}{\text{Initial Applied Strain}} \times 100\%$$

[0029] An "ethylene-based polymer" is a polymer that contains more than 50 weight percent polymerized ethylene monomer (based on the total weight of polymerizable monomers) and, optionally, may contain at least one comonomer. Ethylene-based polymer includes ethylene homopolymer, and ethylene copolymer (meaning units derived from ethylene and one or more comonomers). The terms "ethylene-based polymer" and "polyethylene" may be used interchangeably. Nonlimiting examples of ethylene-based polymer (polyethylene) include low density polyethylene (LDPE) and linear polyethylene. Nonlimiting examples of linear polyethylene include linear low density polyethylene (LLDPE), ultra low density polyethylene (ULDPE), very low density polyethylene (VLDPE), multi-component ethylene-based copolymer (EPE), ethylene/ α -olefin multi-block copolymers (also known as olefin block copolymer (OBC)), single-site catalyzed linear low density polyethylene (m-LLDPE), substantially linear, or linear, plastomers/elastomers, and high density polyethylene (HDPE). Generally, polyethylene may be produced in gas-phase, fluidized bed reactors, liquid phase slurry process reactors, or liquid phase solution process reactors, using a heterogeneous catalyst system, such as Ziegler-Natta catalyst, a

homogeneous catalyst system, comprising Group 4 transition metals and ligand structures such as metallocene, non-metallocene metal-centered, heteroaryl, heterovalent aryloxyether, phosphinimine, and others. Combinations of heterogeneous and/or homogeneous catalysts also may be used in either single reactor or dual reactor configurations.

[0030] "High density polyethylene" (or "HDPE") is an ethylene homopolymer or an ethylene/ α -olefin copolymer with at least one C_4 – C_{10} α -olefin comonomer, or C_4 – C_8 α -olefin comonomer and a density from greater than 0.94 g/cc, or 0.945 g/cc, or 0.95 g/cc, or 0.955 g/cc to 0.96 g/cc, or 0.97 g/cc, or 0.98 g/cc. The HDPE can be a monomodal copolymer or a multimodal copolymer. A "monomodal ethylene copolymer" is an ethylene/ C_4 – C_{10} α -olefin copolymer that has one distinct peak in a gel permeation chromatography (GPC) showing the molecular weight distribution. A "multimodal ethylene copolymer" is an ethylene/ C_4 – C_{10} α -olefin copolymer that has at least two distinct peaks in a GPC showing the molecular weight distribution. Multimodal includes copolymer having two peaks (bimodal) as well as copolymer having more than two peaks. Nonlimiting examples of HDPE include DOW™ High Density Polyethylene (HDPE) Resins (available from The Dow Chemical Company), ELITE™ Enhanced Polyethylene Resins (available from The Dow Chemical Company), CONTINUUM™ Bimodal Polyethylene Resins (available from The Dow Chemical Company), LUPOLEN™ (available from LyondellBasell), as well as HDPE products from Borealis, Ineos, and ExxonMobil.

[0031] An "interpolymer" is a polymer prepared by the polymerization of at least two different monomers. This generic term includes copolymers, usually employed to refer to polymers prepared from two different monomers, and polymers prepared from more than two different monomers, e.g., terpolymers, tetrapolymers, etc.

[0032] "Low density polyethylene" (or "LDPE") consists of ethylene homopolymer, or ethylene/ α -olefin copolymer comprising at least one C_3 – C_{10} α -olefin, preferably C_3 – C_4 that has a density from 0.915 g/cc to 0.940 g/cc and contains long chain branching with broad MWD. LDPE is typically produced by way of high pressure free radical polymerization (tubular reactor or autoclave with free radical initiator). Nonlimiting examples of LDPE

include MarFlex™ (Chevron Phillips), LUPOLEN™ (LyondellBasell), as well as LDPE products from Borealis, Ineos, ExxonMobil, and others.

[0033] "Linear low density polyethylene" (or "LLDPE") is a linear ethylene/ α -olefin copolymer containing heterogeneous short-chain branching distribution comprising units derived from ethylene and units derived from at least one C_3 – C_{10} α -olefin comonomer or at least one C_4 – C_8 α -olefin comonomer, or at least one C_6 – C_8 α -olefin comonomer. LLDPE is characterized by little, if any, long chain branching, in contrast to conventional LDPE. LLDPE has a density from 0.910 g/cc, or 0.915 g/cc, or 0.920 g/cc, or 0.925 g/cc to 0.930 g/cc, or 0.935 g/cc, or 0.940 g/cc. Nonlimiting examples of LLDPE include TUFLIN™ linear low density polyethylene resins (available from The Dow Chemical Company), DOWLEX™ polyethylene resins (available from the Dow Chemical Company), and MARLEX™ polyethylene (available from Chevron Phillips).

[0034] "Ultra low density polyethylene" (or "ULDPE") and "very low density polyethylene" (or "VLDPE") each is a linear ethylene/ α -olefin copolymer containing heterogeneous short-chain branching distribution comprising units derived from ethylene and units derived from at least one C_3 – C_{10} α -olefin comonomer, or at least one C_4 – C_8 α -olefin comonomer, or at least one C_6 – C_8 α -olefin comonomer. ULDPE and VLDPE each has a density from 0.885 g/cc, or 0.90 g/cc to 0.915 g/cc. Nonlimiting examples of ULDPE and VLDPE include ATTANE™ ultra low density polyethylene resins (available from The Dow Chemical Company) and FLEXOMER™ very low density polyethylene resins (available from The Dow Chemical Company).

[0035] "Multi-component ethylene-based copolymer" (or "EPE") comprises units derived from ethylene and units derived from at least one C_3 – C_{10} α -olefin comonomer, or at least one C_4 – C_8 α -olefin comonomer, or at least one C_6 – C_8 α -olefin comonomer, such as described in patent references USP 6,111,023; USP 5,677,383; and USP 6,984,695. EPE resins have a density from 0.905 g/cc, or 0.908 g/cc, or 0.912 g/cc, or 0.920 g/cc to 0.926 g/cc, or 0.929 g/cc, or 0.940 g/cc, or 0.962 g/cc. Nonlimiting examples of EPE resins include ELITE™ enhanced polyethylene (available from The Dow Chemical Company), ELITE AT™ advanced technology resins (available from The Dow Chemical Company), SURPASS™

Polyethylene (PE) Resins (available from Nova Chemicals), and SMART™ (available from SK Chemicals Co.).

[0036] "Single-site catalyzed linear low density polyethylenes" (or "m-LLDPE") are linear ethylene/ α -olefin copolymers containing homogeneous short-chain branching distribution comprising units derived from ethylene and units derived from at least one C₃–C₁₀ α -olefin comonomer, or at least one C₄–C₈ α -olefin comonomer, or at least one C₆–C₈ α -olefin comonomer. m-LLDPE has density from 0.913 g/cc, or 0.918 g/cc, or 0.920 g/cc to 0.925 g/cc, or 0.940 g/cc. Nonlimiting examples of m-LLDPE include EXCEED™ metallocene PE (available from ExxonMobil Chemical), LUFLEXEN™ m-LLDPE (available from LyondellBasell), and ELTEX™ PF m-LLDPE (available from Ineos Olefins & Polymers).

[0037] "Ethylene plastomers/elastomers" are substantially linear, or linear, ethylene/ α -olefin copolymers containing homogeneous short-chain branching distribution comprising units derived from ethylene and units derived from at least one C₃–C₁₀ α -olefin comonomer, or at least one C₄–C₈ α -olefin comonomer, or at least one C₆–C₈ α -olefin comonomer. Ethylene plastomers/elastomers have a density from 0.870 g/cc, or 0.880 g/cc, or 0.890 g/cc to 0.900 g/cc, or 0.902 g/cc, or 0.904 g/cc, or 0.909 g/cc, or 0.910 g/cc, or 0.917 g/cc. Nonlimiting examples of ethylene plastomers/ elastomers include AFFINITY™ plastomers and elastomers (available from The Dow Chemical Company), EXACT™ Plastomers (available from ExxonMobil Chemical), Tafmer™ (available from Mitsui), Nexlene™ (available from SK Chemicals Co.), and Lucene™ (available LG Chem Ltd.).

[0038] Melt flow rate (MFR) is measured in accordance with ASTM D 1238, Condition 280°C/2.16 kg (g/10 minutes).

[0039] Melt index (MI) is measured in accordance with ASTM D 1238, Condition 190°C/2.16 kg (g/10 minutes).

[0040] "Melting Point" or "T_m" as used herein (also referred to as a melting peak in reference to the shape of the plotted DSC curve) is typically measured by the DSC (Differential Scanning Calorimetry) technique for measuring the melting points or peaks of polyolefins as described in USP 5,783,638. It should be noted that many blends comprising

two or more polyolefins will have more than one melting point or peak, many individual polyolefins will comprise only one melting point or peak.

[0041] Molecular weight distribution (Mw/Mn) is measured using Gel Permeation Chromatography (GPC). In particular, conventional GPC measurements are used to determine the weight-average (Mw) and number-average (Mn) molecular weight of the polymer and to determine the Mw/Mn. The gel permeation chromatographic system consists of either a Polymer Laboratories Model PL-210 or a Polymer Laboratories Model PL-220 instrument. The column and carousel compartments are operated at 140°C. Three Polymer Laboratories 10-micron Mixed-B columns are used. The solvent is 1,2,4 trichlorobenzene. The samples are prepared at a concentration of 0.1 grams of polymer in 50 milliliters of solvent containing 200 ppm of butylated hydroxytoluene (BHT). Samples are prepared by agitating lightly for 2 hours at 160°C. The injection volume used is 100 microliters and the flow rate is 1.0 ml/minute.

[0042] Calibration of the GPC column set is performed with 21 narrow molecular weight distribution polystyrene standards with molecular weights ranging from 580 to 8,400,000, arranged in 6 "cocktail" mixtures with at least a decade of separation between individual molecular weights. The standards are purchased from Polymer Laboratories (Shropshire, UK). The polystyrene standards are prepared at 0.025 grams in 50 milliliters of solvent for molecular weights equal to or greater than 1,000,000, and 0.05 grams in 50 milliliters of solvent for molecular weights less than 1,000,000. The polystyrene standards are dissolved at 80°C with gentle agitation for 30 minutes. The narrow standards mixtures are run first and in order of decreasing highest molecular weight component to minimize degradation. The polystyrene standard peak molecular weights are converted to polyethylene molecular weights using the following equation (as described in Williams and Ward, J. Polym. Sci., Polym. Let., 6, 621 (1968)):

$$M_{\text{polypropylene}} = 0.645(M_{\text{polystyrene}}).$$

[0043] Polypropylene equivalent molecular weight calculations are performed using Viscotek TriSEC software Version 3.0.

[0044] An “olefin-based polymer,” as used herein, is a polymer that contains more than 50 weight percent polymerized olefin monomer (based on total amount of polymerizable monomers), and optionally, may contain at least one comonomer. Nonlimiting examples of olefin-based polymer include ethylene-based polymer and propylene-based polymer.

[0045] A “polymer” is a compound prepared by polymerizing monomers, whether of the same or a different type, that in polymerized form provide the multiple and/or repeating “units” or “mer units” that make up a polymer. The generic term polymer thus embraces the term homopolymer, usually employed to refer to polymers prepared from only one type of monomer, and the term copolymer, usually employed to refer to polymers prepared from at least two types of monomers. It also embraces all forms of copolymer, e.g., random, block, etc. The terms “ethylene/ α -olefin polymer” and “propylene/ α -olefin polymer” are indicative of copolymer as described above prepared from polymerizing ethylene or propylene respectively and one or more additional, polymerizable α -olefin monomer. It is noted that although a polymer is often referred to as being “made of” one or more specified monomers, “based on” a specified monomer or monomer type, “containing” a specified monomer content, or the like, in this context the term “monomer” is understood to be referring to the polymerized remnant of the specified monomer and not to the unpolymerized species. In general, polymers herein are referred to as being based on “units” that are the polymerized form of a corresponding monomer.

[0046] A “propylene-based polymer” is a polymer that contains more than 50 weight percent polymerized propylene monomer (based on the total amount of polymerizable monomers) and, optionally, may contain at least one comonomer.

BRIEF DESCRIPTION OF THE DRAWINGS

[0047] FIG. 1 is an exploded perspective view of a packaging article for a product in accordance with an embodiment of the present disclosure.

[0048] FIG. 2 is a sectional view taken along line 2-2 of FIG. 1 showing the packaging article of FIG. 1 in an open configuration.

[0049] FIG. 3 is a sectional view taken along line 2-2 of FIG. 1 showing the packaging article of FIG. 1 in a closed configuration.

[0050] FIG. 4 is an exploded perspective view of a packaging article for a product in accordance with an embodiment of the present disclosure.

[0051] FIG. 5 is an exploded perspective view of a packaging article, including a product, and a band element in accordance with an embodiment of the present disclosure.

[0052] FIG. 6 is a perspective view of the packaging article with the band element of FIG. 5.

[0053] FIG. 7 is an elevational view of the packaging article of FIG. 5 in an open configuration.

[0054] FIG. 8 is a sectional view taken along line 8—8 of FIG. 6 showing the packaging article of FIG. 6 in the closed configuration.

[0055] FIG. 9 is an exploded perspective view of a packaging article for a product in accordance with an embodiment of the present disclosure.

[0056] FIG. 10 is a perspective view of a representation of a packaging article and identification of faces and edges in support of ISTA 3A 2008 testing.

[0057] FIG. 11 is a top plan view of a photograph of a prior art packaging article for a laptop computer, utilizing conventional packaging materials.

DETAILED DESCRIPTION

[0058] The present disclosure provides a packaging article. In an embodiment, the packaging article includes (A) a container having (i) a top wall and a bottom wall, and (ii) a plurality of sidewalls extending between the top wall and bottom wall, the walls defining a compartment. The packaging article includes (B) an upper sheet and (C) a lower sheet located in the compartment. Each sheet is composed of 3-dimensional random loop material (3DRLM). The upper sheet extends between and contacts two opposing sidewalls of the container. The lower sheet extends between and contacts two opposing sidewalls of the container. The upper sheet is in opposing relation to the lower sheet. The packaging article includes (D) a product disposed between the upper sheet and the lower sheet in the compartment.

1. Container

[0059] Referring to the drawings and initially to FIG. 1, a packaging article is indicated generally by the reference numeral 10. The packaging article 10 includes a container 12, an upper sheet 14, a lower sheet 16, and a product 18.

[0060] The container 12 includes a top wall 20, a bottom wall 22, and sidewalls 24 extending between the top wall and the bottom wall. The walls 20-24 form a compartment 26. The container 12 can have from, three, or four, to five, or six, or seven, or eight, or more sidewalls.

[0061] In an embodiment, the container 12 has four sidewalls 24 as shown in FIG. 1.

[0062] The top wall 20 and/or the bottom wall 22 may or may not be attached to one or more sidewalls. For example, the top wall 20 may be a discrete stand-alone component, that is placed on the sidewalls, forming a closed compartment (along with the bottom wall). In an embodiment, the top wall is attached by way of a hinge to one of the sidewalls (*i.e.*, a fold between the top wall and the sidewall) as shown in FIGS. 1-4.

[0063] The top wall and/or the bottom wall 20, 22 may comprise one, two, or more flaps attached to respective one, two, or more sidewalls.

[0064] The container 12 and the formant compartment 26 have a geometric shape. A “geometric shape,” as used herein, is a three dimensional shape or a three dimensional configuration having a length, a width, and a height. The geometric shape can be a regular three dimensional shape, an irregular three dimensional shape, and combinations thereof. Nonlimiting examples of regular three-dimensional shapes include cube, prism, sphere, cone, and cylinder. It is understood that when the geometric shape of the container is a prism, the prism can have a cross-sectional shape that is a regular polygon, or an irregular polygon having three, four, five, six, seven, eight, nine, 10 or more sides.

[0065] The top wall and/or the bottom 20, 22 wall may comprise one, two, or more flaps attached to respective one, two, or more sidewalls.

[0066] The container 12 can be openable from the top wall, the bottom wall, or a sidewall. In an embodiment, the container 12 is openable by way of the top wall.

[0067] The walls 20-24 are made of a rigid material. Nonlimiting examples of suitable material for the walls include cardboard, polymeric material, metal, wood, fiberglass, and any combination thereof. In an embodiment, container 12 has top/bottom walls and four sidewalls the walls 20-24 are made of a corrugated cardboard.

[0068] In an embodiment, the container 12 is a roll end lock front container or a “RELF” container. The RELF container may or may not include dust flaps.

[0069] The container 12 is openable and closable between an open configuration and a closed configuration. An “open configuration” is an arrangement of the walls which allows access to the compartment. A “closed configuration” is an arrangement of the walls preventing, or otherwise denying, access to the compartment. When the container 12 is in the closed configuration, the walls form a completely enclosed compartment. For example, FIG. 1 shows the container 12 in an open configuration with top wall retracted, permitting access to the compartment 26. FIG. 3 shows a cross-sectional view of container 12 in the closed configuration.

2. 3-dimensional random loop material

[0070] The packaging article 10 includes upper sheet 14 and lower sheet 16. Each sheet is composed of a 3-dimensional random loop material 30. A “3-dimensional random loop material” (or “3DRLM”) is a mass or a structure of a multitude of loops 32 formed by allowing continuous fibers 34, to wind, permitting respective loops to come in contact with one another in a molten state and to be heat-bonded at most of the contact points 36. Even when a great stress to cause significant deformation is given, the 3DRLM 30 absorbs the stress with the entire net structure composed of three-dimensional random loops melt-integrated, by deforming itself; and once the stress is lifted, elastic resilience of the polymer manifests itself to allow recovery to the original shape of the structure. When a net structure composed of continuous fibers made from a known non-elastic polymer is used as a cushioning material, plastic deformation is developed and the recovery cannot be achieved, thus resulting in poor heat-resisting durability. When the fibers are not melt-bonded at contact points, the shape cannot be retained and the structure does not integrally change its shape, with the result that a fatigue phenomenon occurs due to the

concentration of stress, thus unbeneficially degrading durability and deformation resistance. In certain embodiments, melt-bonding is the state where all contact points are melt-bonded.

[0071] A nonlimiting method for producing 3DRLM 30 includes the steps of (a) heating a molten olefin-based polymer, at a temperature 10°C-140°C higher than the melting point of the polymer in a typical melt-extruder; (b) discharging the molten interpolymer to the downward direction from a nozzle with plural orifices to form loops by allowing the fibers to fall naturally (due to gravity). The polymer may be used in combination with a thermoplastic elastomer, thermoplastic non-elastic polymer or a combination thereof. The distance between the nozzle surface and take-off conveyors installed on a cooling unit for solidifying the fibers, melt viscosity of the polymer, diameter of orifice and the amount to be discharged are the elements which decide loop diameter and fineness of the fibers. Loops are formed by holding and allowing the delivered molten fibers to reside between a pair of take-off conveyors (belts, or rollers) set on a cooling unit (the distance therebetween being adjustable), bringing the loops thus formed into contact with one another by adjusting the distance between the orifices to this end such that the loops in contact are heat-bonded as they form a three-dimensional random loop structure. Then, the continuous fibers, wherein contact points have been heat-bonded as the loops form a three-dimensional random loop structure, are continuously taken into a cooling unit for solidification to give a net structure. Thereafter, the structure is cut into a desired length and shape. The method is characterized in that the olefin-based polymer is melted and heated at a temperature 10°C-140°C higher than the melting point of the interpolymer and delivered to the downward direction in a molten state from a nozzle having plural orifices. When the polymer is discharged at a temperature less than 10°C higher than the melting point, the fiber delivered becomes cool and less fluidic to result in insufficient heat-bonding of the contact points of fibers.

[0072] Properties, such as, the loop diameter and fineness of the fibers constituting the cushioning net structure provided herein depend on the distance between the nozzle surface and the take-off conveyor installed on a cooling unit for solidifying the

interpolymer, melt viscosity of the interpolymer, diameter of orifice and the amount of the interpolymer to be delivered therefrom. For example, a decreased amount of the interpolymer to be delivered and a lower melt viscosity upon delivery result in smaller fineness of the fibers and smaller average loop diameter of the random loop. On the contrary, a shortened distance between the nozzle surface and the take-off conveyor installed on the cooling unit for solidifying the interpolymer results in a slightly greater fineness of the fiber and a greater average loop diameter of the random loop. These conditions in combination afford the desirable fineness of the continuous fibers of from 100 denier to 100000 denier and an average diameter of the random loop of not more than 100 mm, or from 1 millimeter (mm), or 2 mm, or 10 mm to 25 mm, or 50 mm. By adjusting the distance to the aforementioned conveyor, the thickness of the structure can be controlled while the heat-bonded net structure is in a molten state and a structure having a desirable thickness and flat surface formed by the conveyors can be obtained. Too great a conveyor speed results in failure to heat-bond the contact points, since cooling proceeds before the heat-bonding. On the other hand, too slow a speed can cause higher density resulting from excessively long dwelling of the molten material. In some embodiments the distance to the conveyor and the conveyor speed should be selected such that the desired apparent density of 0.005-0.1 g/cc or 0.01-0.05 g/cc can be achieved.

[0073] In an embodiment, the 3DRLM 30 has, one, some, or all of the properties (i) – (iii) below:

[0074] (i) an apparent density from 0.016 g/cc, or 0.024 g/cc, or 0.032 g/cc to 0.040 g/cc, or 0.048 g/cc; and/or

[0075] (ii) a fiber diameter from 0.1 mm, or 0.5 mm, or 0.7 mm, or 1.0 mm or 1.5 mm to 2.0 mm to 2.5 mm, or 3.0 mm; and/or

[0076] (iii) a thickness (machine direction) from 1.0 cm, 2.0 cm, or 3.0, cm, or 4.0 cm, or 5.0 cm, or 10 cm, or 20 cm, to 50 cm, or 75 cm, or 100 cm, or more. It is understood that the thickness of the 3DRLM 30 will vary based on the type of product to be packaged.

[0077] The 3DRLM 30 is formed into a three dimensional geometric shape to form each sheet (*i.e.*, a prism). The 3DRLM 30 is an elastic material which can be compressed and

stretched and return to its original geometric shape. An “elastic material,” as used herein, is a rubber-like material that can be compressed and/or stretched and which expands/retracts very rapidly to approximately its original shape/length when the force exerting the compression and/or the stretching is released. The three dimensional random loop material 30 has a “neutral state” when no compressive force and no stretch force is imparted upon the 3DRLM 30. The three dimensional random loop material 30 has “a compressed state” when a compressive force is imparted upon the 3DRLM 30. The three dimensional random loop material 30 has “a stretched state” when a stretching force is imparted upon the 3DRLM 30. The sheets 14, 16 can be compressed (compressed state), be neutral (neutral state), and be stretched (stretched state) in a similar manner.

[0078] The three dimensional random loop material 30 is composed of one or more olefin-based polymers. The olefin-based polymer can be one or more ethylene-based polymers, one or more propylene-based polymers, and blends thereof.

[0079] In an embodiment, the ethylene-based polymer is an ethylene/ α -olefin polymer. Ethylene/ α -olefin polymer may be a random ethylene/ α -olefin polymer or an ethylene/ α -olefin multi-block polymer. The α -olefin is a C_3 - C_{20} α -olefin, or a C_4 - C_{12} α -olefin, or a C_4 - C_8 α -olefin. Nonlimiting examples of suitable α -olefin comonomer include propylene, butene, methyl-1-pentene, hexene, octene, decene, dodecene, tetradecene, hexadecene, octadecene, cyclohexyl-1-propene (allyl cyclohexane), vinyl cyclohexane, and combinations thereof.

[0080] In an embodiment, the ethylene-based polymer is a homogeneously branched random ethylene/ α -olefin copolymer.

[0081] “Random copolymer” is a copolymer wherein the at least two different monomers are arranged in a non-uniform order. The term “random copolymer” specifically excludes block copolymers. The term “homogeneous ethylene polymer” as used to describe ethylene polymers is used in the conventional sense in accordance with the original disclosure by Elston in U.S. Pat. No. 3,645,992, the disclosure of which is incorporated herein by reference, to refer to an ethylene polymer in which the comonomer is randomly distributed within a given polymer molecule and wherein substantially all of the polymer molecules have substantially the same ethylene to comonomer molar ratio. As

defined herein, both substantially linear ethylene polymers and homogeneously branched linear ethylene are homogeneous ethylene polymers.

[0082] The homogeneously branched random ethylene/ α -olefin copolymer may be a random homogeneously branched linear ethylene/ α -olefin copolymer or a random homogeneously branched substantially linear ethylene/ α -olefin copolymer. The term "substantially linear ethylene/ α -olefin copolymer" means that the polymer backbone is substituted with from 0.01 long chain branches/1000 carbons to 3 long chain branches/1000 carbons, or from 0.01 long chain branches/1000 carbons to 1 long chain branches/1000 carbons, or from 0.05 long chain branches/1000 carbons to 1 long chain branches/1000 carbons. In contrast, the term "linear ethylene/ α -olefin copolymer" means that the polymer backbone has no long chain branching.

[0083] The homogeneously branched random ethylene/ α -olefin copolymers may have the same ethylene/ α -olefin comonomer ratio within all copolymer molecules. The homogeneity of the copolymers may be described by the SCBDI (Short Chain Branch Distribution Index) or CDBI (Composition Distribution Branch Index) and is defined as the weight percent of the polymer molecules having a comonomer content within 50 percent of the median total molar comonomer content. The CDBI of a polymer is readily calculated from data obtained from techniques known in the art, such as, for example, temperature rising elution fractionation (abbreviated herein as "TREF") as described in U.S. Pat. No. 4,798,081 (Hazlitt et al.), or in U.S. Pat. No. 5,089,321 (Chum et al.) the disclosures of all of which are incorporated herein by reference. The SCBDI or CDBI for the homogeneously branched random ethylene/ α -olefin copolymers is preferably greater than about 30 percent, or greater than about 50 percent.

[0084] The homogeneously branched random ethylene/ α -olefin copolymer may include at least one ethylene comonomer and at least one C₃-C₂₀ α -olefin, or at least one C₄-C₁₂ α -olefin comonomer. For example and not by way of limitation, the C₃-C₂₀ α -olefins may include but are not limited to propylene, isobutylene, 1-butene, 1-hexene, 4-methyl-1-pentene, 1-heptene, 1-octene, 1-nonene, and 1-decene, or, in some embodiments, 1-butene, 1-hexene, 4-methyl-1-pentene and 1-octene.

[0085] The homogeneously branched random ethylene/ α -olefin copolymer may have one, some, or all of the following properties (i) – (iii) below:

[0086] (i) a melt index (1_2) from 1 g/10 min, or 5 g/10 min, or 10 g/10 min, or 20 g/10 min to 30 g/10 min, or 40 g/10 min, or 50 g/10 min, and/or

[0087] (ii) a density from 0.075 g/cc, or 0.880 g/cc, or 0.890 g/cc to 0.90 g/cc, or 0.91 g/cc, or 0.920 g/cc, or 0.925 g/cc; and/or

[0088] (iii) a molecular weight distribution (Mw/Mn) from 2.0, or 2.5, or 3.0 to 3.5, or 4.0.

[0089] In an embodiment, the ethylene-based polymer is a heterogeneously branched random ethylene/ α -olefin copolymer.

[0090] The heterogeneously branched random ethylene/ α -olefin copolymers differ from the homogeneously branched random ethylene/ α -olefin copolymers primarily in their branching distribution. For example, heterogeneously branched random ethylene/ α -olefin copolymers have a distribution of branching, including a highly branched portion (similar to a very low density polyethylene), a medium branched portion (similar to a medium branched polyethylene) and an essentially linear portion (similar to linear homopolymer polyethylene).

[0091] Like the homogeneously branched random ethylene/ α -olefin copolymer, the heterogeneously branched random ethylene/ α -olefin copolymer may include at least one ethylene comonomer and at least one C₃-C₂₀ α -olefin comonomer, or at least one C₄-C₁₂ α -olefin comonomer. For example and not by way of limitation, the C₃-C₂₀ α -olefins may include but are not limited to, propylene, isobutylene, 1-butene, 1-hexene, 4-methyl-1-pentene, 1-heptene, 1-octene, 1-nonene, and 1-decene, or, in some embodiments, 1-butene, 1-hexene, 4-methyl-1-pentene and 1-octene. In one embodiment, the heterogeneously branched ethylene/ α -olefin copolymer may comprise greater than about 50% by wt ethylene comonomer, or greater than about 60% by wt., or greater than about 70% by wt. Similarly, the heterogeneously branched ethylene/ α -olefin copolymer may comprise less than about 50% by wt α -olefin monomer, or less than about 40% by wt., or less than about 30% by wt.

[0092] The heterogeneously branched random ethylene/ α -olefin copolymer may have one, some, or all of the following properties (i) – (iii) below:

[0093] (i) a density from 0.900 g/cc, or 0.0910 g/cc, or 0.920 g/cc to 0.930 g/cc, or 0.094 g/cc;

[0094] (ii) a melt index (I_2) from 1 g/10 min, or 5 g/10 min, or 10 g/10 min, or 20 g/10 min to 30 g/10 min, or 40 g/10 min, or 50 g/10 min; and/or

[0095] (iii) an Mw/Mn from 3.0, or 3.5 to 4.0, or 4.5.

[0096] In an embodiment, the 3DRLM 30 is composed of a blend of a homogeneously branched random ethylene/ α -olefin copolymer and a heterogeneously branched ethylene/ α -olefin copolymer, the blend having one, some, or all of the properties (i) – (v) below:

[0097] (i) a Mw/Mn from 2.5, or 3.0 to 3.5, or 4.0, or 4.5;

[0098] (ii) a melt index (I_2) from 3.0 g/10 min, or 4.0 g/10 min, or 5.0 g/10 min, or 10 g/10 min to 15 g/10 min, or 20 g/10 min, or 25 g/10 min;

[0099] (iii) a density from 0.895 g/cc, or 0.900 g/cc, or 0.910 g/cc, or 0.915 g/cc to 0.920 g/cc, or 0.925 g/cc; and or

[00100] (iv) an I_{10}/I_2 ratio from 5 g/10 min, or 7 g/10 min to 10 g/10 min, or 15 g/10 min; and/or

[00101] (v) a percent crystallinity from 25%, or 30%, or 35%, or 40% to 45%, or 50%, or 55%.

[00102] According to Crystallization Elution Fractionation (CEF), the ethylene/ α -olefin copolymer blend may have a weight fraction in a temperature zone from 90°C to 115°C or about 5% to about 15% by wt., or about 6% to about 12%, or about 8% to about 12%, or greater than about 8%, or greater than about 9%. Additionally, as detailed below, the copolymer blend may have a Comonomer Distribution Constant (CDC) of at least about 100, or at least about 110.

[00103] The present ethylene/ α -olefin copolymer blend may have at least two, or three melting peaks when measured using Differential Scanning Calorimetry (DSC) below a temperature of 130°C. In one or more embodiments, the ethylene/ α -olefin copolymer

blend may include a highest temperature melting peak of at least 115°C, or at least 120°C, or from about 120°C to about 125°C, or from about 122°C to about 124°C. Without being bound by theory, the heterogeneously branched ethylene/ α -olefin copolymer is characterized by two melting peaks, and the homogeneously branched ethylene/ α -olefin copolymer is characterized by one melting peak, thus making up the three melting peaks.

[00104] Additionally, the ethylene/ α -olefin copolymer blend may comprise from about 10 to about 90% by weight, or about 30 to about 70% by weight, or about 40 to about 60% by weight of the homogeneously branched ethylene/ α -olefin copolymer. Similarly, the ethylene/ α -olefin copolymer blend may comprise from about 10 to about 90% by weight, about 30 to about 70% by weight, or about 40 to about 60% by weight of the heterogeneously branched ethylene/ α -olefin copolymer. In a specific embodiment, the ethylene/ α -olefin copolymer blend may comprise from about 50% to about 60% by weight of the homogeneously branched ethylene/ α -olefin copolymer, and 40% to about 50% of the heterogeneously branched ethylene/ α -olefin copolymer.

[00105] Moreover, the strength of the ethylene/ α -olefin copolymer blend may be characterized by one or more of the following metrics. One such metric is elastic recovery. Here, the ethylene/ α -olefin copolymer blend has an elastic recovery, Re , in percent at 100 percent strain at 1 cycle of between 50-80%. Additional details regarding elastic recovery are provided in US Patent 7,803,728, which is incorporated by reference herein in its entirety.

[00106] The ethylene/ α -olefin copolymer blend may also be characterized by its storage modulus. In some embodiments, the ethylene/ α -olefin copolymer blend may have a ratio of storage modulus at 25° C, G' (25°C) to storage modulus at 100°C, G' (100°C) of about 20 to about 60, or from about 20 to about 50, or about 30 to about 50, or about 30 to about 40.

[00107] Moreover, the ethylene/ α -olefin copolymer blend may also be characterized by a bending stiffness of at least about 1.15 Nmm at 6 s, or at least about 1.20 Nmm at 6 s, or at least about 1.25 Nmm at 6 s, or at least about 1.35 Nmm at 6 s. Without being bound by theory, it is believed that these stiffness values demonstrate how the ethylene/ α -olefin

copolymer blend will provide cushioning support when incorporated into 3DRLM fibers bonded to form a cushioning net structure.

[00108] In an embodiment, the ethylene-based polymer is an ethylene/ α -olefin interpolymer composition having one, some, or all of the following properties (i)-(v) below:

[00109] (i) a highest DSC temperature melting peak from 90.0°C to 115.0°C; and/or

[00110] (ii) a zero shear viscosity ratio (ZSVR) from 1.40 to 2.10; and/or

[00111] (iii) a density in the range of from 0.860 to 0.925 g/cc; and/or

[00112] (iv) a melt index (I_2) from 1 g/10 min to 25 g/10 min; and/or

[00113] (v) a molecular weight distribution (M_w/M_n) in the range of from 2.0 to 4.5.

[00114] In an embodiment, the ethylene-based polymer contains a functionalized comonomer such as an ester. The functionalized comonomer can be an acetate comonomer or an acrylate comonomer. Nonlimiting examples of suitable ethylene-based polymer with functionalized comonomer include ethylene vinyl acetate (EVA), ethylene methyl acrylate (EMA), ethylene ethyl acrylate (EEA), and any combination thereof.

[00115] In an embodiment, the olefin-based polymer is a propylene-based polymer. The propylene-based polymer can be a propylene homopolymer or a propylene/ α -olefin polymer. The α -olefin is a C_2 α -olefin (ethylene) or a C_4 - C_{12} α -olefin, or a C_4 - C_8 α -olefin. Nonlimiting examples of suitable α -olefin comonomer include ethylene, butene, methyl-1-pentene, hexene, octene, decene, dodecene, tetradecene, hexadecene, octadecene, cyclohexyl-1-propene (allyl cyclohexane), vinyl cyclohexane, and combinations thereof.

[00116] In an embodiment, the propylene interpolymer includes from 82 wt% to 99 wt% units derived from propylene and from 18 wt% to 1 wt% units derived from ethylene, having one, some, or all of the properties (i) – (vi) below:

[00117] (i) a density of from 0.840 g/cc, or 0.850 g/cc to 0.900 g/cc; and/or

[00118] (ii) a highest DSC melting peak temperature from 50.0°C to 120.0°C; and/or

[00119] (iii) a melt flow rate (MFR) from 1 g/10 min, or 2 g/10 min to 50 g/10 min, or 100 g/10 min; and/or

[00120] (iv) a M_w/M_n of less than 4; and/or

[00121] (v) a percent crystallinity in the range of from 0.5 % to 45%; and/or

[00122] (vi) a DSC crystallization onset temperature, Tc-Onset, of less than 85°C.

[00123] In an embodiment, the olefin-based polymer used in the manufacture of the 3DRLM 14 contains one or more optional additives. Nonlimiting examples of suitable additives include stabilizer, antimicrobial agent, antifungal agent, antioxidant, processing aid, ultraviolet (UV) stabilizer, slip additive, antiblocking agent, color pigment or dyes, antistatic agent, filler, flame retardant, and any combination thereof.

3. Sheets

[00124] The packaging article 10 includes upper sheet 14 and lower sheet 16. Each sheet 14, 16, is made of 3DRLM 30. The composition, and/or the size, and/or the shape of each sheet 14, 16 may be the same or different. In an embodiment, the composition, the size, and the shape of upper sheet 14 is the same as, or substantially the same as, the composition, size, and shape of the lower sheet 16. In a further embodiment, each sheet 14, 16 has the same shape that is a prism.

[00125] The upper sheet 14 extends between and contacts at least two opposing sidewalls of the container 12. The lower sheet 16 extends between and contacts at least two opposing sidewalls of the container 12. Upper sheet 14 is in opposing relation to lower sheet 16.

[00126] In an embodiment, each sheet 14, 16 is sized and shaped to friction fit against opposing sidewalls when placed in the compartment 26. In a further embodiment, each sheet 14,16 is removable from the container. Each sheet 14,16 is thereby reusable and/or recyclable.

4. Product

[00127] The packaging article 10 includes the product 18. A “product,” as used herein, is a tangible object with a mass of at least one gram and having three dimensions—namely, a length, a width, and a height. Nonlimiting examples of suitable products include consumer electronics products, household goods, medical products, comestibles, and any combination thereof.

[00128] Nonlimiting examples of suitable consumer electronics products include computer disk drives, computer input and output (I/O) devices, such as a keyboard, a

mouse; speakers; and video display/monitor; computer; laptop computer; tablet computer; cellphone; smartphone; camera; handheld computing device; television; audio device; computer printer; 3-D printer; wearable technology; drone; virtual reality equipment; video game equipment; media device; accessories such as power cord and power pack; and any combination thereof.

[00129] Nonlimiting examples of suitable household goods include cutlery, glassware, glass picture frames, dishware, small appliances (hair dryer, microwave oven, toaster, food processing device, blender), light bulbs, hardware such as screwdrivers and hammers, and decorative items such as candle holders or vases, and any combination thereof.

[00130] Nonlimiting examples of suitable medical products include vials, ampules, syringes, intravenous (IV) bags, medical devices used in surgical suites including trocars, forceps, clamps, retractors, endoscopes, staplers, specula, drills, and any combination thereof.

[00131] Nonlimiting examples of suitable comestibles include produce such as fruit and vegetables. Nonlimiting examples of suitable fruit and vegetables include apple; apricot; artichoke; asparagus; avocado; banana; beans; beets; bell peppers; blackberries; blueberries; bok choy; boniato; boysenberries; broccoli; Brussel sprouts; cabbage; cantaloupe; carambola; carrots; cauliflower; celery; chayote; cherimoya; cherries; citrus; clementines; collard greens; coconuts; corn; cranberries; cucumber; dates; dragon fruits; durian; eggplant; endive; escarole; feijoa; fennel; figs; garlic; gooseberries; grapefruit; grapes; green beans; green onions; greens (turnip, beet, collard, mustard); guava; horminy; honeydew melon; horned melon; lettuce (iceberg, leaf and romaine); jackfruit; jicama; kale, kiwifruit; kohirabi; kumquat; leeks; lemons; lettuce; lima beans; limes; longan; loquat; lychee; mandarins; malanga; mandarin oranges; mangos; mangosteen; mulberries; mushrooms; mustard greens; napa; nectarines; okra; onion; oranges; papayas; parsnip; passion fruit; peaches; pears; peas; peppers (bell – red, yellow, green, chili); persimmons; pineapple; plantains; plums; pomegranate; potatoes; prickly pear; prunes; pummel; pumpkin; quince; radicchio; radishes; raisins; rambutan; raspberries; red cabbage; rhubarb; romaine lettuce; rutabaga; shallots; snap peas; snow peas; spinach; sprouts; squash (acorn,

banana, buttercup, butternut, hubbard, summer); strawberries; starfruit; string beans; stone fruits; sweet potato; tamarind; tomatoes, tangelo; tangerines; tomatillo; tomato; turnip; ugli fruit; water chestnuts; waxed beans; yams; yellow squash; yucca/cassava; zucchini; and any combination thereof.

[00132] The product 18 is disposed between the upper sheet 14 and the lower sheet 16. A bottom surface of the upper sheet 14 contacts the product 18 and a top surface of the lower sheet 16 contacts the product 18.

[00133] In an embodiment, the container 12 has four sidewalls as shown in FIG. 1. At least one of the sheets 14, 16 extends between and contacts each of the four sidewalls. In a further embodiment, each sheet 14, 16 extends between and contacts each of the four sidewalls. The sheets 14, 16 are sized and shaped to fit, or friction fit, within the compartment 26, the 3DRLM of each sheet in contact with the inner surface of each sidewall. The product 18 is located between, or otherwise sandwiched by, upper sheet 14 and lower sheet 16.

[00134] Collectively, the sheets 14, 16 have a perimeter that is greater than the perimeter of the product 18 when viewed both (i) from plan view and (ii) when viewed from sectional view. FIG.1 shows that sheets 14, 16 each have a perimeter greater than the perimeter of the product 18 from top plan view. In this way, the sheets provide a border of 3DRLM protective cushion around the product providing cushioning and protection from vertical shock of the product 18 in the container 12.

[00135] In an embodiment, FIG. 2 shows the container 12 in an open configuration and the sheets 14, 16, each in the neutral state, each sheet having a height, N. The product 18 is disposed between the sheets 14, 16 (hereafter referred to as the “sheet-product-sheet sandwich” or “SPS sandwich”), the SPS sandwich having a height H1 that is greater than the depth D of the compartment 26. When the container 12 is moved from the open configuration in FIG. 2 to the closed configuration in FIG. 3, the walls of the container impart a compressive force upon the sheets 14, 16. The SPS sandwich is compressed to a height, H2 equal to, or substantially equal to, the depth D of the compartment 26. Height H1 (open configuration) is greater than height H2 (closed configuration). One (or both) sheets 14, 16

move from the neutral state (N) to a compressed state, C when the container is moved from the open configuration (Fig. 2) to the closed configuration (Fig. 3). In the closed configuration of FIG. 3, the elastic nature of the 3DRLM 30 enables one (or both) sheets 14, 16 contort under the compression force of the walls, the 3DRLM 30 of the sheet(s), intimately conforming around the product 18. In other words, the sheets 14, 16 form a reciprocal shape of the product, when the container 12 is in the closed configuration.

[00136] In the closed configuration, the opposing relation of the sheets 14, 16 compressively holds the product 18 in a stationary position within the container 12. The fibers 34 of sheet 14 contact, or otherwise touch, the fibers 34 of the sheet 16. The 3DRLM 30 of sheets 14, 16 surround, and contact substantially every surface, or contact every surface, of the product 18. The product 18 is completely surrounded, or fully engulfed, in protective 3DRLM 30 such that the product 18 is immobilized within the 3DRLM 30 and within the container 12. In the closed configuration, the compressed sheet(s) 14, 16 provide both vertical and lateral support to the product 18, (i) preventing the product 18 from moving up and down, and (ii) preventing the product 18 from moving side to side within the container, when a lateral shock load, or other shock is imparted to the packaging article, for example. The 3DRLM 30 of sheets 14, 16 prevents the product 18 from hitting the sidewalls (and the top/bottom walls) when the container is subject to a lateral shock load, or other force.

[00137] FIG. 3 further shows sheets 14, 16 collectively also have a perimeter greater than the perimeter of the product 18 along a cross-sectional view. In this way, the sheets 14, 16 hold the product 18 stationary, or otherwise hold the product 18 firmly in place, in the compartment 26. The sheets prevent lateral, longitudinal, and/or vertical movement of the product within the container 12. The polymeric material of the 3DRLM also contributes to impart frictional force, or a “holding force” upon the product 18 within the container 12.

[00138] In an embodiment, the packaging article 10 includes product 18 that is a laptop computer and an accessory 40 as shown in FIGS. 1-3. The accessory is located in the compartment 26 along with the product 18. The 3DRLM 30 of sheet 14 and/or sheet 16 compresses upon the accessory 40 to immobilize the accessory 40 within the container 12.

In a further embodiment, the size, and/or shape, and/or dimension of one or both sheets 14, 16 is/are adjusted to accommodate the size, and/or shape of the accessory 40 within the compartment 26.

5. Cut-out

[00139] FIG. 4 shows another embodiment of the packaging article. In this embodiment, one or both of upper sheet/lower sheet 14a, 16a includes a respective cut-out portion. A “cut-out” is a shape formed into the 3DRLM of a sheet, the shape creating a void in the 3DRLM, the shaped-void pre-determined and adapted to receive at least a portion of, or all of, the product. The size and shape of the shaped-void is adapted to the size and shape of the product to be packaged. The cut-out may be formed in a molding process, a cutting procedure, and combinations thereof. The cut-out is present when the 3DRLM is in the neutral state, the cut-out portion being distinct from the compressed state and/or the stretched state of the 3DRLM 30. In this sense, the cut-out is a void shape that is reciprocal in shape to the positive space and shape (or a portion of the positive space and shape) occupied by the product 18.

[00140] One or both sheets 14a, 16a can have a cut-out. Although FIG. 4 shows lower sheet 16a having a cut-out 50, it is understood that upper sheet 14a may also have a cut-out, alone, or in combination with the cut-out 50.

[00141] In an embodiment, the product 18 is a laptop computer, having a rectangular prism shape. In FIG. 4, the lower sheet 16a has a cut-out 50 that is the void of a rectangular prism, the cut-out 50 a void-shape sized and shaped to receive the product 18—a rectangular prism. The cut-out 50 is sized and configured to receive, or otherwise accommodate, the entire product 18. The upper sheet 14a is placed over lower sheet 16a, and over the cut-out 50 so that the 3DRLM 30 of the two sheets 14a, 16a fully encompasses, or otherwise fully surrounds, the product 18. The 3DRLM fibers 34 of upper sheet 14a contact, or otherwise touch, the fibers 34 of the lower sheet 16a. In this way, the two sheets 14a, 16a provide a protective border around the entire outer surface of the product. In other words, the sheets 14a, 16a collectively completely surround the product with 3DRLM because the perimeter of collective sheets 14a, 16a is (i) greater than the

perimeter of the product from plan view and (ii) greater than the perimeter of the product from sectional view.

[00142] In an embodiment, the cut-out is sized and shaped to receive the product 18 (such as a laptop computer, for example) and the cut-out is also sized and shaped to receive an accessory (such as a cord and/or a power pack, for example).

[00143] In an embodiment, one or both sheets 14a, 16a include a cut-out and the product is a comestible, such as a fruit or a vegetable, for example. The void-shape of the cut-out is adapted to receive a portion of, or all of, the comestible. In other words, the void-shape of the cut-out is reciprocal to (or substantially reciprocal to) the positive space and shape occupied by the comestible.

6. Sets of strips

[00144] FIGS. 5-9 show other embodiments of the present packaging article. In an embodiment, another packaging article 110 is provided. The packaging article 110 includes (A) a container 112, (B) a first set 114 of strips and a second set 116 of strips, and (C) a product 118. The container 112 includes (i) a top wall 120 and a bottom wall 122, and an optional sidewall 124 extending between the top wall and the bottom wall. The walls define a compartment 126.

[00145] In an embodiment, the top wall 120 and the bottom wall 122 each is attached by way of a hinge to the sidewall 124 (*i.e.*, folds between the sidewall and each of the top wall and the bottom wall). Alternatively, the top wall 120 is detached from the bottom wall 122.

[00146] Each set 114, 116 includes a respective pair of mated strips. FIG. 5 shows set 114 having strip 115a and strip 115b. Set 116 includes strip 117a and strip 117b. For each set 114, 116, an upper strip (115a, 117a) contacts, or is otherwise attached to, to the top wall 120. For each set 114, 116, lower strip (115b, 117b) contacts, or is otherwise attached to, the bottom wall 122. In each set 114, 116, the strips are mated whereby the strips are in opposing relation to each other. FIGS. 7-8 show strip 115a (117a) in contact with the top wall, strip 115a (117a) opposing strip 115b (117b) and strip 115b (117b) being in contact with the bottom wall 122. In each set, the strips are sized, shaped and positioned to be mirror images of each other in the compartment 126. In an embodiment, strip 115a (117a)

has the same, or substantially the same, size and shape of strip 115b (117b). Each strip 115a, 115b, 117a, 117b is made of the 3DRLM 130 as disclosed above.

[00147] The walls 120, 122, 124 define compartment 126 corners I, J, K, L. Each set of strips 114, 116 extends between two opposing corners of the compartment 126. Set 114 extends between corner I and opposing corner J. Set 116 extends between corner K and opposing corner L. Set 114 is spaced apart from set 116. Set 114 is parallel to, or substantially parallel to, set 116. In other words, the sets 114, 116 are in parallel relation to each other in a spaced-apart manner.

[00148] The product 118 is supported by the sets, the product 118 extending from set 114 to set 116. The product is sandwiched between upper strips 115a, 117a and lower strips 115b, 117b. In FIG. 8, the container 112 is placed into a closed configuration and one, some, or all of the strips 115a, 115b, 117a, 117b move from the neutral state to a compressed state and conform around, and to the shape of, the product 118. In this way, the strips 115a, 115b, compressively hold the product 118 in a stationary position (vertically, horizontally, and laterally) within the compartment 126.

[00149] In an embodiment, the packaging article 110 includes a third set 128 of strips. The set 128 includes mated strips 129a, 129b, each made of the 3DRLM 130. The set 128 is located between set 114 and set 116 in a spaced-apart manner, with space between set 114 and set 128, and space between set 128 and set 116. Set 128 is parallel to set 114 and set 128 is parallel to set 116. The strips 129a, 129b are mated as discussed above with respect to strips 115a, 115b and 117a, 117b.

[00150] FIG. 6 illustrates an embodiment wherein a band element 140 maintains the container 112 in the closed configuration. Nonlimiting examples of a suitable band element include a sleeve, rope, twine, string, cable, belt, adhesive tape, stretch film, shrink film, and any combination thereof. In a further embodiment, the container 112 is a sub-container that is placed within a larger container 160. In a further embodiment, the band element 140 is a sleeve composed of a polymeric material the sleeve surrounding the container 112 as shown in FIG. 6.

[00151] FIG. 9 shows another embodiment of the packaging article 110. In this embodiment, one, some, or all of the strips include a respective cut-out portion 150a-f.

[00152] In an embodiment, the product 118 is a laptop computer, with a rectangular prism shape. In FIG. 9, strips 115a, 115b, 117a, 117b, and 129a, 129b each have a respective cut-out portion 150a, 150b, 150c, 150d, 150e, 150f shaped to receive a portion of the rectangular prism shape of the product 118, the laptop computer.

[00153] For sets 114, 116, the cut-out includes ends 152a, 152b, 152c, 152d. The ends 152a-d prevent lateral movement of the product 118 within the container 112 as previously disclosed herein. The strips 115a, 115b, 117a, 117b, 129a, and 129b prevent vertical movement, prevent horizontal movement, and prevent lateral movement of the product 118 within the container 112 as previously disclosed herein.

[00154] In an embodiment, the packaging article 110 includes an accessory. The accessory may be located in the void space in the compartment 126 that is present between the spaced-apart strips. Alternatively, some or all of the accessory is sandwiched between opposing strips of one or more sets, along with the sandwiching of the product. In a further embodiment, one or more cut-outs 150a-150f are sized and/or shaped to receive the accessory.

[00155] By way of example, and not limitation, some embodiments of the present disclosure will now be described in detail in the following Examples.

EXAMPLES

[00156] Materials used in the examples are provided in Table 1 below.

Table 1

Material/Description	Properties	Source
Control EPE foam Foam	EPE foam with apparent density of 0.02g/cc	
3DRLM	Continuous fibers composed of ethylene/octene copolymer; 3DRLM: apparent density of 0.025g/cc	The Dow Chemical Company

[00157] Simulation of package shipping. The simulation of package shipping is measured in accordance with ISTA 3A 2008. ISTA 3A 2008 is a three-part test. The first part

is a drop test, performed in accordance with ISO 2248 or ASTM D 5276. The first drop test is a series of 9 drops to simulate loading condition. The second part of the ISTA 3A 2008 test is a vibration test, performed in accordance with the apparatus section of ISO 13355 or ASTM D 4728. The second part is an intermediate test to simulate transportation. The third part of the ISTA 3A 2008 is a second drop test, that is a series of 8 drop tests. The second drop test simulates unloading condition.

[00158] A control sample for a packaging article is prepared. The control sample includes a container, a laptop computer, and packaging material. The container is a Federal Express Large Box with dimensions of 31.45cm (12 $\frac{3}{8}$ ") x 7.62cm (3") x 44.45 cm (17 $\frac{1}{2}$ "). The laptop computer is a Hewlett Packard Chromebook. The packaging material includes two opposing endcaps made of expanded polyethylene (EPE) foam, as described in Table 1, with slits to receive opposing ends of the laptop computer. Each endcap is 24.8cm (9 $\frac{3}{4}$ ") long, 6.5cm (2 $\frac{1}{2}$ ") wide, and 6.5cm (2 $\frac{1}{2}$ ") deep at maximum depth. A top plan view of the control sample is shown in FIG. 11.

[00159] For the control sample, the container has a top wall and a bottom wall, with four sidewalls extending between the top wall and the bottom wall. The walls define a compartment. In the compartment are the two separate endcaps of EPE foam. The opposing endcaps hold the laptop at its ends. Each endcap has a shape of a capital letter "E", as shown in FIG. 11. Each endcap has a slit (21.0cm, 8 $\frac{1}{4}$ " long, 2.6cm, 1" wide) along one of the long sides, the slit receiving a respective end of the laptop computer. A smaller third piece of EPE foam is positioned between the laptop computer and a sidewall as shown in FIG. 11. The third piece of EPE foam has the shape of a rectangular prism, and has a pair of opposing parallel short sides and a pair of opposing parallel long sides. The pair of short sides is perpendicular to the pair of long sides. The third piece of EPE foam has a slit (7.7cm, 3" long, 2.6cm, 1" wide) along one of the long sides for receiving an edge of the laptop computer.

[00160] The Inventive Example (henceforth, *Inventive Package*) is a packaging article, including the same, or substantially the same, elements of packaging article 10 as set forth in FIGS. 1-3. The *Inventive Package* includes a container, that is a Federal Express Large Box,

which has dimensions of 31.45cm (12 $\frac{3}{8}$ ") long by 44.45 cm (17 $\frac{1}{2}$ ") wide by 7.62cm (3") deep. The container has a top wall and a bottom wall, with four sidewalls extending between the top wall and the bottom wall. The walls define a compartment. In the compartment is an upper sheet composed of the 3-dimensional random loop material (3DRLM) as described in Table 1. In the compartment, the upper sheet is coextensive with the top wall of the container. Also in the compartment is a lower sheet composed of 3DRLM. In the compartment, the lower sheet is coextensive with the bottom wall of the container. A Hewlett Packard Chromebook laptop computer is disposed between the upper sheet of 3DRLM and the lower sheet of 3DRLM, in a sheet-computer-sheet configuration as shown in FIGS. 1-3. The dimensions for each sheet of 3DRLM are 31.45cm (12 $\frac{3}{8}$ ") long by 44.45 cm (17 $\frac{1}{2}$ ") wide by 7.62cm (3") deep.

[00161] The results of ISTA 3A 2008 testing are provided in Tables 2-4 below. Fig. 10 indicates the package faces, edges, and corners used to describe the various orientations of both the control sample and the *Inventive Package* during ISTA 3A 2008 testing.

Table 2: Drop Tests 1-9 (Loading Condition)

Drop Number	Package Orientation	Drop Height (inches)	Observations (Control)	Observations (<i>Inventive Package</i>)
1	Edge 3-4	18	No visible damage	No visible damage
2	Edge 3-6	18	Small crease at right side	No visible damage
3	Edge 4-6	18	Minor additional creasing (from existing)	Minor crease imparted, suspect laptop has shifted position
4	Corner 3-4-6	18	Corner crease imparted	Corner dent imparted, had to use clamp to hold in place
5	Corner 2-3-5	18	Corner crease imparted	Corner dent imparted, had to use clamp to hold in place
6	Edge 2-3	18	No visible damage	No visible damage
7	Edge 1-2	18	No visible damage	Minor crease and scuffs imparted
8	Face 3	36	No visible damage	No visible damage
9	Face 3	18	Cosmetic scuff marks only	No visible damage

Note: Pre-existing crease noted prior to testing for control

Table 3: Vibration Tests (Random Profile, Transportation)

Test Number	Orientation	Time (mins)	Top Loads (lbs.)	Observations (Control)	Observations (<i>Inventive Package</i>)
1	Face 3 on platform	60	74.97	No visible damage	No visible damage
2	Face 4 on platform	30	17.136 (no top load needed)	No visible damage	No visible damage
3	Face 6 on platform	30	11.466 (no top load needed)	No 4	No visible damage

Table 4: Drop Tests 10-17 (Unloading Condition)

Drop Number	Package Orientation	Drop Height (inches)	Observations (Control)	Observations (<i>Inventive Package</i>)
10	Edge 3-4	18	No visible damage	Scuff marks imparted
11	Edge 3-6	18	Cardboard tab pushed in, very slight damage	Minor creasing imparted
12	Edge 1-5	18	Cosmetic scuff marks imparted	Minor denting imparted
13	Corner 3-4-6	18	Additional creasing imparted	Additional corner denting
14	Corner 1-2-6	18	Crease imparted	Significant corner dent imparted
15	Corner 1-4-5	18	Dent and scuff marks imparted	Significant corner dent imparted
16	Face 3 (damage prone)	36	No visible damage, scuff marks imparted	No visible damage
17	Face 2	18	No visible damage	Slight creasing imparted

RESULTS

[00162] After ISTA 3A 2008 testing, the control sample and the *Inventive Package* each is opened and the laptop checked for damage. No visible damage to the laptop computer from either package is observed. Each laptop computer is then powered on, and operates normally with no errors or problems in computer applications.

[00163] The *Inventive Package* performs the same as, or better than, the control sample. Applicant discovered that, for the *Inventive Package*, the two sheets of 3DRLM protect the laptop computer from drop and vibration. The 3DRLM expands to fill most, or all, of the void volume of the container interior to synergistically (i) hold the laptop computer in place, (ii) provide drop, shock and vibration protection during shipping and handling, (iii) with a lightweight material (i.e., the 3DRLM) that is more flexible than rigid EPE foam endcaps.

[00164] The sheets of 3DRLM from the *Inventive Package* advantageously provide good resilience and breathability. The opposing 3DRLM sheets provide balanced and even pressure distribution within the container interior for drop/vibration protection along the entire body of the laptop computer. In addition, use of the 3DRLM allows for a reduced carbon footprint due to the elimination of foam packaging material that requires blowing agents during foam manufacturing. Hence, the 3DRLM provides an environmentally-friendly option for packaging material production. Furthermore, the 3DRLM is a fully recyclable material.

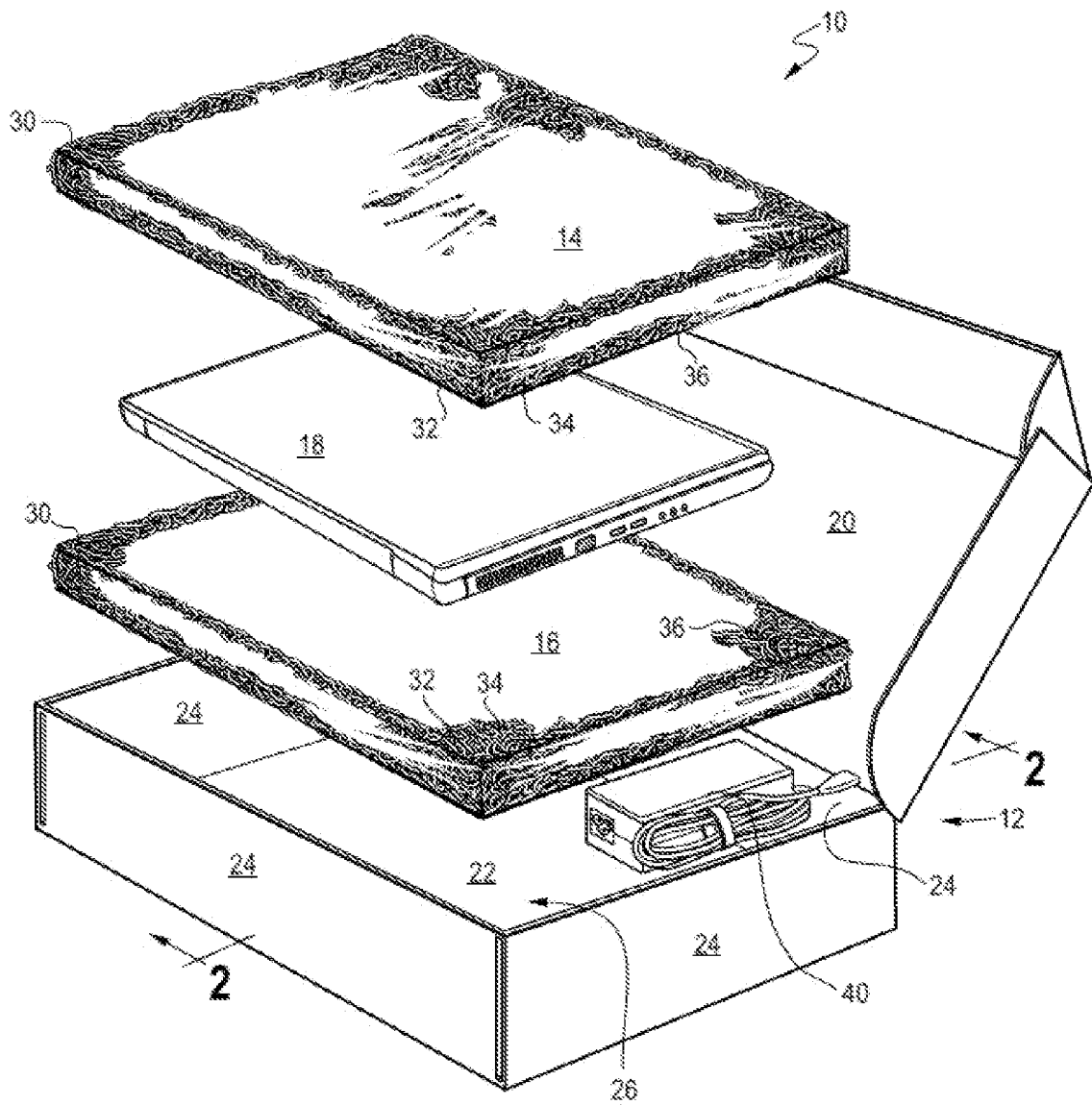
[00165] It is specifically intended that the present disclosure not be limited to the embodiments and illustrations contained herein, but include modified forms of those embodiments including portions of the embodiments and combinations of elements of different embodiments as come with the scope of the following claims.

CLAIMS

1. A packaging article comprising:
 - A. a container having
 - (i) a top wall and a bottom wall;
 - (ii) a plurality sidewalls extending between the top wall and bottom wall, the walls defining a compartment;
 - B. an upper sheet in the compartment, the upper sheet composed of 3-dimensional random loop material (3DRLM), the upper sheet extending between and contacting two opposing sidewalls of the container;
 - C. a lower sheet in the compartment, the lower sheet composed of 3DRLM, the lower sheet extending between and contacting two opposing sidewalls of the container, the two sheets in opposing relation to each other; and
 - D. a product disposed between the upper sheet and the lower sheet.
2. The article of claim 1 wherein the container comprises four sidewalls; and at least one sheet extends between and contacts each of the four sidewalls.
3. The article of claim 1 wherein at least one of the first sheet and the second sheet move from a neutral state to a compressed state around the product, when the container is in a closed configuration.
4. The article of claim 3 wherein a portion of the first sleeve contacts a portion of the second sleeve when the container is in a closed configuration.
5. The article of claim 4 wherein 3DRLM from the first sheet and 3DRLM from the second sheet completely surrounds a perimeter of the product when the container is viewed from (i) a plan view and (ii) from a sectional view.
6. The article of claim 5 wherein the two sheets compressively hold the product in a stationary position in the container.
7. The article of claim 1 wherein at least one sheet comprises a cut-out portion, the cut-out portion configured to receive at least a portion the product.
8. The article of claim 1 wherein the product is a consumer electronics product.

9. The article of claim 1 wherein the product is a comestible.
10. A packaging article comprising:
 - A. a container having
 - (i) a top wall and a bottom wall;
 - (ii) an optional sidewall extending between the top wall and the bottom wall, the walls defining a compartment with four corners;
 - B. a first set of mated strips and a second set of mated strips in the compartment, each set comprising an upper strip and a lower strip, the upper strip and the lower strip in opposing relation to each other, each strip composed of 3-dimensional random loop material (3DRLM);
 - C. each set extending between two opposing sides of the compartment, the sets spaced apart and in parallel relation to each other; and
 - D. a product extending across the two sets, the product disposed between the upper strips and the lower strips.
11. The article of claim 10 wherein at least one strip moves from a neutral state to a compressed state around the product, when the container is in a closed configuration; and
the sets compressively hold the product in a stationary position in the container.
12. The article of claim 11 wherein for each set a portion of the upper strip contacts a portion of the lower strip when the container is in the closed configuration.
13. The article of claim 10 wherein each strip comprises a cut-out portion for receiving the product.
14. The article of claim 10 wherein the product is a consumer electronics product.

Fig. 1



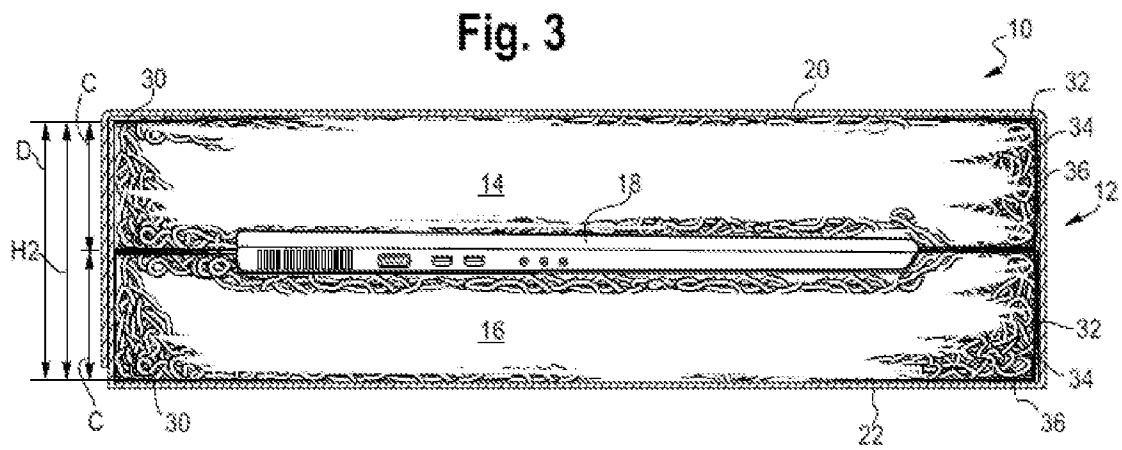
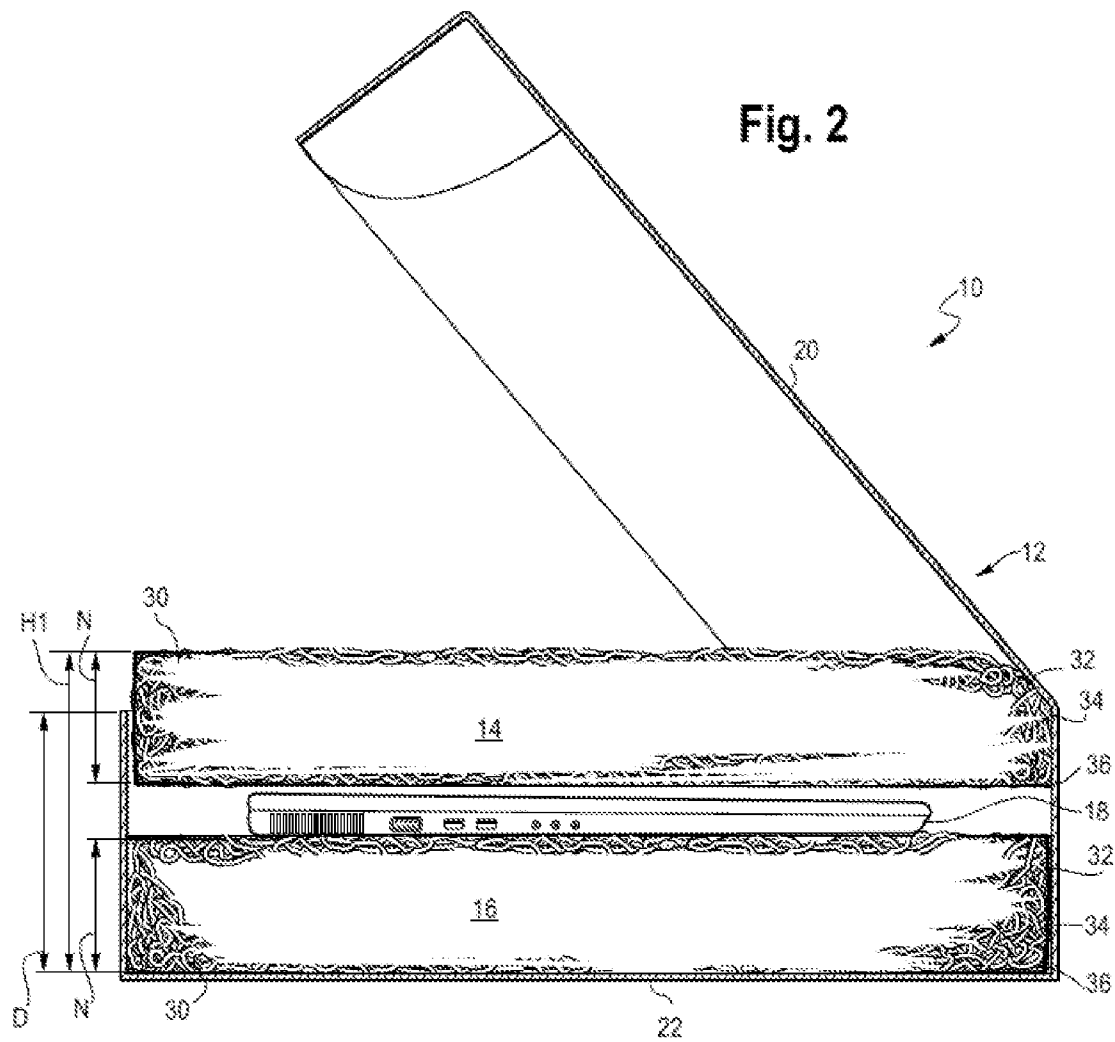
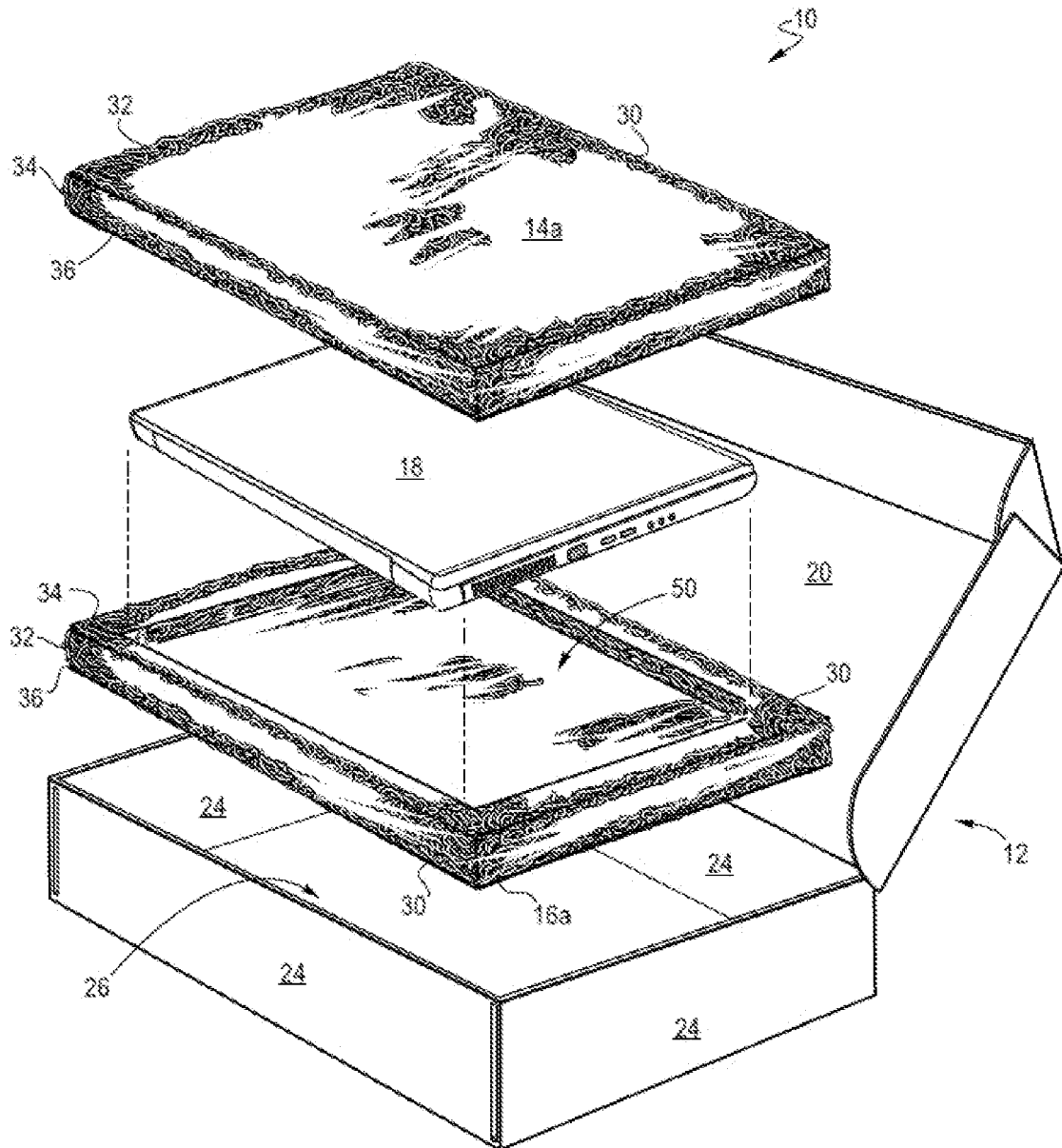
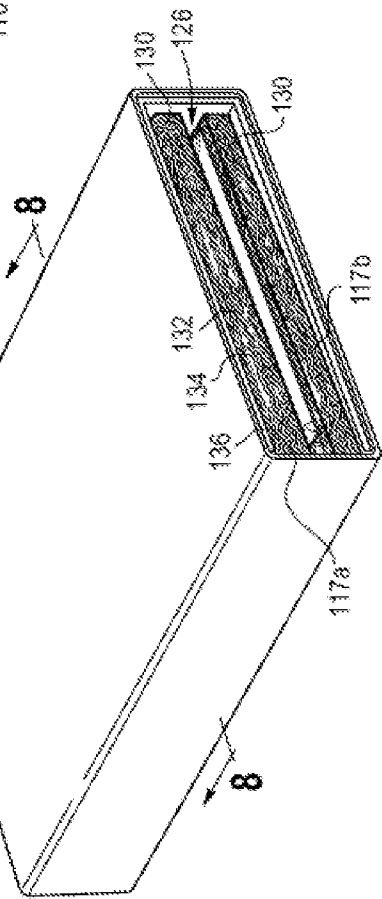
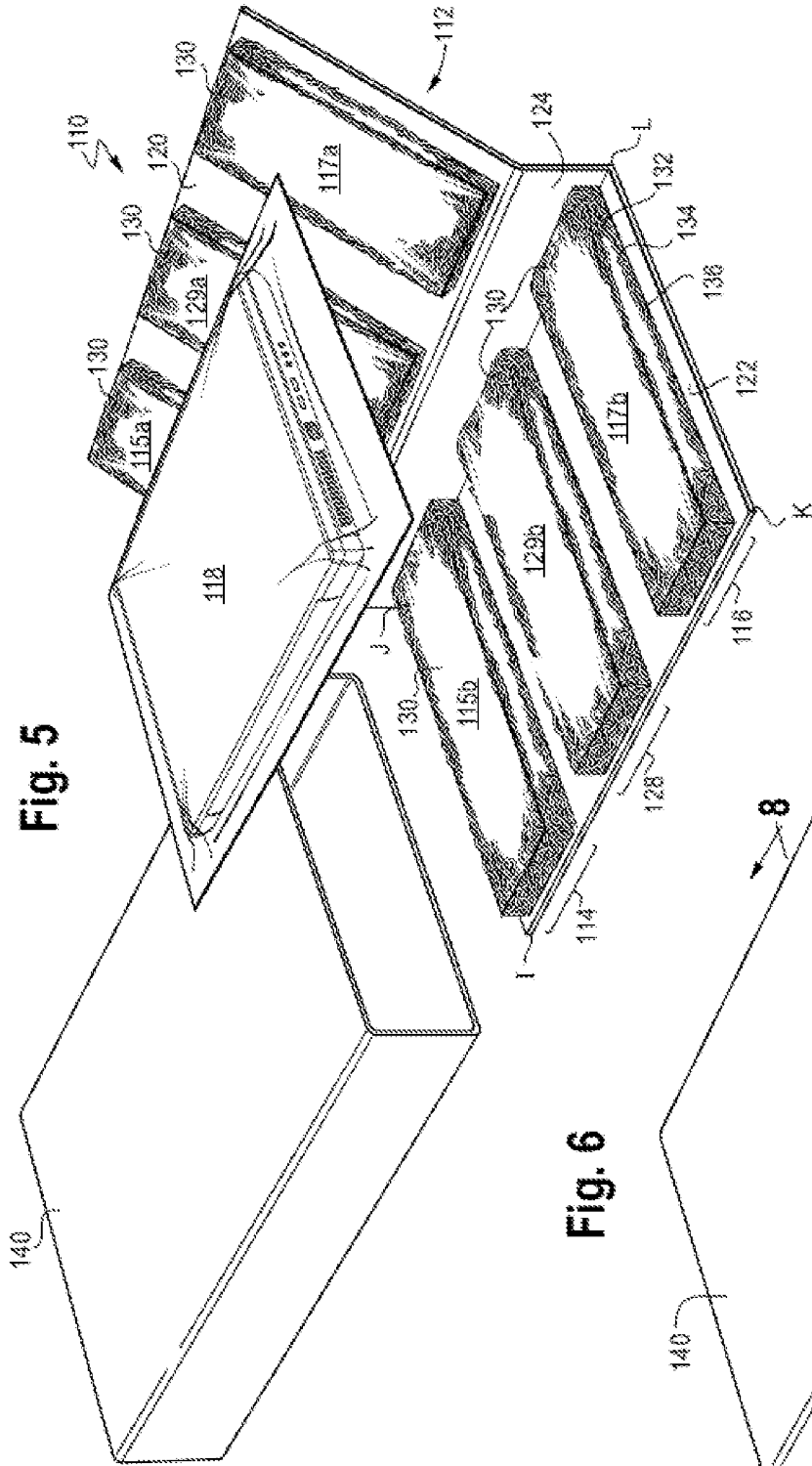


Fig. 4





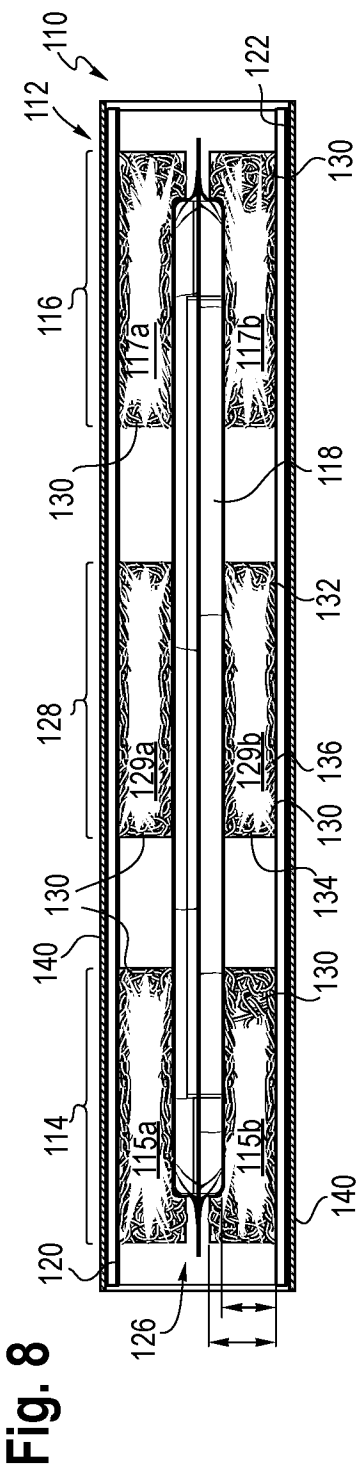
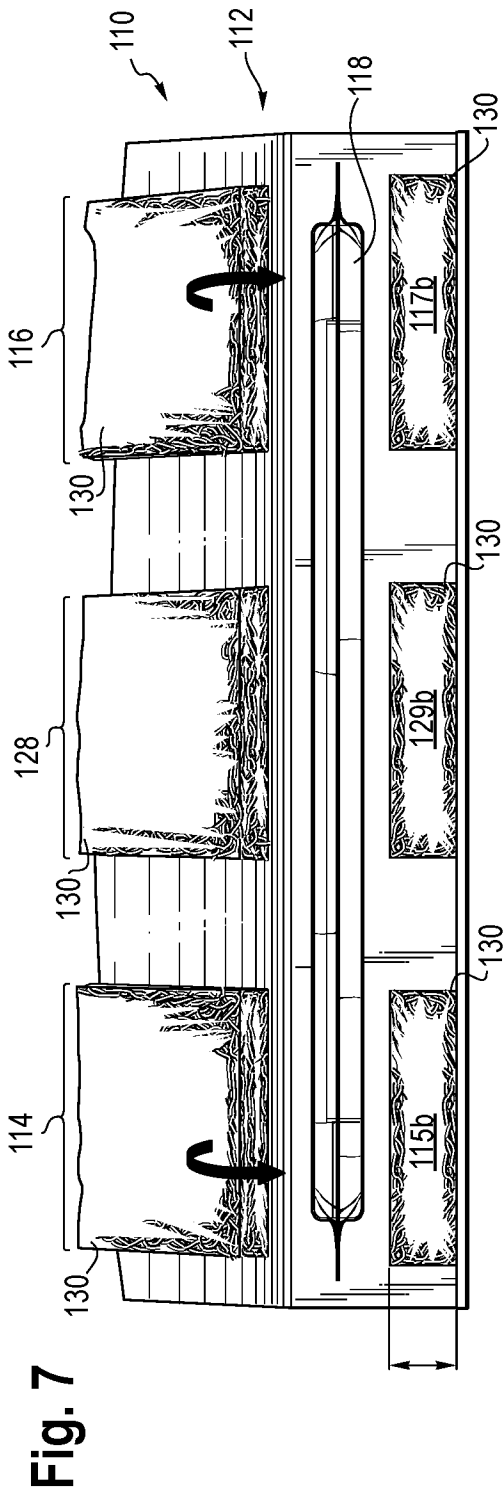


Fig. 9

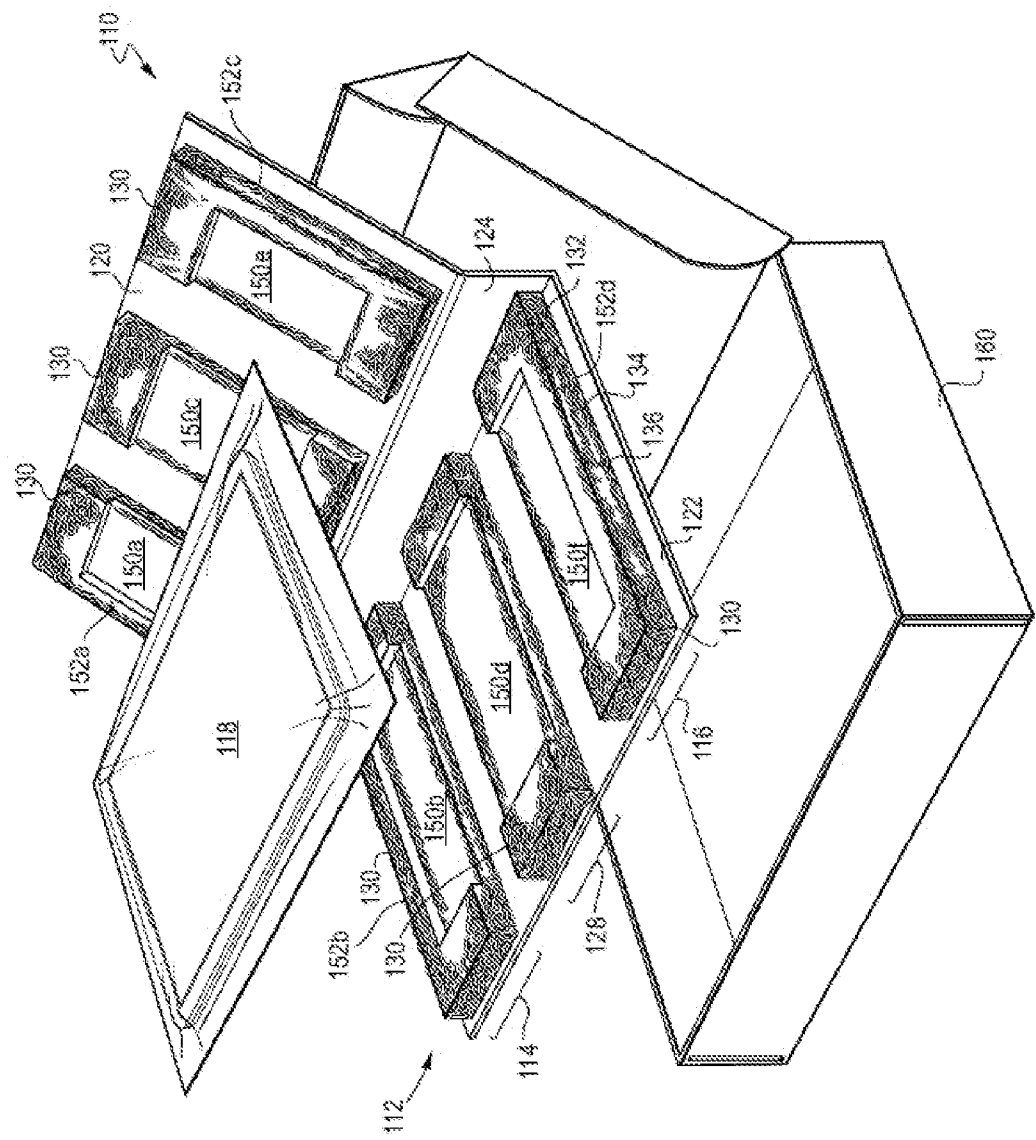


Fig. 10

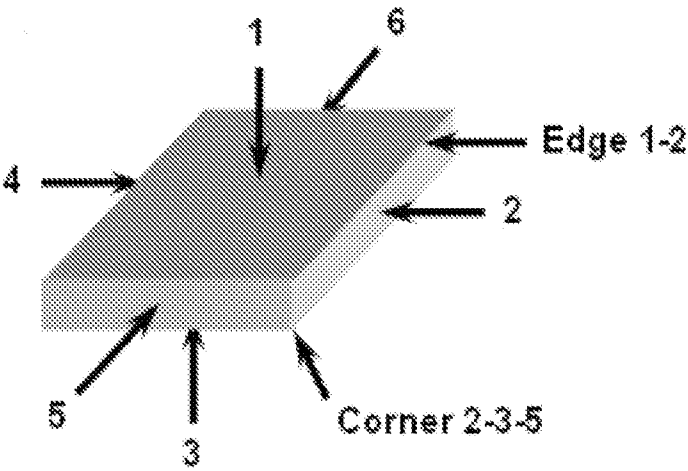
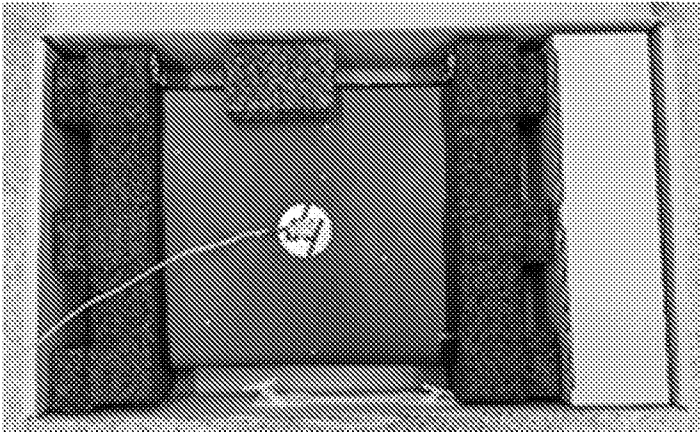


Fig. 11



INTERNATIONAL SEARCH REPORT

International application No
PCT/US2017/068466

A. CLASSIFICATION OF SUBJECT MATTER INV. B65D5/50 B65D81/03 B65D81/05 B65D81/107 B65D81/113 ADD.		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) B65D		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) EPO-Internal		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2010/200436 A1 (GUPTA NIKHIL [US]) 12 August 2010 (2010-08-12) figure 1 -----	1-6, 10-12, 14
Y	US 5 271 499 A (VAN HORSSSEN CHARLES A [US]) 21 December 1993 (1993-12-21) column 2, line 63 - line 7; figures 1, 2 -----	1-3, 5-9, 13
Y	US 2010/156147 A1 (VAN PATTEN MICHAEL [US]) 24 June 2010 (2010-06-24) figure 1 -----	10, 14
Y	WO 2014/179293 A1 (KEENE BUILDING PRODUCTS CO INC [US]) 6 November 2014 (2014-11-06) page 4, line 29 - page 5, line 5; figures 1, 3, 4 ----- -/-	1-14
☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
* Special categories of cited documents : "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 9 March 2018		Date of mailing of the international search report 19/03/2018
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016		Authorized officer Balz, Oliver

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2017/068466

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2004 149959 A (TOYO BOSEKI) 27 May 2004 (2004-05-27) abstract -----	1-14
A	JP 2015 182814 A (TEIJIN LTD) 22 October 2015 (2015-10-22) the whole document -----	1-14

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2017/068466

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2010200436	A1	12-08-2010	NONE
US 5271499	A	21-12-1993	NONE
US 2010156147	A1	24-06-2010	NONE
WO 2014179293	A1	06-11-2014	CA 2918587 A1 06-11-2014 US 2016152396 A1 02-06-2016 WO 2014179293 A1 06-11-2014
JP 2004149959	A	27-05-2004	NONE
JP 2015182814	A	22-10-2015	NONE