[0007] The present disclosure generally provides for co-extruded barrier films, bags comprising the co-extruded films, optionally in combination with one or more non-barrier films, packaged flowable products comprising the co-extruded barrier films and/or bags, and which comprise an amount of barrier material that provides good barrier performance, toughness, flex-crack resistance, and durability, while also being recyclable.

[0008] There is disclosed a co-extruded multi-layer polymeric barrier film comprising at least three layers: (i) an inner sealant layer comprising an ethylene/α-olefin copolymer fraction having a density in the range of 0.894 to 0.920 g/cm^3 in an amount of at least about 50% by weight or thickness of the total inner sealant layer, wherein the inner sealant layer has a total density in the range of 0.910 to 0.924 g/cm^3; (ii) a core barrier layer comprising ethylene-vinyl alcohol (EVOH) comprising about 0.1% to about 10% by total weight or thickness of the co-extruded multi-layer polymeric film, wherein the EVOH comprises at least 38% ethylene in the EVOH copolymer; and (iii) an outer sealant layer comprising an ethylene/α-olefin copolymer fraction having a density in the range of 0.894 to 0.920 g/cm^3 in an amount of at least about 50% by weight or thickness of the total outer sealant layer, wherein the outer sealant layer has a total density in the range of from about 0.910 to 0.924 g/cm^3.

[0009] There is disclosed a co-extruded multi-layer polymeric barrier film comprising at least three layers: (i) an inner sealant layer comprising an ethylene/α-olefin copolymer fraction having a density in the range of 0.894 to 0.920 g/cm^3 in an amount of at least about 50% by weight or thickness of the total inner sealant layer, wherein the inner sealant layer has a total density in the range of 0.910 to 0.924 g/cm^3; (ii) a core barrier layer comprising ethylene-vinyl alcohol (EVOH) comprising about 0.1% to about 5% by total weight or thickness of the co-extruded multi-layer polymeric film, wherein the EVOH comprises at least 38% ethylene in the EVOH copolymer; and (iii) an outer sealant layer comprising an ethylene/α-olefin copolymer fraction having a density in the range of 0.894 to 0.920 g/cm^3 in an amount of at least about 50% by weight or thickness of the total outer sealant layer, wherein the outer sealant layer has a total density in the range of from about 0.910 to 0.924 g/cm^3.

[0010] There is disclosed a co-extruded multi-layer polymeric film comprising five layers: (i) an inner sealant layer comprising an ethylene/α-olefin copolymer fraction having a density in the range of 0.894 to 0.920 g/cm^3 in an amount of at least about 50% by weight or thickness of the total inner sealant layer, wherein the inner sealant layer has a total

density in the range of from about 0.910 to 0.924 g/cm^3; (ii) a first and a second interposed layer comprising an ethylene/α-olefin copolymer fraction having a density in the range of 0.894 to 0.920 g/cm^3 in an amount of at least about 50% by weight or thickness of the first interposed layer, and an adhesive or tie resin in an amount effective to improve adhesion of the first and the second interposed layer to at least one other layers in the co-extruded multi-layer polymeric film, wherein the first and the second interposed layer has a total density in the range of from about 0.910 to 0.924 g/cm^3; (iii) a core barrier layer comprising ethylene-vinyl alcohol (EVOH) comprising about 0.1% to about 10% by total weight or thickness of the co-extruded multi-layer polymeric film, wherein the EVOH comprises at least 38% ethylene in the EVOH copolymer; and (iv) an outer sealant layer comprising an ethylene/α-olefin copolymer fraction having a density in the range of 0.894 to 0.920 g/cm^3 in an amount of at least about 50% by weight or thickness of the total outer sealant layer, wherein the outer sealant layer has a total density in the range of from about 0.910 to 0.924 g/cm^3.

[0011] There is disclosed a co-extruded multi-layer polymeric film comprising five layers: (i) an inner sealant layer comprising an ethylene/α-olefin copolymer fraction having a density in the range of 0.894 to 0.920 g/cm^3 in an amount of at least about 50% by weight or thickness of the total inner sealant layer, wherein the inner sealant layer has a total density in the range of from about 0.910 to 0.924 g/cm^3; (ii) a first and a second interposed layer comprising an ethylene/α-olefin copolymer fraction having a density in the range of 0.894 to 0.920 g/cm^3 in an amount of at least about 50% by weight or thickness of the first interposed layer, and an adhesive or tie resin in an amount effective to improve adhesion of the first and the second interposed layer to at least one other layers in the co-extruded multi-layer polymeric film, wherein the first and the second interposed layer has a total density in the range of from about 0.910 to 0.924 g/cm^3; (iii) a core barrier layer comprising ethylene-vinyl alcohol (EVOH) comprising about 0.1% to about 5% by total weight or thickness of the co-extruded multi-layer polymeric film, wherein the EVOH comprises at least 38% ethylene in the EVOH copolymer; and (iv) an outer sealant layer comprising an ethylene/α-olefin copolymer fraction having a density in the range of 0.894 to 0.920 g/cm^3 in an amount of at least about 50% by weight or thickness of the total outer sealant layer, wherein the outer sealant layer has a total density in the range of from about 0.910 to 0.924 g/cm^3.

[0012] There is disclosed a co-extruded multi-layer polymeric film comprising seven layers: (i) an inner sealant layer comprising an ethylene/α-olefin copolymer fraction having a density in the range of 0.894 to 0.920 g/cm^3 in an amount of at least about 50% by weight or thickness of the total inner sealant layer, wherein the inner sealant layer has a total density in the range of from about 0.910 to 0.924 g/cm^3; (ii) a first and a second outer interposed layer, and a first and a second inner interposed layer, wherein all the interposed layers comprise an ethylene/α-olefin copolymer fraction having a density in the range of 0.894 to 0.920 g/cm^3 in an amount of at least about 50% by weight or thickness of the first interposed layer, wherein all the interposed layers have a total density in the range of from about 0.910 to 0.924 g/cm^3, and wherein the first and second inner interposed layers comprise an adhesive or tie resin in an amount effective to improve adhesion of the first and the second inner interposed layer to at least one layer in the co-extruded multi-layer polymeric film; (iii) a core barrier layer adjacent to and located between the first and the second inner interposed layers, the core barrier layer comprising ethylene-vinyl alcohol (EVOH) comprising about 0.1% to about 10% by total weight or thickness of the co-extruded multi-layer polymeric film, wherein the EVOH comprises at least 38% ethylene in the EVOH copolymer; and (iv) an outer sealant layer comprising an ethylene/α-olefin copolymer fraction having a density in the range of 0.894 to 0.920 g/cm^3 in an amount of at least about 50% by weight or thickness of the total outer sealant layer, wherein the outer sealant layer has a total density in the range of from about 0.910 to 0.924 g/cm^3.

[0013] There is disclosed a co-extruded multi-layer polymeric film comprising seven layers: (i) an inner sealant layer comprising an ethylene/α-olefin copolymer fraction having a density in the range of 0.894 to 0.920 g/cm^3 in an amount of at least about 50% by weight or thickness of the total inner sealant layer, wherein the inner sealant layer has a total density in the range of from about 0.910 to 0.924 g/cm^3; (ii) a first and a second outer interposed layer, and a first and a second inner interposed layer, wherein all the interposed layers comprise an ethylene/α-olefin copolymer fraction having a density in the range of 0.894 to 0.920 g/cm^3 in an amount of at least about 50% by weight or thickness of the first interposed layer, wherein all the interposed layers have a total density in the range of from about 0.910 to 0.924 g/cm^3, and wherein the first and second inner interposed layers comprise an adhesive or tie resin in an amount effective to improve adhesion of the first and the second inner interposed layer to at least one layer in the co-extruded multi-layer polymeric film; (iii) a core barrier layer adjacent to

range of 0.894 to 0.920 g/cm^3 in an amount of at least 50% by weight or thickness of the total inner sealant layer, wherein the inner sealant layer has a total density in the range of from 0.910 to 0.924 g/cm^3; (ii) a first and a second interposed layer comprising an ethylene/α-olefin copolymer fraction having a density in the range of 0.894 to 0.920 g/cm^3 in an amount of at least 50% by weight or thickness of the first interposed layer, and an adhesive or tie resin in an amount effective to improve adhesion of the first and the second interposed layer to at least one other layers in the co-extruded multi-layer polymeric film, wherein the first and the second interposed layer has a total density in the range of from 0.910 to 0.924 g/cm^3; (iii) a core barrier layer comprising ethylene-vinyl alcohol (EVOH) copolymer comprising 0.1% to 5% by total weight or thickness of the co-extruded multi-layer polymeric film, or of the combined weight or thickness of the barrier and non-barrier films, wherein the EVOH copolymer comprises at least 38% ethylene in the EVOH copolymer; and (iv) an outer sealant layer comprising an ethylene/α-olefin copolymer fraction having a density in the range of 0.894 to 0.920 g/cm^3 in an amount of at least 50% by weight or thickness of the total outer sealant layer, wherein the outer sealant layer has a total density in the range of from 0.910 to 0.924 g/cm^3.

[0026] In some embodiments of the above aspect, the bag may comprise a first and a second outer interposed layer, and a first and a second inner interposed layer, wherein all the interposed layers comprise an ethylene/α-olefin copolymer fraction having a density in the range of 0.894 to 0.920 g/cm^3 in an amount of at least 50% by weight or thickness of the first interposed layer, wherein all the interposed layers have a total density in the range of from 0.910 to 0.924 g/cm^3, and wherein the first and second inner interposed layers comprise an adhesive or tie resin in an amount effective to improve adhesion of the first and the second inner interposed layer to at least one layer in the co-extruded multi-layer polymeric film; and wherein the core barrier layer is adjacent to and located between the first and the second inner interposed layers.

[0027] In some aspects, the disclosure provides a packaged product comprising the co-extruded multi-layer polymeric barrier films described herein.

[0028] In some aspects, the disclosure provides a packaged product comprising the bags for packaging flowable materials described herein.

[0029] In some aspects, the disclosure provides a method for manufacturing the co-extruded multi-layer polymeric barrier films described herein.

[0030] In some aspects, the disclosure provides a method for manufacturing the bags for packaging flowable materials described herein.

[0031] In some aspects, the disclosure provides a method for packaging a flowable product comprising the co-extruded multi-layer polymeric barrier films described herein.

[0032] In some aspects, the disclosure provides a method for packaging a flowable product comprising the bags described herein.

[0032a] In another aspect, the disclosure provides a bag for packaging post mix syrup comprising at least one screw-on fitment, a recyclable barrier co-extruded multi-layer polymeric film and a non-barrier co-extruded multi-layer polymeric film, wherein the barrier co-extruded multi-layer polymeric film comprises (i) an inner sealant layer comprising an ethylene/α-olefin copolymer fraction having a density in the range of 0.894 to 0.920 g/cm^3 in an amount of at least 50% by weight or thickness of the total inner sealant layer, wherein the inner sealant layer has a total density in the range of from 0.910 to 0.924 g/cm^3; (ii) a first and a second interposed layer comprising an ethylene/α-olefin copolymer fraction having a density in the range of 0.894 to 0.920 g/cm^3 in an amount of at least 50% by weight or thickness of the first interposed layer, and an adhesive or tie resin in an amount effective to improve adhesion of the first and the second interposed layer to at least one other layers in the co-extruded multi-layer polymeric film, wherein the first and the second interposed layer has a total density in the range of from 0.910 to 0.924 g/cm^3; (iii) a core barrier layer comprising ethylene-vinyl alcohol (EVOH) copolymer comprising 0.1% to 10% by total weight or thickness of the co-extruded multi-layer polymeric film, or 5% or less of the combined weight or thickness of the barrier and non-barrier films, wherein the EVOH copolymer comprises at least 38% ethylene in the EVOH copolymer; and (iv) an outer sealant layer comprising an ethylene/α-olefin copolymer fraction having a density in the range of 0.894 to 0.920 g/cm^3 in an amount of at least 50% by weight or thickness of the total outer sealant layer, wherein the outer sealant layer has a total density in the range of from 0.910 to 0.924 g/cm^3, and wherein the bag passes a standard 40 inch drop test when filled with post mix syrup.

[0033] Additional aspects and embodiments of the disclosure will be apparent to one of ordinary skill in the art in view of the following description and illustrative examples.

BRIEF DESCRIPTION OF THE DRAWINGS

[0034] FIGS. 1A – 1D illustrate a series of general schematic depictions of multi-layer non-barrier films in accordance with several example aspects and embodiments described herein. FIG. 1A depicts an example embodiment of a three layer non-barrier film. FIG. 1B depicts a five layer non-barrier film. FIG 1C depicts a seven layer non-barrier film. FIG 1D depicts a seven layer non-barrier film, wherein four of the seven layers comprise a plurality of individual stacked layers of the same material to form the entire layer.

[0035] FIGS. 2A – 2D illustrate a series of general schematic depictions of multi-layer barrier films in accordance with several example aspects and embodiments described herein. FIG. 2A depicts an example embodiment of a three layer barrier film, wherein the interior layer comprises the barrier layer. FIG. 2B depicts a five layer barrier film, wherein the interior layer comprises the barrier layer. FIG 2C depicts a seven layer barrier film, wherein the interior layer comprises the barrier layer. FIG 2D depicts a seven layer barrier film, wherein five of the seven layers – including the interior barrier layer – comprise a plurality of individual stacked layers of the same material to form the entire layer.

[0036] FIGS. 3A – 3D illustrate a series of general schematic depictions of a 2-ply film structure that includes the multi-layer barrier and non-barrier films in accordance with several example aspects and embodiments described herein. FIG. 3A depicts an example embodiment of a 2-ply film structure that includes the three layer non-barrier and barrier films depicted in FIGS. 1A and and 2A, respectively, wherein the "outer" ply comprises the barrier layer, and the "inner" ply comprises the non-barrier layer. In each of the embodiments depicted in FIGS. 3A-3D, the outer and inner plies are not joined together except at the edges (seals) to form the bags.

CLAIMS

We Claim:

1. A bag for packaging flowable materials comprising a recyclable barrier co-extruded multi-layer polymeric film and a non-barrier co-extruded multi-layer polymeric film, wherein the barrier co-extruded multi-layer polymeric film comprises

(i) an inner sealant layer comprising an ethylene/α-olefin copolymer fraction having a density in the range of 0.894 to 0.920 g/cm^3 in an amount of at least 50% by weight or thickness of the total inner sealant layer, wherein the inner sealant layer has a total density in the range of from 0.910 to 0.924 g/cm^3;

(ii) a first and a second interposed layer comprising an ethylene/α-olefin copolymer fraction having a density in the range of 0.894 to 0.920 g/cm^3 in an amount of at least 50% by weight or thickness of the first interposed layer, and an adhesive or tie resin in an amount effective to improve adhesion of the first and the second interposed layer to at least one other layers in the co-extruded multi-layer polymeric film, wherein the first and the second interposed layer has a total density in the range of from 0.910 to 0.924 g/cm^3;

(iii) a core barrier layer comprising ethylene-vinyl alcohol (EVOH) copolymer comprising 0.1% to 10% by total weight or thickness of the co-extruded multi-layer polymeric film, or 5% or less of the combined weight or thickness of the barrier and non-barrier films, wherein the EVOH copolymer comprises at least 38% ethylene in the EVOH copolymer; and

(iv) an outer sealant layer comprising an ethylene/α-olefin copolymer fraction having a density in the range of 0.894 to 0.920 g/cm^3 in an amount of at least 50% by weight or thickness of the total outer sealant layer, wherein the outer sealant layer has a total density in the range of from 0.910 to 0.924 g/cm^3.

2. A bag for packaging flowable materials comprising a recyclable barrier co-extruded multi-layer polymeric film and a non-barrier co-extruded multi-layer polymeric film, wherein the barrier co-extruded multi-layer polymeric film comprises

(i) an inner sealant layer comprising an ethylene/α-olefin copolymer fraction having a density in the range of 0.894 to 0.920 g/cm^3 in an amount of at least 50% by weight or

thickness of the total inner sealant layer, wherein the inner sealant layer has a total density in the range of from 0.910 to 0.924 g/cm^3;

(ii) a first and a second outer interposed layer, and
a first and a second inner interposed layer, wherein all the interposed layers comprise an ethylene/α-olefin copolymer fraction having a density in the range of 0.894 to 0.920 g/cm^3 in an amount of at least 50% by weight or thickness of the first interposed layer, wherein all the interposed layers have a total density in the range of from 0.910 to 0.924 g/cm^3, and wherein the first and second inner interposed layers comprise an adhesive or tie resin in an amount effective to improve adhesion of the first and the second inner interposed layer to at least one layer in the co-extruded multi-layer polymeric film;

(iii) a core barrier layer adjacent to and located between the first and the second inner interposed layers, the core barrier layer comprising ethylene-vinyl alcohol (EVOH) copolymer comprising 0.1% to 10% by total weight or thickness of the co-extruded multi-layer polymeric film, or 5% or less of the combined weight or thickness of the barrier and non-barrier films, wherein the EVOH copolymer comprises at least 38% ethylene in the EVOH copolymer; and

(iv) an outer sealant layer comprising an ethylene/α-olefin copolymer fraction having a density in the range of 0.894 to 0.920 g/cm^3 in an amount of at least 50% by weight or thickness of the total outer sealant layer, wherein the outer sealant layer has a total density in the range of from 0.910 to 0.924 g/cm^3.

3. The bag of any of Claim 1 or Claim 2, wherein the thickness of each of the barrier film and the non-barrier film is from 1 mil to 5 mils.

4. The bag of any of Claim 1 or Claim 2, wherein the thickness of the non-barrier film is greater than the barrier film.

5. The bag of Claim 4, wherein the thickness of the non-barrier film is 3.8 mil and the thickness of the barrier film is 1.8 mil.

6. The bag of any of Claim 1 or Claim 2, wherein the EVOH layer in the barrier co-extruded multi-layer polymeric film has a percent weight or thickness relative to the entire film selected from the following numbers: 0.5, 0.6, 0.7, 0.8, 0.9, 1.0, 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8, 1.9, 2.0, 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9, 3.0, 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 3.9, 4.0, 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, and 5.0.

7. The bag of any of Claim 1 or Claim 2, wherein the bag is configured to empty from 95% to 99.9% of its contents without incorporating any evacuation aid device.

8. The bag according to any of Claim 1 or Claim 2, wherein the barrier co-extruded multi-layer polymeric comprises an ethylene/a-olefin interpolymer in at least one of the inner sealant layer, the outer sealant layer, the first interposed layer, or the second interposed layer comprises a polymer fraction of linear low density polyethylene and a second copolymer fraction of an ethylene/octene-1 copolymer, an ethylene/hexene- 1 copolymer, or an ethylene/butene-1 copolymer.

9. The bag according to any of Claim 1 or Claim 2, wherein the interpolymer has a density of 0.915 g/cm3 and a melt index of 0.80-1.0 dg/min.

10. The bag according to any of Claim 1 or Claim 2, wherein the barrier co-extruded multi-layer polymeric film comprises an ethylene/a-olefin interpolymer comprising at least one metallocene linear low density polyethylene (mLLDPE) having a density of 0.912 g/cm3.

11. The bag according to any of Claim 1 or Claim 2, wherein the barrier co-extruded multi-layer polymeric film comprises a mole percent of ethylene in said EVOH copolymer selected from the following numbers: 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, and 55.

12. The bag according to any of Claim 1 or Claim 2, wherein the barrier co-extruded multi-layer polymeric film comprises an ethylene/a-olefin interpolymer in at least one of the inner

sealant layer, the outer sealant layer, the first interposed layer, or the second interposed layer having a melt index in the range of 0.2 to 2.0 dg/min.

13. The bag according to any of Claim 1 or Claim 2, wherein the barrier co-extruded multi-layer polymeric film comprises an ethylene/a-olefin interpolymer in at least one of the inner sealant layer, the outer sealant layer, the first interposed layer, or the second interposed layer having a zero shear viscosity ratio (ZSVR) in the range of 1.15 to 2.5.

14. The bag according to any of Claim 1 or Claim 2, wherein the barrier co-extruded multi-layer polymeric film comprises an ethylene/a-olefin interpolymer in at least one of the inner sealant layer, the outer sealant layer, the first interposed layer, or the second interposed layer having a molecular weight distribution, expressed as the ratio of the weight average molecular weight to number average molecular weight (Mw/Mn) in the range of 2.0 - 4.0.

15. The bag according to any of Claim 1 or Claim 2, wherein the barrier co-extruded multi-layer polymeric film comprises at least one outer sealant layer, said at least one inner sealant layer, said core layer, said first at least one interposed layer, and said second at least one interposed layer, individually, comprises from a single layer up to and including 45 layers.

16. A bag for packaging post mix syrup comprising at least one screw-on fitment, a recyclable barrier co-extruded multi-layer polymeric film, and a non-barrier co-extruded multi-layer polymeric film, wherein the barrier co-extruded multi-layer polymeric film comprises

(i) an inner sealant layer comprising an ethylene/α-olefin copolymer fraction having a density in the range of 0.894 to 0.920 g/cm^3 in an amount of at least 50% by weight or thickness of the total inner sealant layer, wherein the inner sealant layer has a total density in the range of from 0.910 to 0.924 g/cm^3;

(ii) a first and a second interposed layer comprising an ethylene/α-olefin copolymer fraction having a density in the range of 0.894 to 0.920 g/cm^3 in an amount of at least 50% by weight or thickness of the first interposed layer, and an adhesive or tie resin in an amount effective to improve adhesion of the first and the second interposed layer to at least one other layers in the co-extruded multi-layer polymeric film, wherein the first

and the second interposed layer has a total density in the range of from 0.910 to 0.924 g/cm^3;

(iii) a core barrier layer comprising ethylene-vinyl alcohol (EVOH) copolymer comprising 0.1% to 10% by total weight or thickness of the co-extruded multi-layer polymeric film, or 5% or less of the combined weight or thickness of the barrier and non-barrier films, wherein the EVOH copolymer comprises at least 38% ethylene in the EVOH copolymer; and

(iv) an outer sealant layer comprising an ethylene/α-olefin copolymer fraction having a density in the range of 0.894 to 0.920 g/cm^3 in an amount of at least 50% by weight or thickness of the total outer sealant layer, wherein the outer sealant layer has a total density in the range of from 0.910 to 0.924 g/cm^3; and

wherein the bag passes a standard 40 inch drop test when filled with post mix syrup.