

PERFLUOROALKYL AND POLYFLUOROALKYL SUBSTANCE-FREE POLYMER PROCESSING AIDS

CROSS-REFERENCES TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Patent Application Serial No. 63/461,774, filed April 25, 2023, the entire contents of which are incorporated herein by reference.

TECHNICAL FIELD

[0002] The present disclosure relates to polymer processing aids and, more specifically, to metal soap compositions free of perfluoroalkyl and polyfluoroalkyl substances and polymers processed in the presence of the metal soap compositions.

BACKGROUND

[0003] Melt processing low viscosity polyolefins, e.g. polyethylene with melt indexes (MI) less than 1.0 g/10 min at 2.16 kg and 190 °C, or resins with very narrow molecular weight distribution, e.g. metallocene catalyzed linear low density polyethylene (mLLDPE), often requires the assistance of lubricants during melt processing. The lubricants are used for multiple reasons including: to improve surface smoothness, gloss, or haze; to reduce extruder torque and pressure; to increase throughput; to prevent die buildup; and generally to improve the functionality/robustness of the extruded/molded part.

[0004] For the last few decades, fluoropolymers such as polyvinylidene difluoride (PVDF) and similar fluorinated copolymers have dominated the market as polymer processing aids (PPAs). These fluorinated copolymers result in microscopic insoluble domains of fluoropolymer. When extruded, these molten fluoropolymer domains contact metal surfaces in the extruder or die and will hydrogen bond to the metal, creating an insoluble, low coefficient of friction barrier between the extruded polymer and metal. This barrier changes the flow characteristics of the polyolefin in the extruder and the die. The flow pattern of the polyolefin will change from parabolic flow to a less turbulent more plug like flow type of rheology. This plug flow results in a smooth surface with fewer surface defects and eliminates melt fracture at the surface when the polymer leaves the die.

[0005] Metal salts of long chain naturally occurring fatty acids have been used for many decades during the production of polyolefins for their ability to be both antacids and lubricants.

As antacids, they react with hydrochloric acid produced from Ziegler Natta catalyst systems to prevent damage to both the equipment and the polymer. As dimers of long chain fatty acids, they also make good lubricants for polyolefins, owing to their slight polarity and their waxy 36-carbon composition.

[0006] Typically, metal soaps are used as simple lubricants such as mold releases or to assist in lubrication for easier to process resins. Before the introduction of PVDF and similar fluorinated polymers, metal soaps were used as process aids for the broader molecular weight LLDPE produced from Ziegler Natta catalysts and other systems. These polymers, especially resins such as bimodal polyethylenes, often need lesser amounts of lubrication to overcome the rheological limitations of processing. With the popularization and growth over the past 20 years of metallocene polyolefins, specifically mLLDPE, the use of PPAs has become a necessity and a standard way of doing business in the polyolefin market. Since their introduction, PPAs have all but eliminated the need for metal soaps as lubricants and have allowed for the manufacture of difficult to process resins such as mLLDPE.

[0007] Despite all the advantages of fluoropolymer PPAs, recent changes in regulations have resulted in state-by-state bans of fluorinated organic materials. This is driven by the findings that certain PFAS (per and polyfluoro alkylated substances) cause cancer and other harm to humans and animals. Since fluoropolymers such as PVDF fall into the category of PFAS, these substances are being banned. Examples of these bans include Jan 1, 2023: California bans PFAS on paper products; Dec 31, 2023/Jan 1, 2024: Colorado, Connecticut, Maryland, Minnesota, New York, Rhode Island, and Vermont ban PFAS in food packaging. These issues have resulted in an immediate need to switch from fluoropolymer processing aids to an alternate lubricant.

[0008] The elimination of traditional fluoropolymer PPAs will affect a variety of polyolefin applications including blown films, pipes, wire and cable insulation, and cast films. This will result in the reformulation of many resins, including mLLDPE, high molecular weight high density polyethylene (HDPE), and polypropylene (PP). These markets will need to switch away from the fluoropolymers to retain compliance or to not have hazard warnings placed on the products. Development and implementation of lubricant systems that comply with the FDA guidelines and other global regulations is an ongoing and immediate need.

SUMMARY

[0009] According to a first aspect of the present disclosure, a polymer processing composition comprises a metal soap and an inorganic antacid, wherein the polymer processing composition is overbased to an overbasing level of at least 0.1%, wherein the overbasing level is defined as $n_2/n_1 \times 100$, where n_1 represents moles of the metal soap in the polymer processing composition and n_2 represents moles of the inorganic antacid in the polymer processing composition.

[0010] A second aspect includes the first aspect, wherein the overbasing level is greater than or equal to 1% and less than or equal to 90%.

[0011] A third aspect include the first aspect, wherein the overbasing level is greater than or equal to 3% and less than or equal to 65%.

[0012] A fourth aspect include the first aspect, wherein the overbasing level is greater than or equal to 8% and less than or equal to 50%.

[0013] A fifth aspect includes any one of the first through fourth aspects, wherein the metal soap of the polymer processing composition comprises: an external lubricant in an amount from 20% to 75% by mass, based on the total mass of the polymer processing composition; an internal lubricant in an amount from 10% to 60% by mass, based on the total mass of the polymer processing composition; and the inorganic antacid of the polymer processing composition comprises: a metal-oxide in an amount from 0.1% to 10% by mass, based on the total mass of the polymer processing composition; and a metal-hydroxide in an amount between 0% and 10% by mass, based on the total mass of the polymer processing composition.

[0014] A sixth aspect includes any one of the first through fourth aspects, wherein the metal soap of the polymer processing composition comprises: an external lubricant in an amount from 20% to 75% by mass, based on the total mass of the polymer processing composition; an internal lubricant in an amount from 10% to 60% by mass, based on the total mass of the polymer processing composition; and the inorganic antacid of the polymer processing composition comprises: a metal-oxide in an amount from 0.2% to 5% by mass, based on the total mass of the polymer processing composition; and a metal-hydroxide in an amount between 0% and 2% by mass, based on the total mass of the polymer processing composition.

[0015] A seventh aspect includes any one of the fifth or sixth aspects, wherein the metal-hydroxide is present in the polymer processing composition in an amount between 0.2% and 2% by mass, based on the total mass of the polymer processing composition.

[0016] An eighth aspect includes any one of the fifth through seventh aspects, wherein: the external lubricant is a fatty acid salt of zinc or magnesium; the internal lubricant is a fatty acid salt of calcium; the metal-oxide is chosen from zinc oxide, magnesium oxide, calcium oxide, strontium oxide, barium oxide, or combinations thereof; and the metal-hydroxide is chosen from calcium hydroxide, zinc hydroxide, magnesium hydroxide, strontium hydroxide, barium hydroxide, or combinations thereof.

[0017] A ninth aspect includes any one of the fifth through eighth aspects, wherein: the external lubricant is zinc stearate, magnesium stearate, or combination thereof; and the internal lubricant is calcium stearate.

[0018] A tenth aspect includes any one of the fifth through ninth aspects, wherein: the external lubricant is zinc stearate; the internal lubricant is calcium stearate; the metal-oxide is zinc oxide; and the metal-hydroxide is calcium hydroxide.

[0019] An eleventh aspect includes any one of the first through tenth aspects, further comprising up to 50% by mass organic lubricant, based on the total mass of the polymer processing composition.

[0020] A twelfth aspect includes the eleventh aspect, wherein the organic lubricant is chosen from ethylene bis behenate, pentaerythritol tetrastearate, pentaerythritol adipate stearate, ethylene bis stearamide, glycerol mono and distearate, glycerol monoleate, glycerol tristearate, stearamide, behenamide, or combinations thereof.

[0021] A thirteenth aspect includes any one of the first through twelfth aspects, wherein the polymer processing composition is substantially free of perfluoroalkyl and polyfluoroalkyl substances.

[0022] A fourteenth aspect includes any one of the first through thirteenth aspects, wherein the polymer processing composition is substantially free of partitioning agents.

[0023] According to a fifteenth aspect of the present disclosure, a masterbatch comprises a carrier polymer and the polymer processing composition according to any one of the first through fourteenth aspects to obtain an initial mixture.

[0024] A sixteenth aspect includes the fifteenth aspect, wherein the masterbatch is formed by an extrusion process.

[0025] A seventeenth aspect includes any one of the fifteenth or sixteenth aspects, wherein the polymer processing composition is present in an amount from 1 wt% to 80 wt%, based on the total weight of the masterbatch.

[0026] An eighteenth aspect includes any one of the fifteenth through seventeenth aspects, wherein the carrier polymer is LDPE, LLDPE, HDPE, or polypropylene.

[0027] According to a nineteenth aspect of the present disclosure, a polymer resin comprises a polymer material and the masterbatch of any one of the fifteenth through eighteenth aspects.

[0028] A twentieth aspect includes the nineteenth aspect, wherein the polymer material comprises LLDPE or a copolymer of LLDPE with an alpha-olefin chosen from 1-butene, 1-hexene, or 1-octene.

[0029] A twenty-first aspect includes the nineteenth aspect, wherein the polymer material comprises a metallocene-catalyst derived LLDPE.

[0030] A twenty-second aspect includes the nineteenth aspect, wherein the polymer material is HDPE.

[0031] A twenty-third aspect includes the nineteenth aspect, wherein the polymer material is polypropylene.

[0032] According to a twenty-fourth aspect of the present disclosure, a method for processing a polymer comprises: combining a polymer material and the polymer processing composition according to any one of the first through fourteenth aspects to obtain an initial mixture; and processing the initial mixture to obtain a final article.

[0033] A twenty-fifth aspect includes the twenty-fourth aspect, further comprising preparing a masterbatch comprising the polymer processing composition and a carrier polymer, then combining the polymer material and the masterbatch to obtain the initial mixture.

[0034] According to a twenty-sixth aspect of the present disclosure, a method for processing a polymer comprises: combining a polymer material, n_1 moles of metal soap, and n_2 moles of inorganic antacid to obtain an initial mixture, wherein: $n_2/n_1 \times 100$ is at least 0.1%; and the metal soap and the inorganic acid are present in a combined amount in the polymer material of from 500

ppm to 10,000 ppm, based on the total mass of the polymer material; and processing the initial mixture to obtain a final article.

[0035] A twenty-seventh aspect includes the twenty-sixth aspect, further comprising preparing one or more masterbatches each comprising a carrier material and together including the n_1 moles of metal soap and n_2 moles of inorganic antacid, then combining the polymer material and the one or more masterbatches to obtain the initial mixture.

[0036] A twenty-eighth aspect includes any one of the twenty-fourth through twenty-seventh aspects, wherein the processing comprises processing the initial mixture by extruding, injection molding, blow molding, cast polymer molding, blown film extrusion, profile extrusion, fiber spinning, or combinations thereof.

[0037] A twenty-ninth aspect includes any one of the twenty-fourth through twenty-eighth aspects, wherein wherein the polymer material comprises LLDPE or a copolymer of LLDPE with an alpha-olefin chosen from 1-butene, 1-hexene, or 1-octene.

[0038] A thirtieth aspect includes any one of the twenty-fourth through twenty-ninth aspects, wherein the polymer material comprises a metallocene-catalyst derived LLDPE.

[0039] A thirty-first aspect includes any one of the twenty-fourth through twenty-eighth aspects, wherein the polymer material is HDPE and the final article is a pipe.

[0040] A thirty-second aspect includes any one of the twenty-fourth through twenty-eighth aspects, wherein the polymer material is polypropylene and the processing comprises blow molding.

[0041] According to a thirty-third aspect of the present disclosure, a method of making a polymer processing composition comprises providing an neutral composition comprising a metal soap; and adding, to the neutral composition, an inorganic antacid thereby forming an overbased composition having an overbasing level level of at least 0.1%; the overbasing level is defined as $n_2/n_1 \times 100$, where n_1 represents moles of the metal soap in the polymer processing composition and n_2 represents moles of the inorganic antacid in the polymer processing composition.

[0042] A thirty-fourth aspect includes the thirty-third aspect, wherein the overbasing level is greater than or equal to 1% and less than or equal to 90%.

[0043] A thirty-fifth aspect includes the thirty-third aspect, wherein the overbasing level is greater than or equal to 3% and less than or equal to 65%.

[0044] A thirty-sixth aspect includes the thirty-third aspect, wherein the overbasing level is greater than or equal to 8% and less than or equal to 50%.

[0045] A thirty-seventh aspect includes any one of the thirty-third through thirty-sixth aspects, wherein: the metal soap of the overbased composition comprises: an external lubricant in an amount from 20% to 75% by mass, based on the total mass of the overbased composition; an internal lubricant in an amount from 10% to 60% by mass, based on the total mass of the overbased composition; and the inorganic antacid of the overbased composition comprises: a metal-oxide in an amount from 0.1% to 10% by mass, based on the total mass of the overbased composition; and a metal-hydroxide in an amount between 0% and 10% by mass, based on the total mass of the overbased composition.

[0046] A thirty-eighth aspect includes any one of the thirty-third through thirty-sixth aspects, wherein: the metal soap of the overbased composition comprises: an external lubricant in an amount from 20% to 75% by mass, based on the total mass of the overbased composition; an internal lubricant in an amount from 10% to 60% by mass, based on the total mass of the overbased composition; and the inorganic antacid of the overbased composition comprises: a metal-oxide in an amount from 0.2% to 5% by mass, based on the total mass of the overbased composition; and a metal-hydroxide in an amount between 0% and 2% by mass, based on the total mass of the overbased composition.

[0047] A thirty-ninth aspect includes any one of the thirty-seventh or thirty-eighth aspects, wherein the metal-hydroxide is present in the overbased composition in an amount between 0.2% and 2% by mass, based on the total mass of the overbased composition.

[0048] A fortieth aspect includes any one of the thirty-seventh through thirty-ninth aspects, wherein: the external lubricant is a fatty acid salt of zinc or magnesium; the internal lubricant is a fatty acid salt of calcium; the metal-oxide is chosen from zinc oxide, magnesium oxide, calcium oxide, strontium oxide, barium oxide, or combinations thereof; and the metal-hydroxide is chosen from calcium hydroxide, zinc hydroxide, magnesium hydroxide, strontium hydroxide, barium hydroxide, or combinations thereof.

[0049] A forty-first aspect includes any one of the thirty-seventh through fortieth aspects, wherein: the external lubricant is zinc stearate, magnesium stearate, or combination thereof; and the internal lubricant is calcium stearate.

[0050] A forty-second aspect includes any one of the thirty-seventh through forty-first aspects, wherein: the external lubricant is zinc stearate; the internal lubricant is calcium stearate; the metal-oxide is zinc oxide; and the metal-hydroxide is calcium hydroxide.

[0051] A forty-third aspect includes the any one of the thirty-third through forty-second aspects, further comprising adding an organic lubricant to the overbased composition such that the overbased composition comprises up to 50% by mass of the organic lubricant, based on the total mass of the overbased composition.

[0052] A forty-fourth aspect includes the forty-third aspect, wherein the organic lubricant is chosen from ethylene bis behenate, pentaerythritol tetrastearate, pentaerythritol adipate stearate, ethylene bis stearamide, glycerol mono and distearate, glycerol monooleate, glycerol tristearate, stearamide, behenamide, or combinations thereof.

[0053] A forty-fifth aspect includes any one of the thirty-third through forty-fourth aspects, wherein perfluoroalkyl and polyfluoroalkyl substances are not added to the polymer processing composition.

[0054] A forty-sixth aspect includes any one of the thirty-third through forty-fifth aspects, wherein partitioning agents are not added to the polymer processing composition.

[0055] Additional features and advantages of the embodiments described herein will be set forth in the detailed description which follows, and in part will be readily apparent to those skilled in the art from that description or recognized by practicing the embodiments described herein, including the detailed description which follows, the claims, as well as the appended drawings.

[0056] It is to be understood that both the foregoing general description and the following detailed description describe various embodiments and are intended to provide an overview or framework for understanding the nature and character of the claimed subject matter. The accompanying drawings are included to provide a further understanding of the various embodiments, and are incorporated into and constitute a part of this specification. The drawings illustrate features of the various embodiments described herein, and together with the description serve to explain the principles and operations of the claimed subject matter.

BRIEF DESCRIPTION OF THE DRAWINGS

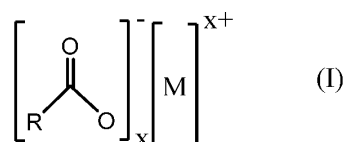
[0057] FIG. 1 is a graph of melt fracture vs. time in an evaluation of polymer processing compositions according to this disclosure.

[0058] FIG. 2 is a graph of melt fracture vs. time in an evaluation of polymer processing compositions comprising an organic lubricant according to this disclosure.

DETAILED DESCRIPTION

[0059] Polymer processing compositions described herein include a metal soap and an inorganic antacid. The metal soap may include an external lubricant and an internal lubricant. The inorganic antacid may contain a metal-oxide and, optionally, a metal-hydroxide. Example compositions include by mass based on the total mass of the composition: from 20% to 75% external lubricant; from 10% to 60% internal lubricant; from 0.2% to 5% metal-oxide inorganic antacid; and from 0 to 2% metal-hydroxide inorganic antacid.

[0060] A metal soap is generally a reaction product of a metal cation and the carboxylate end of a long chain fatty acid, and may be expressed according to formula (I) below:



[0061] where R is an unsaturated or saturated (C₈–C₃₀)alkyl, M is a metal, and x is between 1 and 6. The terms “(C₈–C₃₀)alkyl” means a saturated straight or branched hydrocarbon radical of from 8 to 30 carbon atoms that is unsubstituted or substituted by one or more R^S (e.g., one or more hydroxy groups). An R^S substituted version of the (C₈–C₃₀)alkyl may contain more than 30 carbon atoms depending on the identity of any groups R^S. For example, a (C₈–C₃₀)alkyl substituted with exactly one group R^S, where R^S is phenyl (–C₆H₅)” may contain from 14 to 36 carbon atoms. Thus, when the (C₈–C₃₀)alkyl is substituted by one or more carbon atom-containing substituents R^S, the minimum and maximum total number of carbon atoms of the (C₈–C₃₀)alkyl is determined by adding to both 8 and 30 the combined sum of the number of carbon atoms from all of the carbon atom-containing substituents R^S.

[0062] Examples of metal soaps include, without limitation, metallic stearates, metallic laurates, metallic myristates, metallic palmitates, metallic oleates, and metallic behenates. Example metal cations of metal soaps include, without limitation, zinc, calcium, magnesium, aluminum, sodium, lithium, and potassium. The metal cation of the metal soap may influence the overall reactivity of the metal soap and, due to differences in valency, determines whether one, two, or three fatty acids are coordinated to the metal cation. The choice of metal cation can also influence other properties of the metal soap including its melting point, viscosity, and lubricity, as well as color development seen upon degradation of a polymer processed with the metal soap. Examples of fatty acids of metal soaps include, without limitation, stearic acid, lauric acid, myristic acid, palmitic acid, oleic acid, and behenic acid. The fatty acids may be derived from animal (tallow) or vegetable (e.g., palm) sources.

[0063] The polymer processing compositions described herein are overbased such that a stoichiometric excess of metal is present relative to the amount required to neutralize the anion of the metal soap. The “overbasing level” of the polymer processing compositions described herein refers to the ratio, expressed as a percentage, between the moles of the inorganic antacid n_2 in the polymer processing composition divided by the moles of the metal soap n_1 in the polymer processing composition. Unless specified otherwise, the overbasing level refers to the overall overbasing of the composition, that is, the cumulative moles of the inorganic antacid divided by the cumulative moles of the metal soap. However, it should be understood that overbasing may be expressed with respect to a particular metal when multiple metal soap species are present. For example, for a polymer processing composition wherein the metal soap includes zinc stearate and the inorganic antacid includes zinc oxide, the zinc overbasing level may be calculated as the ratio, expressed as a percentage, between the moles of the zinc oxide divided by the moles of the zinc stearate. Similarly, for a polymer processing composition wherein the metal soap includes calcium stearate and the inorganic antacid includes calcium hydroxide, the calcium overbasing level may be calculated as the ratio, expressed as a percentage, between the moles of the calcium hydroxide divided by the moles of the calcium stearate.

[0064] Without intent to be bound by theory, it is believed that overbasing the metal soaps helps to regenerate the metal soaps, e.g., zinc stearate or calcium stearate, whenever the metal soaps react with acid to form, for example, calcium chloride and stearic acid. It has now been discovered that many unexpected benefits may be realized through the overbasing of polymer

processing compositions and the utilization of the same in polymer processing methods. For example, as shown herein, the use of overbased polymer processing compositions as processing aids in blown film extrusion gives better performance than traditional fluoropolymer processing aids and neutral metal soap processing aids with respect to time to clear melt fracture as well as the resulting aesthetic properties of the blown film.

[0065] In embodiments, the overbasing level of the polymer processing composition is at least 0.1%, at least 0.2%, at least 0.3%, at least 0.4%, at least 0.5%, at least 1.0%, at least 1.5%, at least 2%, at least 2.5%, at least 3.0%, at least 3.5%, at least 4.0%, at least 4.5%, at least 5.0%, at least 5.5%, at least 6.0%, at least 6.5%, at least 7.0%, at least 7.5%, at least 8.0%, at least 8.5%, at least 9.0%, at least 9.5%, or at least 10%. In embodiments, the overbasing level of the polymer processing composition is at most 90%, at most 85%, at most 80%, at most 75%, at most 70%, at most 65%, at most 60%, at most 55%, at most 50%, at most 45%, at most 40%, at most 35%, at most 30%, at most 25%, at most 20%, or at most 10%.

[0066] In embodiments, the overbasing level of the polymer processing composition is greater than or equal to 0.1% and less than or equal to 90%, greater than or equal to 0.5% and less than or equal to 90%, greater than or equal to 1.0% and less than or equal to 90%, greater than or equal to 2.0% and less than or equal to 90%, greater than or equal to 3.0% and less than or equal to 90%, greater than or equal to 4.0% and less than or equal to 90.0%, greater than or equal to 5.0% and less than or equal to 90%, greater than or equal to 6.0% and less than or equal to 90%, greater than or equal to 7.0% and less than or equal to 90%, greater than or equal to 8.0% and less than or equal to 90%, greater than or equal to 9.0% and less than or equal to 90%, or greater than or equal to 10% and less than or equal to 90%.

[0067] In embodiments, the overbasing level of the polymer processing composition is greater than or equal to 3.0% and less than or equal to 90%, greater than or equal to 3.0% and less than or equal to 80%, greater than or equal to 3.0% and less than or equal to 70%, greater than or equal to 3.0% and less than or equal to 65%, greater than or equal to 3.0% and less than or equal to 60%, greater than or equal to 3.0% and less than or equal to 55%, greater than or equal to 3.0% and less than or equal to 50%, greater than or equal to 3.0% and less than or equal to 45%, greater than or equal to 3.0% and less than or equal to 40%, greater than or equal to 3.0% and less than or equal to 35%, greater than or equal to 3.0% and less than or equal to 30%, greater than or equal to 3.0%

and less than or equal to 25%, greater than or equal to 3.0% and less than or equal to 20%, or greater than or equal to 3.0% and less than or equal to 15%.

[0068] In embodiments, the overbasing level of the polymer processing composition is greater than or equal to 5.0% and less than or equal to 90%, greater than or equal to 5.0% and less than or equal to 80%, greater than or equal to 5.0% and less than or equal to 70%, greater than or equal to 5.0% and less than or equal to 65%, greater than or equal to 5.0% and less than or equal to 60%, greater than or equal to 5.0% and less than or equal to 55%, greater than or equal to 5.0% and less than or equal to 50%, greater than or equal to 5.0% and less than or equal to 45%, greater than or equal to 5.0% and less than or equal to 40%, greater than or equal to 5.0% and less than or equal to 35%, greater than or equal to 5.0% and less than or equal to 30%, greater than or equal to 5.0% and less than or equal to 25%, greater than or equal to 5.0% and less than or equal to 20%, or greater than or equal to 5.0% and less than or equal to 15%.

[0069] In embodiments, the overbasing level of the polymer processing composition is greater than or equal to 8.0% and less than or equal to 90%, greater than or equal to 8.0% and less than or equal to 80%, greater than or equal to 8.0% and less than or equal to 70%, greater than or equal to 8.0% and less than or equal to 65%, greater than or equal to 8.0% and less than or equal to 60%, greater than or equal to 8.0% and less than or equal to 55%, greater than or equal to 8.0% and less than or equal to 50%, greater than or equal to 8.0% and less than or equal to 45%, greater than or equal to 8.0% and less than or equal to 40%, greater than or equal to 8.0% and less than or equal to 35%, greater than or equal to 8.0% and less than or equal to 30%, greater than or equal to 8.0% and less than or equal to 25%, greater than or equal to 8.0% and less than or equal to 20%, or greater than or equal to 8.0% and less than or equal to 15%.

[0070] Examples of external lubricants include fatty acid salts of zinc or magnesium. Examples of fatty acids of the fatty acid salts of zinc or magnesium include, without limitation, stearic acid, palmitic acid, arachidic acid, behenic acid, montanic acid, 12-hydroxy stearic acid, oleic acid, linoleic acid, or lauric acid. In embodiments, the external lubricant may be present in the polymer processing composition in an amount from 20% to 75% by mass, from 25% to 75% by mass, from 25% to 70% by mass, from 30% to 70% by mass, from 30% to 65% by mass, from 35% to 65% by mass, from 35% to 60% by mass, from 35% to 55% by mass, from 40% to 60% by mass, from 40% to 55% by mass, from 45% to 55% by mass, or from 45% to 53% by mass, based on the total mass of the polymer processing composition.

[0071] Examples of internal lubricants include inorganic lubricants and organic lubricants. Inorganic internal lubricants include fatty acid salts of calcium. Examples of fatty acids of the fatty acid salts of calcium include, without limitation, stearic acid, palmitic acid, arachidic acid, behenic acid, montanic acid, 12-hydroxy stearic acid, oleic acid, linoleic acid, or lauric acid. Examples of organic lubricants include amides and esters. In embodiments, the internal lubricant may be present in the polymer processing composition in an amount from 10% to 60% by mass, from 15% to 60% by mass, from 15% to 55% by mass, from 20% to 55% by mass, from 25% to 55% by mass, from 30% to 55% by mass, from 35% to 55% by mass, from 40% to 55% by mass, from 45% to 55% by mass, or from 45% to 53% by mass, based on the total mass of the polymer processing composition. In embodiments, the inorganic lubricant may be present in the polymer processing composition in an amount from 10% to 60% by mass, from 15% to 60% by mass, from 15% to 55% by mass, from 20% to 55% by mass, from 25% to 55% by mass, from 30% to 55% by mass, from 35% to 55% by mass, from 40% to 55% by mass, from 45% to 55% by mass, or from 45% to 53% by mass, based on the total mass of the polymer processing composition.

[0072] Exemplary organic lubricants include, without limitation, ethylene bis behenate, pentaerythritol tetrastearate, pentaerythritol adipate stearate, ethylene bis stearamide, glycerol mono and distearate, glycerol monooleate, glycerol tristearate, stearamide, and behenamide. In embodiments, the processing polymer compositions described herein do not contain organic lubricants. In embodiments, the organic lubricant may be present in the polymer processing composition in an amount from 5% to 50% by mass, from 10% to 50% by mass, from 10% to 45% by mass, from 15% to 45% by mass, from 10% to 40% by mass, from 10% to 35% by mass, from 10% to 30% by mass, from 15% to 30% by mass, or from 15% to 25% by mass, based on the total mass of the polymer processing composition. In embodiments wherein the polymer processing composition includes an organic lubricant, the addition of the organic lubricant may be associated with a reduction in the amount of external lubricant, internal inorganic lubricant, or both. In embodiments wherein the polymer processing composition includes an organic lubricant, the inorganic lubricant may be present in the polymer processing composition in an amount from 10% to 60% by mass, from 10% to 55% by mass, from 10% to 50% by mass, from 10% to 55% by mass, from 10% to 40% by mass, from 10% to 35% by mass, from 10% to 30% by mass, from 15% to 30% by mass, or from 20% to 30% by mass, based on the total mass of the polymer processing composition.

[0073] Generally, inorganic antacids include metal-oxides and metal-hydroxides. However, additional inorganic antacids may include, without limitation, hydrotalcites and zeolites.

[0074] Examples of metal-oxide inorganic antacids include, without limitation, zinc oxide, magnesium oxide, calcium oxide, strontium oxide, barium oxide, or combinations thereof. In exemplary compositions, the metal-oxide inorganic antacid is or includes zinc oxide. In embodiments, the metal-oxide may be present in the polymer processing composition in an amount from 0.1% to 10% by mass, from 0.2% to 10% by mass, from 0.2% to 9% by mass, from 0.2% to 8% by mass, from 0.2% to 7% by mass, from 0.2% to 6% by mass, or from 0.5% to 6% by mass, based on the total mass of the polymer processing composition.

[0075] In embodiments, the polymer processing composition includes an external lubricant comprising a fatty acid salt of zinc and an inorganic antacid comprising zinc oxide. In such embodiments, the polymer processing composition may comprise a zinc overbasing level of at least 0.1%, at least 0.2%, at least 0.3%, at least 0.4%, at least 0.5%, at least 1.0%, at least 1.5%, at least 2%, at least 2.5%, at least 3.0%, at least 3.5%, at least 4.0%, at least 4.5%, at least 5.0%, at least 5.5%, at least 6.0%, at least 6.5%, at least 7.0%, at least 7.5%, at least 8.0%, at least 8.5%, at least 9.0%, at least 9.5%, or at least 10%. In embodiments, the zinc overbasing level of the polymer processing composition is at most 120%, at most 110%, at most 100%, at most 90%, at most 85%, at most 80%, at most 75%, at most 70%, at most 65%, at most 60%, at most 55%, at most 50%, at most 45%, at most 40%, at most 35%, at most 30%, at most 25%, at most 20%, or at most 10%.

[0076] In embodiments, the zinc overbasing level of the polymer processing composition is greater than or equal to 0.1% and less than or equal to 120%, greater than or equal to 0.5% and less than or equal to 120%, greater than or equal to 1.0% and less than or equal to 120%, greater than or equal to 2.0% and less than or equal to 120%, greater than or equal to 3.0% and less than or equal to 120%, greater than or equal to 4.0% and less than or equal to 120.0%, greater than or equal to 5.0% and less than or equal to 120%, greater than or equal to 6.0% and less than or equal to 120%, greater than or equal to 7.0% and less than or equal to 120%, greater than or equal to 8.0% and less than or equal to 120%, greater than or equal to 9.0% and less than or equal to 120%, or greater than or equal to 10% and less than or equal to 120%.

[0077] In embodiments, the zinc overbasing level of the polymer processing composition is greater than or equal to 3.0% and less than or equal to 120%, greater than or equal to 3.0% and

less than or equal to 110%, greater than or equal to 3.0% and less than or equal to 100%, greater than or equal to 3.0% and less than or equal to 90%, greater than or equal to 3.0% and less than or equal to 80%, greater than or equal to 3.0% and less than or equal to 70%, greater than or equal to 3.0% and less than or equal to 65%, greater than or equal to 3.0% and less than or equal to 60%, greater than or equal to 3.0% and less than or equal to 55%, greater than or equal to 3.0% and less than or equal to 50%, greater than or equal to 3.0% and less than or equal to 45%, greater than or equal to 3.0% and less than or equal to 40%, greater than or equal to 3.0% and less than or equal to 35%, greater than or equal to 3.0% and less than or equal to 30%, greater than or equal to 3.0% and less than or equal to 25%, greater than or equal to 3.0% and less than or equal to 20%, greater than or equal to 3.0% and less than or equal to 15%, or greater than or equal to 3.0% and less than or equal to 10%.

[0078] In embodiments, the zinc overbasing level of the polymer processing composition is greater than or equal to 5.0% and less than or equal to 120%, greater than or equal to 5.0% and less than or equal to 110%, greater than or equal to 5.0% and less than or equal to 100%, greater than or equal to 5.0% and less than or equal to 90%, greater than or equal to 5.0% and less than or equal to 80%, greater than or equal to 5.0% and less than or equal to 70%, greater than or equal to 5.0% and less than or equal to 65%, greater than or equal to 5.0% and less than or equal to 60%, greater than or equal to 5.0% and less than or equal to 55%, greater than or equal to 5.0% and less than or equal to 50%, greater than or equal to 5.0% and less than or equal to 45%, greater than or equal to 5.0% and less than or equal to 40%, greater than or equal to 5.0% and less than or equal to 35%, greater than or equal to 5.0% and less than or equal to 30%, greater than or equal to 5.0% and less than or equal to 25%, greater than or equal to 5.0% and less than or equal to 20%, greater than or equal to 5.0% and less than or equal to 15%, greater than or equal to 5.0% and less than or equal to 10%.

[0079] In embodiments, the zinc overbasing level of the polymer processing composition is greater than or equal to 8.0% and less than or equal to 120%, greater than or equal to 8.0% and less than or equal to 110%, greater than or equal to 8.0% and less than or equal to 100%, greater than or equal to 8.0% and less than or equal to 90%, greater than or equal to 8.0% and less than or equal to 80%, greater than or equal to 8.0% and less than or equal to 70%, greater than or equal to 8.0% and less than or equal to 65%, greater than or equal to 8.0% and less than or equal to 60%, greater than or equal to 8.0% and less than or equal to 55%, greater than or equal to 8.0% and less

than or equal to 50%, greater than or equal to 8.0% and less than or equal to 45%, greater than or equal to 8.0% and less than or equal to 40%, greater than or equal to 8.0% and less than or equal to 35%, greater than or equal to 8.0% and less than or equal to 30%, greater than or equal to 8.0% and less than or equal to 25%, greater than or equal to 8.0% and less than or equal to 20%, or greater than or equal to 8.0% and less than or equal to 15%.

[0080] While the zinc overbasing levels above are described with respect to polymer processing compositions including an external lubricant comprising a fatty acid salt of zinc and an inorganic antacid comprising zinc oxide, it should be understood that the described overbasing levels for zinc could be implemented in polymer processing compositions including a fatty acid salt of another metal (e.g., magnesium) as the external lubricant and a metal-oxide having a metal other than zinc (e.g., magnesium).

[0081] Examples of metal-hydroxide inorganic antacids include, without limitation, calcium hydroxide, zinc hydroxide, magnesium hydroxide, strontium hydroxide, barium hydroxide, or combinations thereof. In exemplary compositions, the metal-hydroxide inorganic antacid is or includes calcium hydroxide. In embodiments, the metal-hydroxide may be present in the polymer processing composition in an amount from 0% to 10% by mass, from 0.1% to 10% by mass, from 0.1% to 9% by mass, from 0.1% to 8% by mass, from 0.1% to 7% by mass, from 0.1% to 6% by mass, from 0.1% to 5% by mass, from 0.2% to 5% by mass, from 0.2% to 4% by mass, from 0.2% to 3% by mass, or from 0.2% to 2% by mass, based on the total mass of the polymer processing composition.

[0082] In embodiments, the polymer processing composition includes an internal lubricant comprising a fatty acid salt of calcium and an inorganic antacid comprising calcium hydroxide. In such embodiments, the polymer processing composition may comprise a calcium overbasing level of at least 0.1%, at least 0.2%, at least 0.3%, at least 0.4%, at least 0.5%, at least 1.0%, at least 1.5%, at least 2%, at least 2.5%, at least 3.0%, at least 3.5%, at least 4.0%, at least 4.5%, at least 5.0%, at least 5.5%, at least 6.0%, at least 6.5%, at least 7.0%, at least 7.5%, at least 8.0%, at least 8.5%, at least 9.0%, at least 9.5%, or at least 10%. In embodiments, the calcium overbasing level of the polymer processing composition is at most 120%, at most 110%, at most 100%, at most 90%, at most 85%, at most 80%, at most 75%, at most 70%, at most 65%, at most 60%, at most 55%, at most 50%, at most 45%, at most 40%, at most 35%, at most 30%, at most 25%, at most 20%, or at most 10%.

[0083] In embodiments, the calcium overbasing level of the polymer processing composition is greater than or equal to 0.1% and less than or equal to 90%, greater than or equal to 0.5% and less than or equal to 90%, greater than or equal to 1.0% and less than or equal to 90%, greater than or equal to 2.0% and less than or equal to 90%, greater than or equal to 3.0% and less than or equal to 90%, greater than or equal to 4.0% and less than or equal to 90.0%, greater than or equal to 5.0% and less than or equal to 90%, greater than or equal to 6.0% and less than or equal to 90%, greater than or equal to 7.0% and less than or equal to 90%, greater than or equal to 8.0% and less than or equal to 90%, greater than or equal to 9.0% and less than or equal to 90%, or greater than or equal to 10% and less than or equal to 90%.

[0084] In embodiments, the calcium overbasing level of the polymer processing composition is greater than or equal to 3.0% and less than or equal to 90%, greater than or equal to 3.0% and less than or equal to 80%, greater than or equal to 3.0% and less than or equal to 70%, greater than or equal to 3.0% and less than or equal to 65%, greater than or equal to 3.0% and less than or equal to 60%, greater than or equal to 3.0% and less than or equal to 55%, greater than or equal to 3.0% and less than or equal to 50%, greater than or equal to 3.0% and less than or equal to 45%, greater than or equal to 3.0% and less than or equal to 40%, greater than or equal to 3.0% and less than or equal to 35%, greater than or equal to 3.0% and less than or equal to 30%, greater than or equal to 3.0% and less than or equal to 25%, greater than or equal to 3.0% and less than or equal to 20%, or greater than or equal to 3.0% and less than or equal to 15%.

[0085] In embodiments, the calcium overbasing level of the polymer processing composition is greater than or equal to 5.0% and less than or equal to 90%, greater than or equal to 5.0% and less than or equal to 80%, greater than or equal to 5.0% and less than or equal to 70%, greater than or equal to 5.0% and less than or equal to 65%, greater than or equal to 5.0% and less than or equal to 60%, greater than or equal to 5.0% and less than or equal to 55%, greater than or equal to 5.0% and less than or equal to 50%, greater than or equal to 5.0% and less than or equal to 45%, greater than or equal to 5.0% and less than or equal to 40%, greater than or equal to 5.0% and less than or equal to 35%, greater than or equal to 5.0% and less than or equal to 30%, greater than or equal to 5.0% and less than or equal to 25%, greater than or equal to 5.0% and less than or equal to 20%, or greater than or equal to 5.0% and less than or equal to 15%.

[0086] In embodiments, the calcium overbasing level of the polymer processing composition is greater than or equal to 8.0% and less than or equal to 90%, greater than or equal to 8.0% and

less than or equal to 80%, greater than or equal to 8.0% and less than or equal to 70%, greater than or equal to 8.0% and less than or equal to 65%, greater than or equal to 8.0% and less than or equal to 60%, greater than or equal to 8.0% and less than or equal to 55%, greater than or equal to 8.0% and less than or equal to 50%, greater than or equal to 8.0% and less than or equal to 45%, greater than or equal to 8.0% and less than or equal to 40%, greater than or equal to 8.0% and less than or equal to 35%, greater than or equal to 8.0% and less than or equal to 30%, greater than or equal to 8.0% and less than or equal to 25%, greater than or equal to 8.0% and less than or equal to 20%, or greater than or equal to 8.0% and less than or equal to 15%.

[0087] While the calcium overbasing levels described above correspond to polymer processing compositions including an internal lubricant comprising a fatty acid salt of calcium and an inorganic antacid comprising calcium hydroxide, it should be understood that the disclosed calcium overbasing levels could be implemented in polymer processing compositions including a fatty acid salt of another metal (e.g., magnesium) as the internal lubricant and a metal-hydroxide having a metal other than calcium (e.g., magnesium).

[0088] In embodiments, the polymer processing composition comprises an external lubricant in an amount from 20% to 75% by mass, an internal lubricant in an amount from 10% to 60% by mass, a metal-oxide in an amount from 0.1% to 10% by mass, and a metal-hydroxide in an amount between 0% and 10% by mass, based on the total mass of the polymer processing composition.

[0089] In embodiments, the polymer processing composition comprises an external lubricant in an amount from 20% to 75% by mass, an internal lubricant in an amount from 10% to 60% by mass, a metal-oxide in an amount from 0.1% to 10% by mass, and a metal-hydroxide in an amount between 0.1% and 10% by mass, based on the total mass of the polymer processing composition.

[0090] In embodiments, the polymer processing composition comprises an external lubricant in an amount from 20% to 75% by mass, an internal lubricant in an amount from 10% to 60% by mass, a metal-oxide in an amount from 0.2% to 10% by mass, and a metal-hydroxide in an amount between 0.2% and 10% by mass, based on the total mass of the polymer processing composition.

[0091] In embodiments, the polymer processing composition comprises an external lubricant in an amount from 20% to 75% by mass, an internal lubricant in an amount from 10% to 60% by mass, a metal-oxide in an amount from 0.2% to 6% by mass, and a metal-hydroxide in an amount between 0.2% and 6% by mass, based on the total mass of the polymer processing composition.

[0092] In embodiments, the polymer processing composition comprises an external lubricant in an amount from 40% to 55% by mass, an internal lubricant in an amount from 40% to 55% by mass, a metal-oxide in an amount from 0.2% to 6% by mass, and a metal-hydroxide in an amount between 0.2% and 6% by mass, based on the total mass of the polymer processing composition.

[0093] In embodiments, the polymer processing composition comprises an external lubricant in an amount from 40% to 55% by mass, an internal lubricant in an amount from 40% to 55% by mass, a metal-oxide in an amount from 0.5% to 6% by mass, and a metal-hydroxide in an amount between 0.2% and 6% by mass, based on the total mass of the polymer processing composition.

[0094] In embodiments, the polymer processing composition comprises an external lubricant in an amount from 45% to 53% by mass, an internal lubricant in an amount from 45% to 53% by mass, a metal-oxide in an amount from 0.2% to 6% by mass, and a metal-hydroxide in an amount between 0.2% and 6% by mass, based on the total mass of the polymer processing composition.

[0095] In embodiments, the polymer processing composition comprises an external lubricant in an amount from 20% to 75% by mass, an internal inorganic lubricant in an amount from 10% to 60% by mass, a metal-oxide in an amount from 0.1% to 10% by mass, and a metal-hydroxide in an amount between 0% and 10% by mass, and an internal organic lubricant in an amount from 5% to 50% by mass, based on the total mass of the polymer processing composition.

[0096] In embodiments, the polymer processing composition comprises an external lubricant in an amount from 45% to 53% by mass, an internal inorganic lubricant in an amount from 10% to 35% by mass, a metal-oxide in an amount from 0.1% to 10% by mass, and a metal-hydroxide in an amount between 0% and 10% by mass, and an internal organic lubricant in an amount from 15% to 25% by mass, based on the total mass of the polymer processing composition.

[0097] In embodiments, the polymer processing composition comprises an external lubricant in an amount from 45% to 53% by mass, an internal inorganic lubricant in an amount from 10% to 35% by mass, a metal-oxide in an amount from 0.1% to 10% by mass, and a metal-hydroxide in an amount between 0.1% and 10% by mass, and an internal organic lubricant in an amount from 15% to 25% by mass, based on the total mass of the polymer processing composition.

[0098] In embodiments, the polymer processing composition comprises an external lubricant in an amount from 45% to 53% by mass, an internal inorganic lubricant in an amount from 20% to 30% by mass, a metal-oxide in an amount from 0.1% to 10% by mass, and a metal-hydroxide

in an amount between 0.1% and 10% by mass, and an internal organic lubricant in an amount from 15% to 25% by mass, based on the total mass of the polymer processing composition.

[0099] In embodiments, the polymer processing composition comprises an external lubricant in an amount from 45% to 53% by mass, an internal inorganic lubricant in an amount from 20% to 30% by mass, a metal-oxide in an amount from 0.2% to 6% by mass, and a metal-hydroxide in an amount between 0.2% and 6% by mass, and an internal organic lubricant in an amount from 15% to 25% by mass, based on the total mass of the polymer processing composition.

[0100] In embodiments, the polymer processing composition comprises an external lubricant in an amount from 45% to 53% by mass, an internal inorganic lubricant in an amount from 20% to 30% by mass, a metal-oxide in an amount from 0.2% to 6% by mass, and a metal-hydroxide in an amount between 0.2% and 2% by mass, and an internal organic lubricant in an amount from 15% to 25% by mass, based on the total mass of the polymer processing composition.

[0101] In embodiments the polymer processing composition does not include a partitioning agent such as talc or corn starch. Partitioning agents are components typically required in systems including conventional fluoropolymer-based polymer processing aids to prevent agglomeration of the processing aid. In contrast to conventional fluoropolymer-based polymer processing aids that are in the form of insoluble particles, the polymer processing compositions herein can fully disperse or dissolve within the initial mixture, thereby providing substantial benefits to processing, particularly with regard to the cleaning and maintenance of equipment. In particular, the fully dispersed polymer processing composition substantially eliminates build-up on die components (e.g., die lip build-up) in processes such as extrusion, cast, and blow molding. In embodiments, the polymer processing composition is substantially free of perfluoroalkyl and polyfluoroalkyl substances.

[0102] The polymer processing compositions of the present disclosure may be in the form of a homogenized mixture of powders.

[0103] The compositions herein may be incorporated into methods for processing polymers. Such methods may include combining a raw polymer and the polymer processing composition to obtain an initial mixture, then processing the initial mixture to obtain a final polymer. In examples, the initial mixture may be processed by common techniques such as extruding, molding, injection molding, blow molding, cast polymer molding, blown film extrusion, profile extrusion, fiber spinning, or combinations thereof.

[0104] The polymer processing composition may be combined in neat form with the raw polymer, as a component of a preblend, or as a component of a masterbatch. The masterbatch may include the polymer processing composition and a carrier polymer, such as, for example, LDPE, LLDPE, HDPE, or polypropylene. The masterbatch may be prepared using a mixer, such as a Farrel Continuous Mixer (FCM) or a Banbury mixer, and/or an extrusion process, e.g., twin screw extrusion. However, other masterbatch preparation techniques may also be used. When the polymer processing composition is combined with a carrier polymer as a component of a masterbatch, the polymer processing methods described herein may further include preparing the masterbatch comprising the polymer processing composition, then combining raw polymer and the masterbatch to obtain the initial mixture that is subsequently processed to obtain the final polymer. It is also contemplated that multiple masterbatches could be prepared, optionally including other functional additives and fillers, wherein each masterbatch comprises a carrier material and, in combination, include amounts of metal soap and inorganic antacid needed to achieve desired overbasing levels. In such embodiments, the masterbatches would then be combined with the polymer material to obtain the initial mixture.

[0105] In embodiments, the loading of the polymer processing composition in the masterbatch is greater than or equal to 1.0 wt% and less than or equal to 80 wt%, greater than or equal to 1.5 wt% and less than or equal to 80 wt%, greater than or equal to 2.0 wt% and less than or equal to 80 wt%, greater than or equal to 2.5 wt% and less than or equal to 80 wt%, greater than or equal to 3.0 wt% and less than or equal to 80 wt%, greater than or equal to 3.5 wt% and less than or equal to 80 wt%, or greater than or equal to 4.0 wt% and less than or equal to 80 wt%, based on the total weight of the masterbatch. In embodiments, the loading of the polymer processing composition in the masterbatch is greater than or equal to 1.0 wt% and less than or equal to 70 wt%, greater than or equal to 1.0 wt% and less than or equal to 60 wt%, greater than or equal to 1.0 wt% and less than or equal to 50 wt%, greater than or equal to 1.0 wt% and less than or equal to 40 wt%, greater than or equal to 1.0 wt% and less than or equal to 30 wt%, greater than or equal to 1.0 wt% and less than or equal to 25 wt%, greater than or equal to 1.0 wt% and less than or equal to 20 wt%, greater than or equal to 1.0 wt% and less than or equal to 15 wt%, greater than or equal to 1.0 wt% and less than or equal to 10 wt%, greater than or equal to 1.0 wt% and less than or equal to 5.0 wt%, or greater than or equal to 2.5 wt% and less than or equal to 5.0 wt%, based on the total weight of the masterbatch.

[0106] The concentration of the polymer processing composition in the initial mixture may be greater than or equal to 300 ppm and less than or equal to 10,000 ppm, greater than or equal to 400 ppm and less than or equal to 10,000 ppm, greater than or equal to 500 ppm and less than or equal to 10,000 ppm, greater than or equal to 600 ppm and less than or equal to 10,000 ppm, greater than or equal to 700 ppm and less than or equal to 10,000 ppm, greater than or equal to 800 ppm and less than or equal to 10,000 ppm, greater than or equal to 900 ppm and less than or equal to 10,000 ppm, or greater than or equal to 1,000 ppm and less than or equal to 10,000 ppm, based on the total mass of the raw polymer.

[0107] In embodiments, the polymer processing composition is not pre-mixed prior to being combined with raw polymer for polymer processing. That is, in embodiments, methods for processing polymers include combining raw polymer, a metal soap, and an inorganic antacid to obtain an initial mixture, wherein the ratio between the moles of inorganic antacid (n_2) and the moles of metal soap (n_1) is at least 0.1% (or otherwise in accordance with any of the overbasing levels described above), and then processing the initial mixture to obtain a final article. Such methods may further comprise preparing one or more masterbatches each comprising a carrier material and together including the n_1 moles of metal soap and n_2 moles of inorganic antacid, then combining the polymer material and the one or more masterbatches to obtain the initial mixture. For example, a first masterbatch may be prepared containing the metal soap and a second masterbatch may be prepared containing the inorganic antacid, and the method for processing a polymer may include combining raw polymer with the first and second masterbatches to obtain the initial mixture.

[0108] The concentration of the metal soap in the initial mixture may be greater than or equal to 300 ppm and less than or equal to 10,000 ppm, greater than or equal to 400 ppm and less than or equal to 10,000 ppm, greater than or equal to 500 ppm and less than or equal to 10,000 ppm, greater than or equal to 600 ppm and less than or equal to 10,000 ppm, greater than or equal to 700 ppm and less than or equal to 10,000 ppm, greater than or equal to 800 ppm and less than or equal to 10,000 ppm, greater than or equal to 900 ppm and less than or equal to 10,000 ppm, or greater than or equal to 1,000 ppm and less than or equal to 10,000 ppm, based on the total mass of the raw polymer.

[0109] The concentration of the inorganic antacid in the initial mixture may be greater than or equal to 30 ppm and less than or equal to 1,000 ppm, greater than or equal to 40 ppm and less than

or equal to 1,000 ppm, greater than or equal to 50 ppm and less than or equal to 1,000 ppm, greater than or equal to 60 ppm and less than or equal to 1,000 ppm, greater than or equal to 70 ppm and less than or equal to 1,000 ppm, greater than or equal to 80 ppm and less than or equal to 1,000 ppm, greater than or equal to 90 ppm and less than or equal to 1,000 ppm, or greater than or equal to 100 ppm and less than or equal to 1,000 ppm, based on the total mass of the raw polymer.

[0110] The raw polymer may be any polymer source material such as polymer pellets, for example. Examples of raw polymer include, without limitation, finished polymers (e.g., sold by resin manufacturers), process polymers (i.e., unstabilized polymer from a reactor), and recycled polymers. Specific examples of raw polymer include polyethylene (PE), polypropylene (PP), linear low-density polyethylene (LLDPE), medium density polyethylene (MDPE), high-density polyethylene (HDPE), low density polyethylene (LDPE), polyethylene waxes, and the like. The polymer processing compositions herein are particularly useful for processing polymers such as LLDPE or copolymers of LLDPE with an alpha-olefin such as 1-butene, 1-hexene, or 1-octene. The LLDPE may be a polymer that has been polymerized or derived from a monomeric source in the presence of a catalyst such as a Ziegler–Natta catalyst, a Phillips catalyst, or a metallocene catalyst. In preferred embodiments, the raw polymer comprises a metallocene-catalyst derived LLDPE.

[0111] Metallocene catalyzed polymers typically have narrower molecular weight distributions than Ziegler–Natta catalyzed polymers. With Ziegler–Natta catalyst systems there is often lower molecular weight/wax portions/tails in the GPC (HPLC) spectra that allow Ziegler–Natta polymers to have greater processability. Metallocene typically has a single high molecular weight portion that results in a very difficult to process product that is very tough mechanically.

[0112] The final polymers prepared by the methods herein including the polymer processing composition described herein exhibit excellent melt-fracture, time-to-clear, and surface roughness characteristics equal to or greater than those typically observed for polymers prepared with a fluoropolymer-based processing aid. These characteristics are particularly beneficial for final polymers for which optical clarity is desired. Without intent to be bound by theory, it is believed that micron sized domains of polyfluoroalkyl substances (PFAS) as a processing aid have differences in refractive index compared to the polymer matrix (particularly in processing of polyethylenes such as LLDPE). This in turn causes changes of refractive index that can result in

haze. Additionally, poor dispersion of PFAS can result in millimeter-sized domains that can diminish the quality of the final part or process.

[0113] Further embodiments are directed to finished articles prepared from the final polymer prepared by the method as previously described. Examples of such finished article include, without limitation, single-layer films, multilayer films, sheets, pipes, bottles, fibers, wire and cable insulation/jacketing, profiles, and the like.

[0114] In some embodiments, the internal lubricant, the external lubricant, or both, may be derived partially or wholly from vegetable-based sources.

[0115] The polymer processing compositions described herein are further advantageous over fluoropolymer-based processing aids with regard to changeover between products on a single processing line. Further, the polymer processing compositions described herein exhibit fast elimination of melt fracture, especially compared to conventional PFAS-based processing aids. The quick elimination of melt fracture may obviate the need to precondition or shock the initial mixture with high loadings of polymer processing aid when starting a production campaign.

EXAMPLES

[0116] The following Examples are offered by way of illustration and are presented in a manner such that one skilled in the art should recognize are not meant to be limiting to the present disclosure as a whole or to the appended claims.

PPA Blends

[0117] TABLE 1A below provides the compositions for Comparative PPA Blends C1–C4 and Inventive PPA Blends 1–9 that were used for blown film testing. Comparative Blend C1 is a fluoropolymer-based PPA control (Dynamar 5920A from 3M). Comparative Blend C2 is a conventional metal soap PPA blend having a 50:50 ratio of zinc stearate to calcium stearate. Comparative Blend C3 is an underbased blend. Comparative Blend C4 is an underbased blend containing ethylene bis stearamide as an organic lubricant. Blends 1–9 are Inventive PPA blends having varying degrees of overbasing with Blends 5–9 also containing ethylene bis stearamide as an organic lubricant.

TABLE 1A: PPA Blend Compositions

PPA Blends	Zinc Stearate* (wt%)	Calcium Stearate* (wt%)	Zinc Oxide (wt%)	Calcium Hydroxide (wt%)	Ethylene Bis Stearamide* (wt%)	Stearic Acid* (wt%)
C1 [†]	—	—	—	—	—	—
C2	49.0	49.0	0.0	0.0	—	2.0
C3	50.0	50.0	0.0	0.0	—	—
1	49.8	49.8	0.2	0.2	—	—
2	49.5	49.5	0.5	0.5	—	—
3	48.0	48.0	2.0	2.0	—	—
4	47.0	47.0	6.0	0.0	—	—
C4	50.5	27.5	0.0	0.0	20.0	2.0
5	51.6	28.0	0.2	0.2	20.0	—
6	51.0	28.0	0.5	0.5	20.0	—
7	49.0	27.0	2.0	2.0	20.0	—
8	50.0	24.0	6.0	0.0	20.0	—
9	38.0	20.0	2.0	0.0	40.0	—

* Vegetable derived

[†] Dynamar 5920A obtained from 3M

[0118] To prepare the PPA blends shown above in TABLE 1A, the zinc stearate and calcium stearate (both stoichiometrically neutral) of each blend were mixed as powders before adding the other constituents. Each mixture was then drum tumbled for 30 minutes to homogenize.

[0119] TABLE 1B shows the molar amounts for the metal soap and inorganic antacid components of each PPA blend in TABLE 1A, assuming a 100 g basis and calculated using molecular weights for the zinc stearate, calcium stearate, zinc oxide, and calcium oxide of 632 g/mol, 607 g/mol, 81.4 g/mol, and 74.1 g/mol, respectively. As described above, the zinc overbasing level is calculated as the ratio, expressed as a percentage, between the moles of the zinc oxide in the PPA blend divided by the moles of the zinc stearate in the PPA blend. Similarly, the calcium overbasing level is calculated as the ratio, expressed as a percentage, between the moles of the calcium hydroxide in the PPA blend divided by the moles of the calcium stearate in the PPA blend. The overall overbasing level refers to the ratio, expressed as a percentage, between the moles of the inorganic antacid (combined moles of zinc oxide and calcium hydroxide) in the PPA blend divided by the moles of the metal soap (combined moles of zinc stearate and calcium stearate) in the PPA blend.

[0120] TABLE 1B

PPA Blends	Zinc Stearate* (moles)	Calcium Stearate* (moles)	Zinc Oxide (moles)	Calcium Hydroxide (moles)	Zinc Overbasing (%)	Calcium Overbasing (%)	Overall Overbasing (%)
C1	—	—	—	—	—	—	—
C2	0.0775	0.0807	0.0000	0.0000	—	—	0.0%
C3	0.0791	0.0824	0.0000	0.0000	—	—	0.0%
1	0.0788	0.0820	0.0025	0.0027	3.1%	3.3%	3.2%
2	0.0783	0.0815	0.0061	0.0067	7.8%	8.3%	8.1%
3	0.0759	0.0791	0.0246	0.0270	32.4%	34.1%	33.3%
4	0.0744	0.0774	0.0737	0.0000	99.1%	—	48.6%
C4	0.0799	0.0453	0.0000	0.0000	—	—	0.0%
5	0.0816	0.0461	0.0025	0.0027	3.0%	5.9%	4.0%
6	0.0807	0.0461	0.0061	0.0067	7.6%	14.6%	10.2%
7	0.0775	0.0445	0.0246	0.0270	31.7%	60.7%	42.3%
8	0.0791	0.0395	0.0737	0.0000	93.2%	—	62.1%
9	0.0601	0.0329	0.0246	0.0000	40.9%	—	26.4%

Example 1 – Time to Clear Melt Fracture Study

Masterbatch Preparation

[0121] Masterbatches were prepared via twin screw extrusion for each PPA blend in TABLE 1A above by a professional masterbatch manufacturer. The masterbatches had a total concentration of PPA blend of 5 wt% for Comparative Blends C2–C4 and Inventive Blends 1–9, and 2.5 wt% for Comparative Blend C1. An LDPE homopolymer obtained from Lyondellbasell Industries and having a melt index of 6 g/10 min was used as the carrier polymer for the masterbatch, and 0.1 wt% of a standard stabilizer blend (4:1) phosphite antioxidant:phenolic antioxidant was added to give stability and prevent gel formation.

Blown Film Line Conditions

[0122] The resin tested for studying time to clear melt fracture as a function of overbasing level was a barefoot octene mLLDPE obtained from Nova Chemicals and having a melt index of 0.8 g/10 min and a density of 0.919 g/cm³. The resin tested for melt fracture did not contain slip, antiblock, UV, or PPA additives. The barefoot octene mLLDPE resin and masterbatch were dosed via a side feeder at the feed throat of the extruder at a 4% let down ratio of the masterbatch to

achieve a final PPA concentration of 2,000 ppm for each PPA blend except for Comparative Blend C1, for which a final PPA concentration of 1,000 ppm was achieved.

[0123] Blown Film was prepared using an Alpine Blown Film line using an HX75/30 UTC Flex Extruder and BF 10-25 K2 monolayer die having a 250 mm die diameter and a 2 mm die gap. The extruder temperature was set to 200 °C and the melt temperature was set to 215 °C. The extruder was run at 95 revolutions per minute (rpms) corresponding to a throughput rate of 191 lbs/hr. The extruder dwell time was one minute. The blow up ratio was approximately 2.25:1 and the film thickness was 1.25 mil (31.75 micrometers). The blown film line was purged for a minimum of 30 minutes using a highly loaded calcium carbonate purge compound to clean the extruder and die between experiments. After each calcium carbonate purge, a minimum of 30 minutes of purging with pure resin was performed to reestablish melt fracture and ensure the lubrication study was reproducible.

[0124] These conditions, including the narrow die gap, lower processing temperatures, and higher throughput rates, were chosen to maximize melt fracture of the resin while staying within the operational capabilities of the equipment. Without any processing aid, severe melt fracture was seen on the film. This melt fracture appeared as ragged parallel lines orthogonal to the machine direction of the film as well as a hazy film surface between the melt fracture lines. These melt fracture lines were the result of rupturing of the melt surface and gave a temporary change in film thickness as the polymer came out of the die. To ensure steady state and reproducibility in the experiments, more than 30 minutes of melt fracture was observed before beginning PPA studies.

Time to Clear Melt Fracture

[0125] Time to clear melt fracture was measured visually based on a backlit lay flat portion of film. The amount of melt fracture for each time to clear measurement was calculated by comparing the quantity of melt fracture to the total quantity of film being tested. Time to clear was determined by taking samples of film every 10 minutes. A 30 cm length of film was cut in the machine direction to lay flat in a single layer. The single layer film was held up to a bright window and visually examined to determine the amount of melt fracture present. The total percent of melt fracture was calculated compared to the total amount of width in the film.

[0126] TABLE 3 and FIGS. 1 and 2 show the time to clear for the various PPA blends tested. The fluoropolymer-based Comparative Blend C1 showed typical time to clear times of approximately 30 minutes and showed typical elimination of melt fracture patterns. These patterns were seen as machine direction-oriented lines of extremely clear film surrounded by lines of complete melt fracture. These lines of clear film continued to increase over time till the melt fracture was eliminated.

[0127] Typically, at 10 to 20 minutes, all bands of melt fracture were eliminated for Inventive Blends 1–9. Elimination of melt fracture was seen to be longer for the underbased Comparative Blends C2 and C4.

TABLE 3: Time to Clear Melt Fracture

Time	C1	C2	C3	1	2	3	4	C4	5	6	7	8	9
0	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
10	40%	15%	100%	15%	5%	10%	5%	15%	5%	2%	5%	5%	5%
20	2%	15%	10%	5%	2%	2%	2%	10%	0%	0%	1%	2%	2%
30	0%	50%	0%	0%	0%	0%	0%	5%	0%	0%	0%	0%	0%
40	0%	5%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
50	0%	5%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
60	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

[0128] Based on the experiments conducted, traditional fluoropolymer-based PPA (Comparative Blend C1) gave better performance than the traditional neutral (Comparative Blend C3) and underbased metal soap blends (Comparative Blends C2 and C4) for elimination of melt fracture in mLLDPE blown film, as was expected. Addition of other functional additives, as well as skewing the composition of the traditional metal soap blend was able to dramatically improve elimination of melt fracture. As can be seen from FIGS. 1 and 2, overbased Blends 1–9 showed improved time to clear performance relative the neutral metal soap blend, the underbased blends, and the fluoropolymer-based PPA. Moreover, it can be seen that the underbased blends showed longer time to clear than the neutral metal soap blend, which further highlights the significance of the overbasing of the metal soap PPAs described herein.

[0129] The improved time to clear melt fracture performance of the overbased polymer processing compositions described herein was not expected. Overbased metal soaps have not been used in the polyolefin industry as polymer processing aids as those skilled in the art would expect the use of overbased metal soaps to produce negative effects such as forming gels. Additionally

the use of inorganic antacids such as zinc oxide and calcium hydroxide as overbasing agents does not give any lubricating effect (worsens lubricating properties,), so it would not be an obvious addition to traditional neutral metal soap PPAs. Additionally, as shown below in Example 2, the addition of overbasing agents to neutral metal soaps can cause increased haze. In view of these potential negative effects of incorporating overbasing agents in metal soap PPAs, the demonstrated improved time to clear of the overbased PPAs described herein was completely unexpected.

Example 2 - Aesthetic Properties of Final Article Study

[0130] Aesthetics are one additional reason to use PPAs. Besides eliminating melt fracture, the smooth surface of the polymer also reduces haze in the polymer as well as increases the surface gloss.

Masterbatch Preparation

[0131] For the aesthetic properties study, masterbatches were prepared via twin screw extrusion for Comparative PPA Blends C1 and C3 and Inventive PPA Blends 2 and 6. The masterbatches had a total concentration of PPA blend of 5 wt% for Comparative Blend C3 and Inventive Blends 2 and 6, and 2.5 wt% for Comparative Blend C1. An LDPE homopolymer obtained from Lyondellbasell Industries and having a melt index of 6 g/10 min was used as the carrier polymer for the masterbatch, and 0.1 wt% of a standard stabilizer blend (4:1) phosphite antioxidant:phenolic antioxidant was added to give stability and prevent gel formation.

Blown Film Line Conditions

[0132] The resin tested for studying the aesthetic benefits of the PPAs described herein was Ineos mLLDPE Eltex PF 6212 AA, which has a melt index of 1.3 g/10 min and a density of 0.919 g/cm³. This Ineos product did not contain processing aids, was readily available, and was determined to be difficult to process without additional lubrication. The Ineos mLLDPE resin and masterbatch were blended before addition to the extruder in half full 5-gallon buckets for 10 minutes to homogenize at a 4% let down ratio of the masterbatch to achieve a final PPA concentration of 2,000 ppm for PPA Blends C3, 2, and 6, and 1,000 ppm for PPA Blend C1. For

Inventive Blends 2 and 6, additional tests were also performed wherein the final PPA concentration was 1,300 ppm.

[0133] Blown Film was prepared using a Collin Labline E45E single screw extruder attached to a Labline BL 600P Blown Film Line. The die diameter was 80 mm and the die gap was 1 mm. The extruder temperature was set to 200 °C and the melt temperature was set to 200 °C. The extruder was run at 40 rpms corresponding to a throughput rate of 12.5 kg/hr. The extruder dwell time was four minutes. The blow up ratio was approximately 3.18:1 and the film thickness was 50 micrometers. The blown film line was purged for a minimum of 30 minutes using a highly loaded calcium carbonate purge compound to clean the extruder and die between experiments. After each calcium carbonate purge, a minimum of 30 minutes of purging with pure resin was performed to reestablish melt fracture and ensure the lubrication study was reproducible.

Gloss & Haze

[0134] Gloss was measured at 60° using a PCE-PGM 100 Gloss Meter from PCE Americas Inc. The film was placed on a sheet of white paper on a flat surface for measurement. An average of at least 5 measurements was reported. Haze was measured on an average of 4 points using a Hunter Lab UltraScan VIS. The gloss and haze measurements were performed on a 30 cm length of film that was cut in the machine direction to lay flat in a single layer. The gloss and haze results are shown below in TABLE 4.

TABLE 4: Gloss and Haze

PPA Blend	Concentration	Haze	Gloss
Melt Fractured Film (comparative)	—	9	40
C1	1000 ppm	8.73	52
C3	2000 ppm	7.13	51.1
2	2000 ppm	8.55	51.6
6	2000 ppm	8.08	51.9
2	1300 ppm	6.97	52.9
6	1300 ppm	8.67	53.9

[0135] As expected, Comparative Blend C1 showed good gloss and haze compared to a melt fractured sample wherein no PPA was used. PPA Blends C3, 2, and 6 unexpectedly showed further improvements in both gloss and haze for the film samples compared to standard fluoropolymer

(Blend C1). This is unexpected due to standard fluoropolymer PPAs typically being known for their ability to improve these properties, especially in mLLDPE. Moreover, Inventive Blends 2 and 6, at both 1,300 ppm and 2,000 ppm, showed improve gloss compared to traditional fluoropolymer (Blend C1) and the traditional neutral metal soap (Blend C3). Further Inventive Blend 2 at 1,300 ppm showed improved gloss and haze relative to the traditional metal soap (50:50 zinc stearate to calcium stearate; no inorganic antacid) at 2,000 ppm.

[0136] In the foregoing examples, the PPA was combined with the polymer as a component of a masterbatch. As a further example, the PPA may be added in neat form to the polymer. In one example, an LLDPE film is produced using a monolayer blown film line with an output of 400 pounds per hour using standard extrusion conditions. Full melt fracture is established, followed by starting a microfeeder at a rate of 0.2% (2,000 ppm) of the Blend 6 in a pastille form and 99.8% LLDPE resin. Samples are taken every 10 minutes. Full elimination of melt fracture is achieved in 20 minutes, compared to 60 minutes using the Blend 6 masterbatch as previously described.

[0137] In such an example, it is possible to add a neat Blend 6, owing to the pastillated nature of the material. As a pastille, the PPA can be handled neat, without agents to prevent clumping. The product can flow and disperse to the molecular level because the additives fully melt and disperse into the polymer. Traditional fluoropolymer-based PPAs require anti clumping agents such as calcium carbonate or talc to prevent agglomeration. Feeding neat fluoropolymer-based PPAs at a blown film line will not give sufficient dispersion due to their insoluble nature and will result in agglomerated chunks of fluoropolymer in the blown film.

[0138] Melt Index values provided herein were measured on a Tinius Olsen Model MP993 Extrusion Plastometer using method ASTM D1238-10 at 190 °C and 2.16 kg.

[0139] It is noted that the terms “substantially” and “about” may be utilized herein to represent the inherent degree of uncertainty that may be attributed to any quantitative comparison, value, measurement, or other representation. These terms are also utilized herein to represent the degree by which a quantitative representation may vary from a stated reference without resulting in a change in the basic function of the subject matter at issue. The term “substantially” is used herein also to represent the degree by which a quantitative representation may vary from a stated reference without resulting in a change in the basic function of the subject matter at issue. Thus, it is used to represent the inherent degree of uncertainty that may be attributed to any quantitative comparison, value, measurement, or other representation, referring to an arrangement of elements

or features that, while in theory would be expected to exhibit exact correspondence or behavior, may in practice embody something less than exact.

[0140] Unless otherwise defined, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which the invention belongs. The terminology used in the description herein is for describing particular embodiments only and is not intended to be limiting. As used in the specification and appended claims, the singular forms “a,” “an,” and “the” are intended to include the plural forms as well, unless the context clearly indicates otherwise.

[0141] It is noted that one or more of the following claims utilize the term “wherein” as a transitional phrase. For the purposes of defining the present technology, it is noted that this term is introduced in the claims as an open-ended transitional phrase that is used to introduce a recitation of a series of characteristics of the structure and should be interpreted in like manner as the more commonly used open-ended preamble term “comprising.”

[0142] It should be understood that where a first component is described as “comprising” or “including” a second component, it is contemplated that, in some embodiments, the first component “consists” or “consists essentially of” the second component. Additionally, the term “consisting essentially of” is used in this disclosure to refer to quantitative values that do not materially affect the basic and novel characteristic(s) of the disclosure.

[0143] It should be understood that any two quantitative values assigned to a property or measurement may constitute a range of that property or measurement, and all combinations of ranges formed from all stated quantitative values of a given property or measurement are contemplated in this disclosure.

[0144] While particular embodiments have been illustrated and described herein, it should be understood that various other changes and modifications may be made without departing from scope of the claimed subject matter. Moreover, although various aspects of the claimed subject matter have been described herein, such aspects need not be utilized in combination. It is therefore intended that the appended claims cover all such changes and modifications that are within the scope of the claimed subject matter.

CLAIMS

1. A polymer processing composition, comprising:
a metal soap; and
an inorganic antacid;
wherein:
the polymer processing composition is overbased to an overbasing level of at least 0.1%;
the overbasing level is defined as $n_2/n_1 \times 100$, where n_1 represents moles of the metal soap in the polymer processing composition and n_2 represents moles of the inorganic antacid in the polymer processing composition.
2. The polymer processing composition of claim 1, wherein the overbasing level is greater than or equal to 1% and less than or equal to 90%.
3. The polymer processing composition of claim 1, wherein the overbasing level is greater than or equal to 3% and less than or equal to 65%.
4. The polymer processing composition of claim 1, wherein the overbasing level is greater than or equal to 8% and less than or equal to 50%.
5. The polymer processing composition of claim 1, wherein:
the metal soap of the polymer processing composition comprises an external lubricant
and an internal lubricant;
the inorganic antacid of the polymer processing composition comprises a metal-oxide
and a metal-hydroxide; and
the polymer processing composition comprises, based on the total mass of the polymer processing composition:
from 20% to 75% by mass, the external lubricant;
from 10% to 60% by mass, the internal lubricant;
from 0.1% to 10% by mass, the metal-oxide; and
between 0% and 10% by mass, the metal-hydroxide.

6. The polymer processing composition of claim 1, wherein:
 - the metal soap of the polymer processing composition comprises an external lubricant and an internal lubricant;
 - the inorganic antacid of the polymer processing composition comprises a metal-oxide and a metal-hydroxide; and
 - the polymer processing composition comprises, based on the total mass of the polymer processing composition:
 - from 20% to 75% by mass, the external lubricant;
 - from 10% to 60% by mass, the internal lubricant;
 - from 0.2% to 5% by mass, the metal-oxide; and
 - between 0% and 2% by mass, the metal-hydroxide.
7. The polymer processing composition of claim 5 or 6, comprising from 0.2% to 2% by mass of the metal-hydroxide, based on the total mass of the polymer processing composition.
8. The polymer processing composition of claim 5 or 6, wherein:
 - the external lubricant is a fatty acid salt of zinc or magnesium;
 - the internal lubricant is a fatty acid salt of calcium;
 - the metal-oxide is chosen from zinc oxide, magnesium oxide, calcium oxide, strontium oxide, barium oxide, or combinations thereof; and
 - the metal-hydroxide is chosen from calcium hydroxide, zinc hydroxide, magnesium hydroxide, strontium hydroxide, barium hydroxide, or combinations thereof.
9. The polymer processing composition of claim 8, wherein:
 - the external lubricant is zinc stearate, magnesium stearate, or combination thereof; and
 - the internal lubricant is calcium stearate.
10. The polymer processing composition of claim 8, wherein:
 - the external lubricant is zinc stearate;
 - the internal lubricant is calcium stearate;
 - the metal-oxide is zinc oxide; and
 - the metal-hydroxide is calcium hydroxide.

11. The polymer processing composition of any one of claims 1–6, further comprising up to 50% by mass organic lubricant, based on the total mass of the polymer processing composition.
12. The polymer processing composition of claim 11, wherein the organic lubricant is chosen from ethylene bis behenate, pentaerythritol tetrastearate, pentaerythritol adipate stearate, ethylene bis stearamide, glycerol mono and distearate, glycerol monoleate, glycerol tristearate, stearamide, behenamide, or combinations thereof.
13. The polymer processing composition of any one of claims 1–6, wherein the polymer processing composition is substantially free of perfluoroalkyl and polyfluoroalkyl substances.
14. The polymer processing composition of any one of claims 1–6, wherein the polymer processing composition is substantially free of partitioning agents.
15. A masterbatch comprising a carrier polymer and the polymer processing composition according to any one of claims 1–6.
16. The masterbatch of claim 15, wherein the masterbatch is formed by extruding an initial mixture of the carrier polymer and the polymer processing composition.
17. The masterbatch of claim 15, wherein the masterbatch comprises from 1% to 80% by mass polymer processing composition, based on the total weight of the masterbatch.
18. The masterbatch of claim 15, wherein the carrier polymer is LDPE, LLDPE, HDPE, or polypropylene.
19. A polymer resin comprising a polymer material and the masterbatch of claim 15.
20. The polymer resin of claim 19, wherein the polymer material comprises LLDPE or a copolymer of LLDPE with an alpha-olefin chosen from 1-butene, 1-hexene, or 1-octene.
21. The polymer resin of claim 19, wherein the polymer material comprises a metallocene-catalyst derived LLDPE.

22. The polymer resin of claim 19, wherein the polymer material is HDPE.
23. The polymer resin of claim 19, wherein the polymer material is polypropylene.
24. A method for processing a polymer, the method comprising:
combining a polymer material and the polymer processing composition according to any
one of claims 1–6 to obtain an initial mixture; and
processing the initial mixture to obtain a final article.
25. The method of claim 24, further comprising preparing a masterbatch comprising the
polymer processing composition and a carrier polymer, then combining the polymer material
and the masterbatch to obtain the initial mixture.
26. A method for processing a polymer, the method comprising:
combining a polymer material, n_1 moles of metal soap, and n_2 moles of inorganic antacid
to obtain an initial mixture, wherein:
 $n_2/n_1 \times 100$ is at least 0.1%; and
the polymer material comprises from 500 ppm to 10,000 ppm by mass, a
combination of the metal soap and the inorganic acid, based on the total
mass of the polymer material; and
processing the initial mixture to obtain a final article.
27. The method of claim 26, further comprising preparing one or more masterbatches each
comprising a carrier material and together including the n_1 moles of metal soap and n_2 moles of
inorganic antacid, then combining the polymer material and the one or more masterbatches to
obtain the initial mixture.
28. The method of claim 24, wherein the processing comprises processing the initial mixture
by extruding, injection molding, blow molding, cast polymer molding, blown film extrusion,
profile extrusion, fiber spinning, or combinations thereof.
29. The method of claim 24, wherein the polymer material comprises LLDPE or a
copolymer of LLDPE with an alpha-olefin chosen from 1-butene, 1-hexene, or 1-octene.

30. The method of claim 24, wherein the polymer material comprises a metallocene-catalyst derived LLDPE.
31. The method of claim 24, wherein the polymer material is HDPE and the final article is a pipe.
32. The method of claim 24, wherein the polymer material is polypropylene and the processing comprises blow molding.
33. A method of making a polymer processing composition, the method comprising:
providing a neutral composition comprising a metal soap; and
adding, to the neutral composition, an inorganic antacid thereby forming an overbased composition having an overbasing level level of at least 0.1%;
wherein the overbasing level is defined as $n_2/n_1 \times 100$, where n_1 represents moles of the metal soap in the polymer processing composition and n_2 represents moles of the inorganic antacid in the polymer processing composition.
34. The method of claim 33, wherein the overbasing level is greater than or equal to 1% and less than or equal to 90%.
35. The method of claim 33, wherein the overbasing level is greater than or equal to 3% and less than or equal to 65%.
36. The method of claim 33, wherein the overbasing level is greater than or equal to 8% and less than or equal to 50%.
37. The method of claim 33, wherein:
the metal soap of the polymer processing composition comprises an external lubricant and an internal lubricant;
the inorganic antacid of the polymer processing composition comprises a metal-oxide and a metal-hydroxide; and
the polymer processing composition comprises, based on the total mass of the polymer processing composition:

from 20% to 75% by mass, the external lubricant;
from 10% to 60% by mass, the internal lubricant;
from 0.1% to 10% by mass, the metal-oxide; and
between 0% and 10% by mass, the metal-hydroxide.

38. The method of claim 33, wherein:
the metal soap of the polymer processing composition comprises an external lubricant
and an internal lubricant;
the inorganic antacid of the polymer processing composition comprises a metal-oxide
and a metal-hydroxide; and
the polymer processing composition comprises, based on the total mass of the polymer
processing composition:
from 20% to 75% by mass, the external lubricant;
from 10% to 60% by mass, the internal lubricant;
from 0.2% to 5% by mass, the metal-oxide; and
between 0% and 2% by mass, the metal-hydroxide.
39. The method of claim 37 or 38, wherein the overbased composition comprises between
0.2% and 2% by mass of the metal-hydroxide, based on the total mass of the overbased
composition.
40. The method of claim 37 or 38, wherein:
the external lubricant is a fatty acid salt of zinc or magnesium;
the internal lubricant is a fatty acid salt of calcium;
the metal-oxide is chosen from zinc oxide, magnesium oxide, calcium oxide, strontium
oxide, barium oxide, or combinations thereof; and
the metal-hydroxide is chosen from calcium hydroxide, zinc hydroxide, magnesium
hydroxide, strontium hydroxide, barium hydroxide, or combinations thereof.
41. The method of claim 40, wherein:
the external lubricant is zinc stearate, magnesium stearate, or combination thereof; and
the internal lubricant is calcium stearate.

42. The method of claim 40, wherein:
the external lubricant is zinc stearate;
the internal lubricant is calcium stearate;
the metal-oxide is zinc oxide; and
the metal-hydroxide is calcium hydroxide.
43. The method of any one of claims 33–38, further comprising adding an organic lubricant to the overbased composition such that the overbased composition comprises up to 50% by mass of the organic lubricant, based on the total mass of the overbased composition.
44. The method of claim 43, wherein the organic lubricant is chosen from ethylene bis behenate, pentaerythritol tetrastearate, pentaerythritol adipate stearate, ethylene bis stearamide, glycerol mono and distearate, glycerol monooleate, glycerol tristearate, stearamide, behenamide, or combinations thereof.
45. The method of any one of claims 33–38, wherein the polymer processing composition does not contain any perfluoroalkyl substances or polyfluoroalkyl substances.
46. The method of any one of claims 33–38, wherein the polymer processing composition does not contain any partitioning agents.