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61/488,488 20 May 2011 (20.05.2011) US(71) Applicant (for all designated States except US): **THE PROCTER & GAMBLE COMPANY** [US/US]; One Procter & Gamble Plaza, Cincinnati, Ohio 45202 (US).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **ALLEN, William, Maxwell** [US/US]; 5612 Safari Drive, Liberty Township, Ohio 45044 (US). **BOND, Eric, Bryan** [US/US]; 253 Terwilliger's Run, Maineville, Ohio 45039 (US). **NODA, Isao** [US/US]; 1568 Hunter Road, Fairfield, Ohio 45014 (US). **MURRAY, Donald, Stuart** [US/US]; 6456 Winding Oaks Drive, Liberty Township, Ohio 45044 (US).(74) Common Representative: **THE PROCTER & GAMBLE COMPANY**; c/o Eileen L. Hughett, Global

Patent Services, 299 East Sixth Street, Sycamore Building, 4th Floor, Cincinnati, Ohio 45202 (US).

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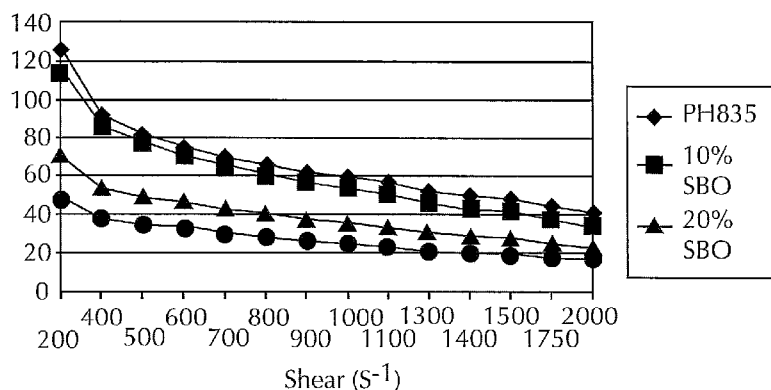


Fig. 1

(57) Abstract: Compositions comprising thermoplastic polymers and oils are disclosed, where the oil is dispersed throughout the thermoplastic polymer. Also disclosed are methods of making these compositions.

POLYMER-OIL COMPOSITIONS, METHODS OF MAKING AND USING THE SAME

FIELD OF THE INVENTION

The present invention relates to compositions comprising intimate admixtures of thermoplastic polymers and oils. The present invention also relates to methods of making these compositions.

BACKGROUND OF THE INVENTION

Thermoplastic polymers are used in a wide variety of applications. However, thermoplastic polymers, such as polypropylene and polyethylene pose additional challenges compared to other polymer species, especially with respect to formation of, for example, fibers. This is because the material and processing requirements for production of fibers are much more stringent than for producing other forms, for example, films. For the production of fibers, polymer melt flow characteristics are more demanding on the material's physical and rheological properties vs other polymer processing methods. Also, the local shear/extensional rate and shear rate are much greater in fiber production than other processes and, for spinning very fine fibers, small defects, slight inconsistencies, or phase incompatibilities in the melt are not acceptable for a commercially viable process. Moreover, high molecular weight thermoplastic polymers cannot be easily or effectively spun into fine fibers. Given their availability and potential strength improvement, it would be desirable to provide a way to easily and effectively spin such high molecular weight polymers. The use of high molecular weight polymers is also beneficial for use in film and injection molding applications as it generally improves strength and toughness.

Most thermoplastic polymers, such as polyethylene, polypropylene, and polyethylene terephthalate, are derived from monomers (e.g., ethylene, propylene, and terephthalic acid, respectively) that are obtained from non-renewable, fossil-based resources (e.g., petroleum, natural gas, and coal). Thus, the price and availability of these resources ultimately have a significant impact on the price of these polymers. As the worldwide price of these resources escalates, so does the price of materials made from these polymers. Furthermore, many consumers display an aversion to purchasing products that are derived solely from petrochemicals, which are non-renewable fossil based resources. In some instances, consumers are hesitant to purchase products made from non-renewable fossil-

based resources. Other consumers may have adverse perceptions about products derived from petrochemicals as being "unnatural" or not environmentally friendly.

Thermoplastic polymers are often incompatible with, or have poor miscibility with additives (e.g., oils, pigments, organic dyes, perfumes, etc.) that might otherwise contribute to a reduced consumption of these polymers in the manufacture of downstream articles.

Heretofore, the art has not effectively addressed how to reduce the amount of thermoplastic polymers derived from non-renewable, fossil-based resources in the manufacture of common articles employing these polymers. Accordingly, it would be desirable to address this deficiency. Existing art has combined polypropylene with additives, with polypropylene as the minor component to form cellular structures. These cellular structures are the purpose behind including renewable materials that are later removed or extracted after the structure is formed. U.S. Patent No. 3,093,612 describes the combination of polypropylene with various fatty acids where the fatty acid is removed. The scientific paper *J. Apply. Polym. Sci* 82 (1) pp. 169-177 (2001) discloses use of diluents on polypropylene for thermally induced phase separation to produce an open and large cellular structure but at low polymer ratio, where the diluent is subsequently removed from the final structure. The scientific paper *J. Apply. Polym. Sci* 105 (4) pp. 2000-2007 (2007) produces microporous membranes via thermally induced phase separation with dibutyl phthalate and soy bean oil mixtures, with a minor component of polypropylene. The diluent is removed in the final structure. The scientific paper *Journal of Membrane Science* 108 (1-2) pp. 25-36 (1995) produces hollow fiber microporous membranes using soy bean oil and polypropylene mixtures, with a minor component of polypropylene and using thermally induced phase separation to produce the desired membrane structure. The diluent is removed in the final structure. In all of these cases, the diluent as described is removed to produce the final structure. These structures before the diluent is removed are oily with excessive amounts of diluent to produce very open microporous structures with pore sizes > 10µm.

Thus, a need exists for compositions of thermoplastic polymers that allow for use of higher molecular weight and/or decreased non-renewable resource based materials, and/or incorporation of further additives, such as perfumes and dyes. A still further need is for compositions that leave the additive present to deliver renewable materials in the final product and that can also enable the addition of further additives into the final structure, such as dyes and perfumes, for example.

SUMMARY OF THE INVENTION

In one aspect, the invention is directed to compositions comprising an intimate admixture of a thermoplastic polymer and about 5 wt% to about 40 wt% of an oil, based upon the total weight of the composition, wherein the oil has a melting point of 25°C or less and a boiling point greater than 160°C. The composition can be in the form of pellets produced to be used as-is or for storage for future use, for example to make fibers. Optionally, the composition can be further processed into the final usable form, such as fibers, films and molded articles. The fibers can have a diameter of less than 200 µm. The fibers can be monocomponent or bicomponent, discrete and/or continuous, in addition to being round or shaped. The fiber can be thermally bondable.

The thermoplastic polymer can comprise a polyolefin, a polyester, a polyamide, copolymers thereof, or combinations thereof. The thermoplastic polymer can be selected from the group consisting of polypropylene, polyethylene, polypropylene co-polymer, polyethylene co-polymer, polyethylene terephthalate, polybutylene terephthalate, polylactic acid, polyhydroxyalkanoates, polyamide-6, polyamide-6,6, and combinations thereof. Polypropylene having a melt flow index of greater than 0.5 g/10 min or of greater than 10 g/10 min can be used. The polypropylene can have a weight average molecular weight of about 20 kDa to about 700 kDa. The thermoplastic polymer can be derived from a renewable bio-based feed stock origin, such as bio polyethylene or bio polypropylene, and/or can be recycled source, such as post consumer use. The oil can be present in the composition in an amount of about 8 wt% to about 30 wt% or about 10 wt% to about 20 wt%, based upon the total weight of the composition. The oil can comprise a lipid, which can be selected from the group consisting of a monoglyceride, diglyceride, triglyceride, fatty acid, fatty alcohol, esterified fatty acid, epoxidized lipid, maleated lipid, hydrogenated lipid, alkyd resin derived from a lipid, sucrose polyester, or combinations thereof. The oil can comprise a mineral oil, such as a linear alkane, a branched alkane, or combinations thereof. The oil can be selected from the group consisting of soy bean oil, epoxidized soy bean oil, maleated soy bean oil, corn oil, cottonseed oil, canola oil, castor oil, coconut oil, coconut seed oil, corn germ oil, fish oil, linseed oil, olive oil, oiticica oil, palm kernel oil, palm oil, palm seed oil, peanut oil, rapeseed oil, safflower oil, sperm oil, sunflower seed oil, tall oil, tung oil, whale oil, triolein, trilinolein, 1-stearo- dilinolein, 1-palmito-dilinolein, lauroleic acid, linoleic acid, linolenic acid, myristoleic acid, oleic acid, palmitoleic acid, 1,2-diacetopalmitin, and combinations thereof.

The oil can be dispersed within the thermoplastic polymer such that the oil has a droplet size of less than 10 μm , less than 5 μm , less than 1 μm , or less than 500 nm within the thermoplastic polymer. The oil can be a renewable material.

The compositions disclosed herein can further comprise an additive. The additive can be oil soluble or oil dispersible. Examples of additives include perfume, dye, pigment, surfactant, nucleating agent, clarifying agent, anti-microbial agent, nanoparticle, antistatic agent, filler, or combination thereof.

In another aspect, provided is a method of making a composition as disclosed herein, the method comprising a) mixing the thermoplastic polymer, in a molten state, with the oil, also in the molten state, to form the admixture; and b) cooling the admixture to a temperature at or less than the solidification temperature of the thermoplastic polymer in 10 seconds or less to form the composition. The method of making a composition can comprise a) melting a thermoplastic polymer to form a molten thermoplastic polymer; b) mixing the molten thermoplastic polymer and oil to form an admixture; and c) cooling the admixture to a temperature at or less than the solidification temperature of the thermoplastic polymer in 10 seconds or less. The mixing can be at a shear rate of greater than 10 s^{-1} , or about 30 to about 100 s^{-1} . The admixture can be cooled in 10 seconds or less to a temperature of 50°C or less. The composition can be pelletized. The pelletizing can occur after cooling the admixture or before or simultaneous to cooling the admixture. The composition can be made using an extruder, such as a single- or twin-screw extruder. Alternatively, the method of making a composition can comprise a) melting a thermoplastic polymer to form a molten thermoplastic polymer; b) mixing the molten thermoplastic polymer and a oil to form an admixture; and c) extruding the molten mixture to form the finished structure, for example filaments or fibers which solidify upon cooling.

BRIEF DESCRIPTION OF THE DRAWINGS

For a more complete understanding of the disclosure, reference should be made to the following detailed description and accompanying drawing wherein:

Figure 1 shows the viscosity of the polypropylene carrier PH-835 with increasing addition of the SBO at 10, 20, and 30 wt% levels (Examples 2, 3, and 4), which shows decreasing viscosity with increasing amounts of oil additive.

Figure 2 are scanning electron microscopy (SEM) images of polypropylene without any oil (A); and Examples 2 (B), 3 (C), and 4 (D) disclosed herein.

While the disclosed invention is susceptible of embodiments in various forms, there are illustrated in the drawings (and will hereafter be described) specific embodiments of the invention, with the understanding that the disclosure is intended to be illustrative, and is not intended to limit the invention to the specific embodiments described and illustrated herein.

5

DETAILED DESCRIPTION OF THE INVENTION

Compositions disclosed herein include an intimate admixture of a thermoplastic polymer and an oil. The term “intimate admixture” refers to the physical relationship of the oil and thermoplastic polymer, wherein the oil is dispersed within the thermoplastic polymer. The droplet size of the oil within in the thermoplastic polymer is a parameter that indicates the level of dispersion of the oil within the thermoplastic polymer. The smaller the droplet size, the higher the dispersion of the oil within the thermoplastic polymer, the larger the droplet size the lower the dispersion of the oil within the thermoplastic polymer.

The droplet size of the oil within the thermoplastic polymer is less than 10 μm , and can be less than 5 μm , less than 1 μm , or less than 500 nm. Other contemplated droplet sizes of the oil dispersed within the thermoplastic polymer include less than 9.5 μm , less than 9 μm , less than 8.5 μm , less than 8 μm , less than 7.5 μm , less than 7 μm , less than 6.5 μm , less than 6 μm , less than 5.5 μm , less than 4.5 μm , less than 4 μm , less than 3.5 μm , less than 3 μm , less than 2.5 μm , less than 2 μm , less than 1.5 μm , less than 900 nm, less than 800 nm, less than 700 nm, less than 600 nm, less than 400 nm, less than 300 nm, and less than 200 nm. As used herein, the term “admixture” refers to the intimate admixture of the present invention, and not an “admixture” in the more general sense of a standard mixture of materials.

The droplet size of the oil can be measured by scanning electron microscopy (SEM) indirectly by measuring a void size in the thermoplastic polymer, after removal of the oil from the composition. Removal of the oil is typically performed prior to SEM imaging due to incompatibility of the oil and the SEM imaging technique. Thus, the void measured by SEM imaging is correlated to the droplet size of the oil in the composition, as exemplified in Figure 2.

One exemplary way to achieve a suitable dispersion of the oil within the thermoplastic polymer is by admixing the thermoplastic polymer, in a molten state, and the oil. The thermoplastic polymer is melted (e.g., exposed to temperatures greater than the thermoplastic polymer's solidification temperature) to provide the molten thermoplastic

polymer and mixed with the oil. The thermoplastic polymer can be melted prior to addition of the oil or can be melted in the presence of the oil.

The thermoplastic polymer and oil can be mixed, for example, at a shear rate of greater than 10s^{-1} . Other contemplated shear rates include greater than 10, about 15 to about 5
1000, about 20 to about 200, or up to 500 s^{-1} . The higher the shear rate of the mixing, the greater the dispersion of the oil in the composition as disclosed herein. Thus, the dispersion can be controlled by selecting a particular shear rate during formation of the composition.

The oil and molten thermoplastic polymer can be mixed using any mechanical means capable of providing the necessary shear rate to result in a composition as disclosed herein.
10 Non-limiting examples of mechanical means include a mixer, such as a Haake batch mixer, and an extruder (e.g., a single- or twin-screw extruder).

The mixture of molten thermoplastic polymer and oil is then rapidly (e.g., in less than 10 seconds) cooled to a temperature lower than the solidification temperature (either via traditional thermoplastic polymer crystallization or passing below the polymer glass
15 transition temperature) of the thermoplastic polymer.

The admixture can be cooled to less than 200°C , less than 150°C , less than 100°C less than 75°C , less than 50°C , less than 40°C , less than 30°C , less than 20°C , less than 15°C , less than 10°C , or to a temperature of about 0°C to about 30°C , about 0°C to about 20°C , or about 0°C to about 10°C . For example, the mixture can be placed in a low temperature liquid (e.g.,
20 the liquid is at or below the temperature to which the mixture is cooled) or gas. The liquid can be ambient or controlled temperature water. The gas can be ambient air or controlled temperature and humidity air. Any quenching media can be used so long as it cools the admixture rapidly. Additional liquids such as oils, alcohols and ketones can be used for quenching, along with mixtures comprising water (sodium chloride for example) depending
25 on the admixture composition. Additional gases can be used, such as carbon dioxide and nitrogen, or any other component naturally occurring in atmospheric temperature and pressure air.

Optionally, the composition is in the form of pellets. Pellets of the composition can be formed prior to, simultaneous to, or after cooling of the mixture. The pellets can be
30 formed by strand cutting or underwater pelletizing. In strand cutting, the composition is rapidly quenched (generally in a time period much less than 10 seconds) then cut into small pieces. In underwater pelletizing, the mixture is cut into small pieces and simultaneously or immediately thereafter placed in the presence of a low temperature liquid that rapidly cools

and solidifies the mixture to form the pelletized composition. Such pelletizing methods are well understood by the ordinarily skilled artisan. Pellet morphologies can be round or cylindrical, and can have no dimension larger than 10 mm, more preferably less than 5mm, or no dimension larger than 2 mm.

5 Alternatively, the admixture (As used herein, the term “admixture” refers to the intimate admixture of the present invention, and not an “admixture” in the more general sense of a standard mixture of materials) can be used whilst mixed in the molten state and formed directly into fibers, for example. Other suitable forms are films and molded articles.

Thermoplastic polymers

10 Thermoplastic polymers, as used in the disclosed compositions, are polymers that melt and then, upon cooling, crystallize or harden, but can be re-melted upon further heating. Suitable thermoplastic polymers used herein have a melting temperature from about 60°C to about 300°C, from about 80°C to about 250°C, or from 100°C to 215°C.

15 The thermoplastic polymers can be derived from renewable resources or from fossil minerals and oils. The thermoplastic polymers derived from renewable resources are bio-based, for example such as bio produced ethylene and propylene monomers used in the production polypropylene and polyethylene. These material properties are essentially identical to fossil based product equivalents, except for the presence of carbon-14 in the thermoplastic polymer. Renewable and fossil based thermoplastic polymers can be combined together in the present
20 invention in any ratio, depending on cost and availability. Recycled thermoplastic polymers can also be used, alone or in combination with renewable and/or fossil derived thermoplastic polymers. The recycled thermoplastic polymers can be pre-conditioned to remove any unwanted contaminants prior to compounding or they can be used during the compounding and extrusion process, as well as simply left in the admixture. These contaminants can
25 include trace amounts of other polymers, pulp, pigments, inorganic compounds, organic compounds and other additives typically found in processed polymeric compositions. The contaminants should not negatively impact the final performance properties of the admixture, for example, causing spinning breaks during a fiber spinning process.

30 The molecular weight of the thermoplastic polymer is sufficiently high to enable entanglement between polymer molecules and yet low enough to be melt spinnable. Addition of the oil into the composition allows for compositions containing higher molecular weight thermoplastic polymers to be spun, compared to compositions without an oil. Thus, suitable thermoplastic polymers can have weight average molecular weights of about 1000 kDa or

less, about 5 kDa to about 800 kDa, about 10 kDa to about 700 kDa, or about 20 kDa to about 400 kDa. The weight average molecular weight is determined by the specific method for each polymer, but is generally measured using either gel permeation chromatography (GPC) or from solution viscosity measurements. The thermoplastic polymer weight average molecular weight should be determined before addition into the admixture.

More specifically, however, the thermoplastic polymers preferably include polyolefins such as polyethylene or copolymers thereof, including low density, high density, linear low density, or ultra low density polyethylenes such that the polyethylene density ranges between 0.90grams per cubic centimeter to 0.97 grams per cubic centimeter, most preferred between 0.92 and 0.95 grams per cubic centimeter. The density of the polyethylene will is determined by the amount and type of branching and depends on the polymerization technology and comonomer type. Polypropylene and/or polypropylene copolymers, including atactic polypropylene; isotactic polypropylene, syndiotactic polypropylene, and combination thereof can also be used. Polypropylene copolymers, especially ethylene can be used to lower the melting temperature and improve properties. These polypropylene polymers can be produced using metallocene and Ziegler-Natta catalyst systems. These polypropylene and polyethylene compositions can be combined together to optimize end-use properties. Polybutylene is also a useful polyolefin.

Other suitable polymers include polyamides or copolymers thereof, such as Nylon 6, Nylon 11, Nylon 12, Nylon 46, Nylon 66; polyesters or copolymers thereof, such as maleic anhydride polypropylene copolymer, polyethylene terephthalate; olefin carboxylic acid copolymers such as ethylene/acrylic acid copolymer, ethylene/maleic acid copolymer, ethylene/methacrylic acid copolymer, ethylene/vinyl acetate copolymers or combinations thereof; polyacrylates, polymethacrylates, and their copolymers such as poly(methyl methacrylates).

Other nonlimiting examples of polymers include polycarbonates, polyvinyl acetates, poly(oxymethylene), styrene copolymers, polyacrylates, polymethacrylates, poly(methyl methacrylates), polystyrene/methyl methacrylate copolymers, polyetherimides, polysulfones, or combinations thereof. In some embodiments, thermoplastic polymers include polypropylene, polyethylene, polyamides, polyvinyl alcohol, ethylene acrylic acid, polyolefin carboxylic acid copolymers, polyesters, and combinations thereof.

Biodegradable thermoplastic polymers also are contemplated for use herein. Biodegradable materials are susceptible to being assimilated by microorganisms, such as

molds, fungi, and bacteria when the biodegradable material is buried in the ground or otherwise contacts the microorganisms (including contact under environmental conditions conducive to the growth of the microorganisms). Suitable biodegradable polymers also include those biodegradable materials which are environmentally-degradable using aerobic or anaerobic digestion procedures, or by virtue of being exposed to environmental elements such as sunlight, rain, moisture, wind, temperature, and the like. The biodegradable thermoplastic polymers can be used individually or as a combination of biodegradable or non-biodegradable polymers. Biodegradable polymers include polyesters containing aliphatic components. Among the polyesters are ester polycondensates containing aliphatic constituents and poly(hydroxycarboxylic) acid. The ester polycondensates include diacids/diol aliphatic polyesters such as polybutylene succinate, polybutylene succinate co-adipate, aliphatic/aromatic polyesters such as terpolymers made of butylenes diol, adipic acid and terephthalic acid. The poly(hydroxycarboxylic) acids include lactic acid based homopolymers and copolymers, polyhydroxybutyrate (PHB), or other polyhydroxyalkanoate homopolymers and copolymers. Such polyhydroxyalkanoates include copolymers of PHB with higher chain length monomers, such as C₆-C₁₂, and higher, polyhydroxyalkanoates, such as those disclosed in U.S. Patent Nos. RE 36,548 and 5,990,271.

An example of a suitable commercially available polylactic acid is NATUREWORKS from Cargill Dow and LACEA from Mitsui Chemical. An example of a suitable commercially available diacid/diol aliphatic polyester is the polybutylene succinate/adipate copolymers sold as BIONOLLE 1000 and BIONOLLE 3000 from the Showa High Polymer Company, Ltd. (Tokyo, Japan). An example of a suitable commercially available aliphatic/aromatic copolyester is the poly(tetramethylene adipate-co-terephthalate) sold as EASTAR BIO Copolyester from Eastman Chemical or ECOFLEX from BASF.

Non-limiting examples of suitable commercially available polypropylene or polypropylene copolymers include Basell Profax PH-835 (a 35 melt flow rate Ziegler-Natta isotactic polypropylene from Lyondell-Basell), Basell Metocene MF-650W (a 500 melt flow rate metallocene isotactic polypropylene from Lyondell-Basell), Polybond 3200 (a 250 melt flow rate maleic anhydride polypropylene copolymer from Crompton), Exxon Achieve 3854 (a 25 melt flow rate metallocene isotactic polypropylene from Exxon-Mobil Chemical), Mosten NB425 (a 25 melt flow rate Ziegler-Natta isotactic polypropylene from Unipetrol), Danimer 27510 (a polyhydroxyalkanoate polypropylene from Danimer Scientific LLC), Dow Aspun 6811A (a 27 melt index polyethylene polypropylene copolymer from Dow Chemical),

and Eastman 9921 (a polyester terephthalic homopolymer with a nominally 0.81 intrinsic viscosity from Eastman Chemical).

The thermoplastic polymer component can be a single polymer species as described above or a blend of two or more thermoplastic polymers as described above.

- 5 If the polymer is polypropylene, the thermoplastic polymer can have a melt flow index of greater than 5 g/10 min, as measured by ASTM D-1238, used for measuring polypropylene. Other contemplated melt flow indices include greater than 10 g/10 min, greater than 20 g/10 min, or about 5 g/10 min to about 50 g/10 min.

Oils

- 10 An oil, as used in the disclosed composition, is a lipid, mineral oil, or combination thereof, having a melting point of 25°C or less and a boiling point of greater than 160°C. The lipid can be a monoglyceride, diglyceride, triglyceride, fatty acid, fatty alcohol, esterified fatty acid, epoxidized lipid, maleated lipid, hydrogenated lipid, alkyd resin derived from a lipid, sucrose polyester, or combinations thereof. The mineral oil can be a linear alkane, a
15 branched alkane, or combinations thereof.

- Because the oil may contain a distribution of melting temperatures to generate a peak melting temperature, the oil melting temperature is defined as having a peak melting temperature 25°C or below as defined when > 50 weight percent of the oil component melts at or below 25°C. This measurement can be made using a differential scanning calorimeter
20 (DSC), where the heat of fusion is equated to the weight percent fraction of the oil.

 The oil number average molecular weight, as determined by gel permeation chromatography (GPC), should be less than 2kDa, preferably less than 1.5kDa, still more preferred less than 1.2kDa.

- The amount of oil is determined via gravimetric weight loss method. The solidified
25 mixture is placed, with the narrowest specimen dimension no greater than 1mm, into hexane (or acetone) at a ratio of 1g or mixture per 100g of hexane using a refluxing flask system. First the mixture is weighed before being placed into the reflux flask, and then the hexane and mixtures are heated to 60°C for 20 hours. The sample is removed and air dried for 60 minutes and a final weight determined. The equation for calculating the weight percent oil is

- 30
$$\text{weight \% oil} = ([\text{initial mass} - \text{final mass}] / [\text{initial mass}]) \times 100\%$$

Non-limiting examples of oils contemplated in the compositions disclosed herein include castor oil, coconut oil, coconut seed oil, corn germ oil, cottonseed oil, linseed oil, fish oil, olive oil, oiticica oil, palm kernel oil, palm oil, palm seed oil, peanut oil, cottonseed oil, hempseed oil, rapeseed oil, safflower oil, soybean oil, sperm oil, sunflowerseed oil, tall oil, tung oil, whale oil, and combinations thereof. Preferred oils are corn, soy bean, canola, cottonseed, and palm kernel oil. The preferred oils can be new or processed or recycled oils, such as those used at least once, for example as used in cooking. Non-limiting examples of specific triglycerides include triglycerides such as, for example, triolein, trilinolein, 1-stearo-dilinolein, and 1,2-diacetopalmitin. Coconut oil, palm oil and palm kernel oil all have melting temperatures close to or at 25°C and are classified as oils in the present application. The oils can be from edible plant sources and inedible plant sources. Edible plant sources, for example, include soy bean and corn. Inedible sources include jatropha oil and some variants of rapeseed oil. Other contemplated oils include 1-palmito-dilinolein, lauroleic acid, linoleic acid, linolenic acid, myristoleic acid, oleic acid, palmitoleic acid, and combinations thereof.

The oil can be from a renewable material (e.g., derived from a renewable resource). As used herein, a “renewable resource” is one that is produced by a natural process at a rate comparable to its rate of consumption (e.g., within a 100 year time frame). The resource can be replenished naturally, or via agricultural techniques. Non-limiting examples of renewable resources include plants (e.g., sugar cane, beets, corn, potatoes, citrus fruit, woody plants, lignocellulosics, hemicellulosics, cellulosic waste), animals, fish, bacteria, fungi, and forestry products. These resources can be naturally occurring, hybrids, or genetically engineered organisms. Natural resources such as crude oil, coal, natural gas, and peat, which take longer than 100 years to form, are not considered renewable resources. Mineral oil is viewed as a by-product waste stream of coal, and while not renewable, it can be considered a by-product oil.

The oil, as disclosed herein, is present in the composition at a weight percent of about 5 wt% to about 40 wt%, based upon the total weight of the composition. Other contemplated wt% ranges of the oil include about 8 wt% to about 30 wt%, with a preferred range from about 10 wt% to about 30 wt%, about 10 wt% to about 20 wt%, or about 12 wt% to about 18 wt%, based upon the total weight of the composition. Specific oil wt% contemplated include about 5 wt%, about 6 wt%, about 7 wt%, about 8 wt%, about 9 wt%, about 10 wt%, about 11 wt%, about 12 wt%, about 13 wt%, about 14 wt%, about 15 wt%, about 16 wt%, about 17 wt%, about 18 wt%, about 19 wt%, about 20 wt%, about 21 wt%, about 22 wt%, about 23

wt%, about 24 wt%, about 25 wt%, about 26 wt%, about 27 wt%, about 28 wt%, about 29 wt%, about 30 wt%, about 31 wt%, about 32 wt%, about 33 wt%, about 34 wt%, about 35 wt%, about 36 wt%, about 37 wt%, about 38 wt%, about 39 wt%, and about 40 wt%, based upon the total weight of the composition.

5 **Additives**

The compositions disclosed herein can further include an additive. The additive can be dispersed throughout the composition, or can be substantially in the thermoplastic polymer portion of the thermoplastic layer or substantially in the oil portion of the composition. In cases where the additive is in the oil portion of the composition, the additive can be oil
10 soluble or oil dispersible.

Non-limiting examples of classes of additives contemplated in the compositions disclosed herein include perfumes, dyes, pigments, nanoparticles, antistatic agents, fillers, and combinations thereof. The compositions disclosed herein can contain a single additive or a mixture of additives. For example, both a perfume and a colorant (e.g., pigment and/or
15 dye) can be present in the composition. The additive(s), when present, is/are present in a weight percent of about 0.05 wt% to about 20 wt%, or about 0.1 wt% to about 10 wt %. Specifically contemplated weight percentages include about 0.5 wt%, about 0.6 wt%, about 0.7 wt%, about 0.8 wt%, about 0.9 wt%, about 1 wt%, about 1.1 wt%, about 1.2 wt%, about 1.3 wt%, about 1.4 wt%, about 1.5 wt%, about 1.6 wt%, about 1.7 wt%, about 1.8 wt%, about
20 1.9 wt%, about 2 wt%, about 2.1 wt%, about 2.2 wt%, about 2.3 wt%, about 2.4 wt%, about 2.5 wt%, about 2.6 wt%, about 2.7 wt%, about 2.8 wt%, about 2.9 wt%, about 3 wt%, about 3.1 wt%, about 3.2 wt%, about 3.3 wt%, about 3.4 wt%, about 3.5 wt%, about 3.6 wt%, about 3.7 wt%, about 3.8 wt%, about 3.9 wt%, about 4 wt%, about 4.1 wt%, about 4.2 wt%, about 4.3 wt%, about 4.4 wt%, about 4.5 wt%, about 4.6 wt%, about 4.7 wt%, about 4.8 wt%, about
25 4.9 wt%, about 5 wt%, about 5.1 wt%, about 5.2 wt%, about 5.3 wt%, about 5.4 wt%, about 5.5 wt%, about 5.6 wt%, about 5.7 wt%, about 5.8 wt%, about 5.9 wt%, about 6 wt%, about 6.1 wt%, about 6.2 wt%, about 6.3 wt%, about 6.4 wt%, about 6.5 wt%, about 6.6 wt%, about 6.7 wt%, about 6.8 wt%, about 6.9 wt%, about 7 wt%, about 7.1 wt%, about 7.2 wt%, about 7.3 wt%, about 7.4 wt%, about 7.5 wt%, about 7.6 wt%, about 7.7 wt%, about 7.8 wt%, about
30 7.9 wt%, about 8 wt%, about 8.1 wt%, about 8.2 wt%, about 8.3 wt%, about 8.4 wt%, about 8.5 wt%, about 8.6 wt%, about 8.7 wt%, about 8.8 wt%, about 8.9 wt%, about 9 wt%, about 9.1 wt%, about 9.2 wt%, about 9.3 wt%, about 9.4 wt%, about 9.5 wt%, about 9.6 wt%, about 9.7 wt%, about 9.8 wt%, about 9.9 wt%, and about 10 wt%.

As used herein the term “perfume” is used to indicate any odoriferous material that is subsequently released from the composition as disclosed herein. A wide variety of chemicals are known for perfume uses, including materials such as aldehydes, ketones, alcohols, and esters. More commonly, naturally occurring plant and animal oils and exudates including
5 complex mixtures of various chemical components are known for use as perfumes. The perfumes herein can be relatively simple in their compositions or can include highly sophisticated complex mixtures of natural and synthetic chemical components, all chosen to provide any desired odor. Typical perfumes can include, for example, woody/earthy bases containing exotic materials, such as sandalwood, civet and patchouli oil. The perfumes can
10 be of a light floral fragrance (e.g. rose extract, violet extract, and lilac). The perfumes can also be formulated to provide desirable fruity odors, e.g. lime, lemon, and orange. The perfumes delivered in the compositions and articles of the present invention can be selected for an aromatherapy effect, such as providing a relaxing or invigorating mood. As such, any material that exudes a pleasant or otherwise desirable odor can be used as a perfume active in
15 the compositions and articles of the present invention.

A pigment or dye can be inorganic, organic, or a combination thereof. Specific examples of pigments and dyes contemplated include pigment Yellow (C.I. 14), pigment Red (C.I. 48:3), pigment Blue (C.I. 15:4), pigment Black (C.I. 7), and combinations thereof. Specific contemplated dyes include water soluble ink colorants like direct dyes, acid dyes,
20 base dyes, and various solvent soluble dyes. Examples include, but are not limited to, FD&C Blue 1 (C.I. 42090:2), D&C Red 6(C.I. 15850), D&C Red 7(C.I. 15850:1), D&C Red 9(C.I. 15585:1), D&C Red 21(C.I. 45380:2), D&C Red 22(C.I. 45380:3), D&C Red 27(C.I. 45410:1), D&C Red 28(C.I. 45410:2), D&C Red 30(C.I. 73360), D&C Red 33(C.I. 17200), D&C Red 34(C.I. 15880:1), and FD&C Yellow 5(C.I. 19140:1), FD&C Yellow 6(C.I.
25 15985:1), FD&C Yellow 10(C.I. 47005:1), D&C Orange 5(C.I. 45370:2), and combinations thereof.

Contemplated fillers include, but are not limited to inorganic fillers such as, for example, the oxides of magnesium, aluminum, silicon, and titanium. These materials can be added as inexpensive fillers or processing aides. Other inorganic materials that can function
30 as fillers include hydrous magnesium silicate, titanium dioxide, calcium carbonate, clay, chalk, boron nitride, limestone, diatomaceous earth, mica glass quartz, and ceramics. Additionally, inorganic salts, including alkali metal salts, alkaline earth metal salts, phosphate salts, can be used. Additionally, alkyd resins can also be added to the composition. Alkyd resins comprise a polyol, a polyacid or anhydride, and/or a fatty acid.

Additional contemplated additives include nucleating and clarifying agents for the thermoplastic polymer. Specific examples, suitable for polypropylene, for example, are benzoic acid and derivatives (e.g. sodium benzoate and lithium benzoate), as well as kaolin, talc and zinc glycerolate. Dibenzlidene sorbitol (DBS) is an example of a clarifying agent
5 that can be used. Other nucleating agents that can be used are organocarboxylic acid salts, sodium phosphate and metal salts (for example aluminum dibenzoate) The nucleating or clarifying agents can be added in ranges from 20 parts per million (20ppm) to 20,000ppm, more preferred range of 200ppm to 2000ppm and the most preferred range from 1000ppm to 1500ppm. The addition of the nucleating agent can be used to improve the tensile and impact
10 properties of the finished admixture composition.

Contemplated surfactants include anionic surfactants, amphoteric surfactants, or a combination of anionic and amphoteric surfactants, and combinations thereof, such as surfactants disclosed, for example, in U.S. Patent Nos. 3,929,678 and 4,259,217 and in EP 414 549, WO93/08876 and WO93/08874.

Contemplated nanoparticles include metals, metal oxides, allotropes of carbon, clays, organically modified clays, sulfates, nitrides, hydroxides, oxy/hydroxides, particulate water-insoluble polymers, silicates, phosphates and carbonates. Examples include silicon dioxide, carbon black, graphite, graphene, fullerenes, expanded graphite, carbon nanotubes, talc, calcium carbonate, bentonite, montmorillonite, kaolin, zinc glycerolate, silica,
15 aluminosilicates, boron nitride, aluminum nitride, barium sulfate, calcium sulfate, antimony oxide, feldspar, mica, nickel, copper, iron, cobalt, steel, gold, silver, platinum, aluminum, wollastonite, aluminum oxide, zirconium oxide, titanium dioxide, cerium oxide, zinc oxide, magnesium oxide, tin oxide, iron oxides (Fe_2O_3 , Fe_3O_4) and mixtures thereof. Nanoparticles can increase the strength, thermal stability, and/or abrasion resistance of the compositions
20 disclosed herein, and can give the compositions electric properties.

It is contemplated to add waxes or that some amount of wax is present in the composition. The wax may be unrelated to the lipid present or can be a saturated version of the oil. Regardless of the nature of the wax, it's level should be less than 50 weight percent in relation to the amount of oil present. Non-limiting examples of waxes contemplated in the
30 compositions disclosed herein include beef tallow, castor wax, coconut wax, coconut seed wax, corn germ wax, cottonseed wax, fish wax, linseed wax, olive wax, oiticica wax, palm kernel wax, palm wax, palm seed wax, peanut wax, rapeseed wax, safflower wax, soybean wax, sperm wax, sunflower seed wax, tall wax, tung wax, whale wax, and combinations

thereof. Non-limiting examples of specific triglycerides include triglycerides such as, for example, tristearin, tripalmitin, 1,2-dipalmitoolein, 1,3-dipalmitoolein, 1-palmito-3-stearo-2-olein, 1-palmito-2-stearo-3-olein, 2-palmito-1-stearo-3-olein, 1,2-dipalmitolinolein, 1,2-distearo-olein, 1,3-distearo-olein, trimyristin, trilaurin and combinations thereof. Non-limiting examples of specific fatty acids contemplated include capric acid, caproic acid, caprylic acid, lauric acid, myristic acid, palmitic acid, stearic acid, and mixtures thereof. Other specific waxes contemplated include hydrogenated soy bean oil, partially hydrogenated soy bean oil, partially hydrogenated palm kernel oil, and combinations thereof. Inedible waxes from Jatropa and rapeseed oil can also be used. The wax can be selected from the group consisting of a hydrogenated plant oil, a partially hydrogenated plant oil, an epoxidized plant oil, a maleated plant oil. Specific examples of such plant oils include soy bean oil, corn oil, canola oil, and palm kernel oil. The amount of wax present can range from 0 weight percent to 40 weight percent of the composition, more preferably from 5 weight percent to 20 weight percent of the composition and most preferably from 8 weight percent to 15 weight percent of the composition.

Specific examples of mineral wax include paraffin (including petrolatum), Montan wax, as well as polyolefin waxes produced from cracking processes, preferentially polyethylene derived waxes. Mineral waxes and plant derived waxes can be combined together. Plant based waxes can be differentiated by their carbon-14 content.

Contemplated anti-static agents include fabric softeners which are known to provide antistatic benefits. For example those fabric softeners that have a fatty acyl group which has an iodine value of above 20, such as N,N-di(tallowoyl-oxy-ethyl)-N,N-dimethyl ammonium methylsulfate.

Processes of Making the Compositions as Disclosed herein

Melt mixing of the polymer and oil: The polymer and oil can be suitably mixed by melting the polymer in the presence of the oil. In the melt state, the polymer and oil are subjected to shear which enables a dispersion of the oil into the polymer. In the melt state, the oil and polymer are significantly more compatible with each other.

The melt mixing of the polymer and oil can be accomplished in a number of different processes, but processes with high shear are preferred to generate the preferred morphology of the composition. The processes can involve traditional thermoplastic polymer processing equipment. The general process order involves adding the polymer to the system, melting the

polymer, and then adding the oil. However, the materials can be added in any order, depending on the nature of the specific mixing system.

Haake Batch Mixer: A Haake Batch mixer is a simple mixing system with low amount of shear and mixing. The unit is composed of two mixing screws contained within a heated, fixed volume chamber. The materials are added into the top of the unit as desired. The preferred order is to add the polymer, heat to 20°C to 120°C above the polymer's melting (or solidification) temperature into the chamber first. Once the polymer is melted, the oil can be added and mixed with the molten polymer. The mixture is then mixed in the melt with the two mixing screws for about 5 to about 15 minutes at screw RPM from about 60 to about 120. Once the composition is mixed, the front of the unit is removed and the mixed composition is removed in the molten state. By its design, this system leaves parts of the composition at elevated temperatures before crystallization starts for several minutes. This mixing process provides an intermediate quenching process, where the composition can take about 30 seconds to about 2 minutes to cool down and solidify. Mixture of polypropylene with soy bean oil in the Haake mixture showed that greater than 20wt% of oil lead to incomplete incorporation of the oil in the polypropylene mixture, indicating that higher shear rates can lead to better incorporation of oil and greater amounts of oil able to be incorporated.

Single Screw Extruder: A single screw extruder is a typical process unit used in most molten polymer extrusion. The single screw extruder typically includes a single shaft within a barrel, the shaft and barrel engineered with certain screw elements (e.g., shapes and clearances) to adjust the shearing profile. A typical RPM range for single screw extruder is about 10 to about 120. The single screw extruder design is composed of a feed section, compression section and metering section. In the feed section, using fairly high void volume flights, the polymer is heated and supplied into the compression section, where the melting is completed and the fully molten polymer is sheared. The compression section the void volume between the flights is reduced. In the metering section the polymer the polymer is subjected to its highest shearing amount using low void volume between the flights. For this work, general purpose single screw designs were used. In this unit, a continuous or steady state type of process is achieved where the composition components are introduced at desired locations, and then subjected to temperatures and shear within target zones. The process can be considered to be a steady state process as the physical nature of the interaction at each location in the single screw process is constant as a function of time. This allows for optimization of the mixing process by enabling a zone-by-zone adjustment of the temperature

and shear, where the shear can be changed through the screw elements and/or barrel design or screw speed.

The mixed composition exiting the single screw extruder can then be pelletized via extrusion of the melt into a liquid cooling medium, often water, and then the polymer strand
5 can be cut into small pieces or pellets. Alternatively, the mixed composition can be used to produce the final formed structure, for example fibers. . There are two basic types of molten polymer pelletization process used in polymer processing: strand cutting and underwater pelletization. In strand cutting the composition is rapidly quenched (generally much less than 10 seconds) in the liquid medium then cut into small pieces. In the underwater pelletization
10 process, the molten polymer is cut into small pieces then simultaneously or immediately thereafter placed in the presence of a low temperature liquid which rapidly quenches and crystallizes the polymer. These methods are commonly known and used within the polymer processing industry.

The polymer strands that come from the extruder are rapidly placed into a water bath,
15 most often having a temperature range of 1°C to 50°C (e.g., normally is about room temperature, which is 25°C). An alternate end use for the mixed composition is further processing into the desired structure, for example fiber spinning or injection molding. The single screw extrusion process can provide for a high level of mixing and high quench rate. A single screw extruder also can be used to further process a pelletized composition into
20 fibers and injection molded articles. For example, the fiber single screw extruder can be a 37 mm system with a standard general purpose screw profile and a 30:1 length to diameter ratio.

Twin Screw Extruder: A twin screw extruder is the typical unit used in most molten polymer extrusion, where high intensity mixing is required. The twin screw extruder includes two shafts and an outer barrel. A typical RPM range for twin screw extruder is
25 about 10 to about 1200. The two shafts can be co-rotating or counter rotating and allow for close tolerance, high intensity mixing. In this type of unit, a continuous or steady state type of process is achieved where the composition components are introduced at desired locations along the screws, and subjected to high temperatures and shear within target zones. The process can be considered to be a steady state process as the physical nature of the interaction
30 at each location in the single screw process is constant as a function of time. This allows for optimization of the mixing process by enabling a zone-by-zone adjustment of the temperature and shear, where the shear can be changed through the screw elements and/or barrel design.

The mixed composition at the end of the twin screw extruder can then be pelletized via extrusion of the melt into a liquid cooling medium, often water, and then the polymer strand is cut into small pieces. There are two basic types of molten polymer pelletization process, strand cutting and underwater pelletization, used in polymer processing. In strand cutting the composition is rapidly quenched (generally much less than 10s) in the liquid medium then cut into small pieces. In the underwater pelletization process, the molten polymer is cut into small pieces then simultaneously or immediately thereafter placed in the presence of a low temperature liquid which rapidly quenches and crystallizes the polymer. An alternate end use for the mixed composition is further processing into the desired structure, for example fiber spinning or injection molding.

Three different screw profiles can be employed using a Baker Perkins CT-25 25mm corotating 40:1 length to diameter ratio system. This specific CT-25 is composed of nine zones where the temperature can be controlled, as well as the die temperature. Four liquid injection sites as also possible, located between zone 1 and 2 (location A), zone 2 and 3 (location B), zone 4 and 5 (location C). and zone 6 and 7 (location D).

The liquid injection location are not directed heated, but indirectly through the adjacent zone temperatures. Locations A, B, C and D can be used to inject the additive. Zone 6 can contain a side feeder for adding additional solids or used for venting. Zone 8 contains a vacuum for removing any residual vapor, as needed.

Two types of regions, conveyance and mixing, are used in the CT-25. In the conveyance region, the materials are heated (including through melting which is done in Zone 1 into Zone 2 if needed) and conveyed along the length of the barrel, under low to moderate shear. The mixing section contains special elements that dramatically increase shear and mixing. The length and location of the mixing sections can be changed as needed to increase and decrease shear as needed.

Two primary types of mixing elements are used for shearing and mixing. The first are kneading blocks and the second are thermal mechanical energy elements. The simple mixing screw has 10.6% of the total screw length using mixing elements composed of kneading blocks in a single set followed by a reversing element. The kneading elements are RKB 45/5/12 (right handed forward kneading block with 45° offset and five lobes at 12mm total element length), followed by two RKB 45/5/36 (right handed forward kneading block with 45° offset and five lobes at 36mm total element length), that is followed by two RKB 45/5/12

and reversing element 24/12 LH (left handed reversing element 24mm pitch at 12mm total element length).

The Simple mixing screw mixing elements are located in zone 7. The Intensive screw is composed of additional mixing sections, four in total. The first section is single set of kneading blocks is a single element of RKB45/5/36 (located in zone 2) followed by conveyance elements into zone 3 where the second mixing zone is located. In the second mixing zone, two RKB 45/5/36 elements are directly followed by four TME 22.5/12 (thermomechanical element with 22.5 teeth per revolution and total element length of 12mm) then two conveyance elements into the third mixing area. The third mixing area, located at the end of zone 4 into zone 5, is composed of three RKB 45/5/36 and a KB45/5/12 LH (left handed forward reversing block with 45° offset and five lobes at 12mm total element length). The material is conveyed through zone 6 into the final mixing area comprising two TME 22.5/12, seven RKB 45/5/12, followed by SE 24/12 LH. The SE 24/12 LH is a reversing element that enables the last mixing zone to be completely filled with polymer and additive, where the intensive mixing takes place. The reversing elements can control the residence time in a given mixing area and are a key contributor to the level of mixing.

The High Intensity mixing screw is composed of three mixing sections. The first mixing section is located in zone 3 and is two RKB45/5/36 followed by three TME 22.5/12 and then conveyance into the second mixing section. Prior to the second mixing section three RSE 16/16 (right handed conveyance element with 16mm pitch and 16mm total element length) elements are used to increase pumping into the second mixing region. The second mixing region, located in zone 5, is composed of three RKB 45/5/36 followed by a KB 45/5/12 LH and then a full reversing element SE 24/12 LH. The combination of the SE 16/16 elements in front of the mixing zone and two reversing elements greatly increases the shear and mixing. The third mixing zone is located in zone 7 and is composed of three RKB 45/5/12, followed by two TME 22.5.12 and then three more RKB45/5/12. The third mixing zone is completed with a reversing element SE 24/12 LH.

An additional screw element type is a reversing element, which can increase the filling level in that part of the screw and provide better mixing. Twin screw compounding is a mature field. One skilled in the art can consult books for proper mixing and dispersion. These types of screw extruders are well understood in the art and a general description can be found in: Twin Screw Extrusion 2E: Technology and Principles by James White from Hansen

Publications. Although specific examples are given for mixing, many different combination are possible using various element configurations to achieve the needed level of mixing.

Properties of Compositions

5 The compositions as disclosed herein can have one or more of the following properties that provide an advantage over known thermoplastic compositions. These benefits can be present alone or in a combination.

Shear Viscosity Reduction: As shown in Figure 1, addition of an oil, e.g., SBO, to a thermoplastic polymer, e.g., Basell PH-835, reduces the viscosity of the thermoplastic polymer (here, polypropylene). In this comparison, the viscosity of the polypropylene carrier
10 PH-835 is reduced with increasing addition of the SBO at 10, 20, and 30 wt% levels. Viscosity reduction is a process improvement as it can allow for effectively higher polymer flow rates by having a reduced process pressure (lower shear viscosity), or can allow for an increase in polymer molecular weight, which improves the material strength. Without the presence of the oil, it may not be possible to process the polymer with a high polymer flow
15 rate at existing process conditions in a suitable way.

Sustainable Content: Inclusion of sustainable materials into the existing polymeric system is a strongly desired property. Materials that can be replaced every year through natural growth cycles contribute to overall lower environmental impact and are desired.

Pigmentation: Adding pigments to polymers often involves using expensive
20 inorganic compounds that are particles within the polymer matrix. These particles are often large and can interfere in the processing of the composition. Using an oil as disclosed herein, because of the fine dispersion (as measured by droplet size) and uniform distribution throughout the thermoplastic polymer allows for coloration, such as via traditional ink compounds. Soy ink is widely used in paper publication) that does not impact processability.

25 Fragrance: Because the oils, for example SBO, can contain perfumes much more preferentially than the base thermoplastic polymer, the present composition can be used to contain scents that are beneficial for end-use. Many scented candles are made using SBO based or paraffin based materials, so incorporation of these into the polymer for the final composition is useful.

30 Morphology: The benefits are delivered via the morphology produced in production of the compositions. The morphology is produced by a combination of intensive mixing and rapid crystallization. The intensive mixing comes from the compounding process used and

rapid crystallization comes from the cooling process used. High intensity mixing is desired and rapid crystallization is used to preserve the fine pore size and relatively uniform pore size distribution. Figure 2 shows various amounts of SBO dispersed within Basell Profax PH-835, with the small pore sizes of less than 10 μm , less than 5 μm , and less than 1 μm .

5

EXAMPLES

Polymers: The primary polymers used in this work are polypropylene (PP) and polyethylene (PE), but other polymers can be used (see, e.g., U.S. Patent No. 6,783,854, which provides a comprehensive list of polymers that are possible, although not all have been tested). Specific polymers evaluated were:

- 10 • Basell Profax PH-835: Produced by Lyondell-Basell as nominally a 35 melt flow rate Ziegler-Natta isotactic polypropylene.
- Basell Metocene MF-650W: Produced by Lyondell-Basell as nominally a 500 melt flow rate metallocene isotactic polypropylene.
- Polybond 3200: Produced by Crompton as a nominally 250 melt flow rate maleic
15 anhydride copolymer.
- Exxon Achieve 3854: Produced by Exxon-Mobil Chemical as nominally a 25 melt flow rate metallocene isotactic polypropylene.
- Mosten NB425: Produced by Unipetrol as nominally a 25 melt flow rate Ziegler-Natta isotactic polypropylene.
- 20 • Danimer 27510: a polyhydroxyalkanoate copolymer from Danimer Scientific LLC.
- Dow Aspun 6811A: Produced by Dow Chemical as a 27 melt index polyethylene copolymer.
- Eastman 9921: Produced by Eastman Chemical as a polyester terephthalic homopolymer with a nominally 0.81 intrinsic viscosity.
- 25 Oils: Specific examples used were: Soy Bean Oil (SBO); Epoxidized soy bean oil (ESBO); Corn Oil (CO); Cottonseed Oil (CSO); and Canola Oil (CNO).

Compositions were made using a Baker Perkins CT-25 Screw, with the process conditions as noted in the below table:

Table

	Polymer	Oil	Ratio		Twin-Screw Temperature Profile (°C)											Poly Temp (°C)	Oil Temp (°C)	Screw RPM	Screw Type	Torque (%)
			Poly-mer	Oil	Z1	Z2	Z3	Z4	Z5	Z6	Z7	Z8	Z9	Die						
1	835/650W	SBO	90	10	40	160	180	200	200	200	210	210	210	170	216	80	500	Intensive	29	
2	PH-835	SBO	90	10	40	160	180	200	200	200	210	210	210	170	214	80	500	Intensive	81	
3	PH-835	SBO	80	20	40	160	180	200	200	200	210	210	210	170	214	80	500	Intensive	56	
4	PH-835	SBO	70	30	40	160	180	200	200	200	210	210	210	170	217	80	500	Intensive	41	
5	PH-835	SBO	65	35	40	160	180	200	200	200	210	210	210	170	NR	80	500	Intensive	NR	
6	Achieve 3854	SBO	90	10	40	160	180	200	200	200	210	210	210	170	220	80	500	Intensive	64	
7	Achieve 3854	SBO	80	20	40	160	180	200	200	200	210	210	210	170	NR	80	500	Intensive	NR	
8	Mosten NB425	SBO	80	20	40	160	180	200	200	200	210	210	210	170	220	80	500	Intensive	44	
9	Mosten NB425	SBO	70	30	40	160	180	200	200	200	210	210	210	170	213	80	500	Intensive	37	
10	Mosten NB425	SBO	65	35	40	160	180	200	200	200	210	210	210	170	NR	80	500	Intensive	NR	
11	835/PB32 00	SBO	90	10	40	160	180	200	200	200	210	210	210	170	216	80	500	Intensive	46	
12	835/PB32 00	SBO	80	20	40	160	180	200	200	200	210	210	210	170	NR	80	500	Intensive	NR	

	Polymer	Oil	Ratio		Twin-Screw Temperature Profile (°C)										Poly Temp (°C)	Oil Temp (°C)	Screw RPM	Screw Type	Torque (%)
			Poly-mer	Oil	Z1	Z2	Z3	Z4	Z5	Z6	Z7	Z8	Z9	Die					
13	PH-835	ESBO	90	10	40	160	180	200	200	200	210	210	210	170	213	80	500	Intensive	47
14	PH-835	ESBO	80	20	40	160	180	200	200	200	210	210	210	170	NR	80	500	Intensive	NR
15	Achieve 3854	ESBO	90	10	40	160	180	200	200	200	210	210	210	170	216	80	500	Intensive	46
16	Achieve 3854	ESBO	80	20	40	160	180	200	200	200	210	210	210	170	NR	80	500	Intensive	NR
17	PH-835	CO	90	10	40	160	180	200	200	200	210	210	210	170	197	80	400	High	63
18	PH-835	CO	80	20	40	160	180	200	200	200	210	210	210	170	197	80	400	High	50
19	PH-835	CO	70	30	40	160	180	200	200	200	210	210	210	170	210	80	400	High	39
20	Achieve 3854	CO	90	10	40	160	180	200	200	200	210	210	210	170	204	80	400	High	63
21	Achieve 3854	CO	80	20	40	160	180	200	200	200	210	210	210	170	200	80	400	High	52
22	Achieve 3854	CO	70	30	40	160	180	200	200	200	210	210	210	170	202	80	400	High	40
23	PH-835	CNO	90	10	40	160	180	200	200	200	210	210	210	170	201	80	400	High	60
24	PH-835	CNO	80	20	40	160	180	200	200	200	210	210	210	170	201	80	400	High	50
25	PH-835	CNO	70	30	40	160	180	200	200	200	210	210	210	170	204	80	400	High	39
26	Achieve 3854	CNO	90	10	40	160	180	200	200	200	210	210	210	170	206	80	400	High	62

	Polymer	Oil	Ratio		Twin-Screw Temperature Profile (°C)										Poly Temp (°C)	Oil Temp (°C)	Screw RPM	Screw Type	Torque (%)
			Poly-mer	Oil	Z1	Z2	Z3	Z4	Z5	Z6	Z7	Z8	Z9	Die					
27	Achieve 3854	CNO	80	20	40	160	180	200	200	200	210	210	210	170	207	80	400	High	51
28	Achieve 3854	CNO	70	30	40	160	180	200	200	200	210	210	210	170	204	80	400	High	41
29	PH-835	CSO	90	10	40	160	180	200	200	200	210	210	210	170	197	80	400	High	60
30	PH-835	CSO	80	20	40	160	180	200	200	200	210	210	210	170	196	80	400	High	51
31	PH-835	CSO	70	30	40	160	180	200	200	200	210	210	210	170	196	80	400	High	39
32	Achieve 3854	CSO	90	10	40	160	180	200	200	200	210	210	210	170	199	80	400	High	62
33	Achieve 3854	CSO	80	20	40	160	180	200	200	200	210	210	210	170	193	80	400	High	51
34	Achieve 3854	CSO	70	30	40	160	180	200	200	200	210	210	210	170	194	80	400	High	40
35	Danimer 27510	SBO	95	5	40	170	180	180	180	180	180	180	180	170	177	80	500	High	40
36	Danimer 27510	SBO	93	7	40	170	180	180	180	180	180	180	180	170	171	80	500	High	32
37	Danimer 27510	SBO	90	10	40	170	180	180	180	180	180	180	180	170	169	80	500	High	22
38	Aspun 6811A	SBO	90	10	40	160	180	190	190	190	190	190	190	170	176	80	500	High	50

	Polymer	Oil	Ratio		Twin-Screw Temperature Profile (°C)										Poly Temp (°C)	Oil Temp (°C)	Screw RPM	Screw Type	Torque (%)
			Poly-mer	Oil	Z1	Z2	Z3	Z4	Z5	Z6	Z7	Z8	Z9	Die					
39	Aspun 6811A	SBO	80	20	40	160	180	190	190	190	190	190	190	170	179	80	500	High	41
40	Aspun 6811A	SBO	70	30	40	160	180	190	190	190	190	190	190	170	168	80	500	High	28
41	Eastman 9921	SBO	85	15	40	220	260	270	290	290	290	290	280	250	262	80	600	High	43
42	Eastman 9921	SBO	80	20	40	220	260	270	290	290	290	290	280	250	NR	80	500	High	NR

For examples 5, 7, 10, 12, 16, and 42, it was noted that the SBO was surging at the end of the CT-25 extruder. Examples 5, 7, 10, 12, 16, 39, and 41 failed to properly pelletize. Example 41 produced brittle strands.

Figure 1 shows the shear viscosity influence of adding soy bean oil to Lyondell Basell Profax PH-835 at 10, 20 and 30wt%. The shear viscosity was measured using a capillary rheometer according to ASTM D3835 at 230°C using a 30:1 capillary. Figure 1 shows the neat PP resin compared with Examples 2-4. Adding 30wt% soy bean oil to PH-835 results in a 50% reduction in shear viscosity at 1000 s^{-1} , which results in lower flow forces and process pressures.

Examples 1-34 show the polymer plus additive tested in a stable range and to the limit. As used herein, stable refers to the ability of the composition to be extruded and to be pelletized. What was observed was that during the stable composition, strands from the B&P 25mm system could be extruded, quenched in a water bath at 5°C and cut via a pelletizer without interruption. The twin-screw extrudate was immediately dropped into the water bath. During stable extrusion, no significant amount of oil separated from the formulation strand (>99wt% made it through the pelletizer). The composition became unstable when it was clear that the polymer and oil were separating from each other at the end of the twin-screw and the composition strands could not be maintained. Without being bound by theory, the polymer at this point is considered fully saturated. The saturation point can change based on the oil and polymer combination, along with the process conditions. The practical utility is that the oil and polymer remain admixed and do not separate, which is a function of the mixing level and quench rate for proper dispersion of the additive. Specific Examples where the extrusion became unstable from high oil inclusion are Example 5, 7, 10, 12, 16 and 42.

Figure 2 shows SEM images for Examples 1 (B), 2 (C), and 3 (D), showing the pore size, or dispersion of the oil within the polypropylene polymer. Sample preparation was as follows.

Freeze Fracture Procedure: 1) The pellets were immersed in liquid nitrogen and were allowed to cool down until any boiling reached a minimum. 2) The bottom inch or so of a standard woodworking chisel was also immersed in liquid nitrogen and allowed to cool down until any boiling reached a minimum. 3) The pellets were then fractured across the cylinder by placing the chisel on the pellet and tapping it with a hammer. 4) The fragments were removed from the liquid nitrogen and allowed to warm up while sitting on the lab bench.

Extraction Procedure: Hexane 1) Approximately 15 ml of Hexanes (Mallinckrodt Chemicals, Cat# H487-10) was placed into a glass vial. The fractured pellets were added to solvent and a cap put on the vial. The fractured pellets were soaked in the solvent.

Occasionally, the vial was shaken by hand. 2) After 30 minutes the fractured pellets were
5 removed from the solvent and allowed to dry.

Mounting and Coating Procedure: 1) A piece of double sided carbon tape (Electron Microscopy Sciences, Cat# 77825-12) was affixed to the sample stub. The fractured pellet was then affixed to the top of the tape trying to keep the fracture surface pointed up and as parallel to the surface of the stub as possible. 2) The sample was then mounted in the SEM
10 holder for the Hitachi S-5200 Scanning Electron Microscope and loaded into the Gatan Alto 2500 coated and coated for 90 seconds at 10 mA current with gold/palladium (Refining Systems Inc., Gold Palladium Target, 1" Diameter x 0.010" Thick). Argon gas (Matheson Tri-Gas, Ultra-High Purity) was used.

Imaging: Imaging was performed in the Hitachi S-5200 Scanning Electron
15 Microscope at 3KV accelerating voltage and 5-10 μ A tip current.

All documents cited in the Detailed Description of the Invention are, in relevant part, incorporated herein by reference; the citation of any document is not to be construed as an admission that it is prior art with respect to the present invention. To the extent that any meaning or definition of a term in this document conflicts with any meaning or definition of
20 the same term in a document incorporated by reference, the meaning or definition assigned to that term in this document shall govern.

The dimensions and values disclosed herein are not to be understood as being strictly limited to the exact numerical values recited. Instead, unless otherwise specified, each such dimension is intended to mean both the recited value and a functionally equivalent range
25 surrounding that value. For example, a dimension disclosed as "40 mm" is intended to mean "about 40 mm".

While particular embodiments of the present invention have been illustrated and described, it would be obvious to those skilled in the art that various other changes and modifications can be made without departing from the spirit and scope of the invention. It is
30 therefore intended to cover in the appended claims all such changes and modifications that are within the scope of this invention.

CLAIMS

What is claimed is:

1. A composition comprising an intimate admixture of
 - (a) a thermoplastic polymer; and
 - (b) 5 wt% to 40 wt% of an oil, based upon the total weight of the composition, the oil having a melting point of 25°C or less and a boiling point greater than 160°C.
2. The composition of claim 1, wherein the thermoplastic polymer comprises a polyolefin, a polyester, a polyamide, copolymers thereof, or combinations thereof.
3. The composition of claim 2, wherein the thermoplastic polymer is selected from the group consisting of polypropylene, polyethylene, polypropylene co-polymer, polyethylene co-polymer, polyethylene terephthalate, polybutylene terephthalate, polylactic acid, polyhydroxyalkanoates, polyamide-6, polyamide-6,6, and combinations thereof.
4. The composition of any one of claims 1 to 3, wherein the thermoplastic polymer comprises polypropylene.
5. The composition of any one of claims 1 to 4, comprising 8 wt% to 30 wt% of the oil, based upon the total weight of the composition.
6. The composition of any one of claims 1 to 5, wherein the oil comprises a lipid.
7. The composition of claim 6, wherein the lipid comprises a monoglyceride, diglyceride, triglyceride, fatty acid, fatty alcohol, esterified fatty acid, epoxidized lipid, maleated lipid, hydrogenated lipid, alkyd resin derived from a lipid, sucrose polyester, or combinations thereof.
8. The composition of any one of claims 1 to 5, wherein the oil is selected from the group consisting of soy bean oil, epoxidized soy bean oil, maleated soy bean oil, corn oil, cottonseed oil, canola oil, castor oil, coconut oil, coconut seed oil, corn germ oil, linseed oil, fish oil, olive oil, oiticica oil, palm kernel oil, palm oil, palm seed oil, peanut oil, cottonseed oil, hempseed oil, rapeseed oil, safflower oil, sperm oil, sunflower seed oil, tall oil, tung oil, whale oil, triolein, trilinolein, 1-stearo- dilinolein, 1-palmito-dilinolein, lauroleic acid, linoleic acid, linolenic acid, myristoleic acid, oleic acid, palmitoleic acid, 1,2-diacetopalmitin, and combinations thereof.

9. The composition of any one of claims 1 to 8, wherein the oil is dispersed within the thermoplastic polymer such that the oil has a droplet size of less than 10 μm within the thermoplastic polymer.

10. The composition of claim 9, wherein the droplet size is less than 1 μm .

AMENDED CLAIMS
received by the International Bureau on 22 October 2012 (22.10.2012)

What is claimed is:

1. A composition comprising an intimate admixture of
 - (a) a thermoplastic polymer; and
 - (b) 5 wt% to 40 wt% of an oil, based upon the total weight of the composition, the oil having a melting point of 25°C or less and a boiling point greater than 160°C, said oil being dispersed within said thermoplastic polymer such that the oil has a droplet size of less than 10 µm within the thermoplastic polymer.
2. The composition of claim 1, wherein the thermoplastic polymer comprises a polyolefin, a polyester, a polyamide, copolymers thereof, or combinations thereof.
3. The composition of claim 2, wherein the thermoplastic polymer is selected from the group consisting of polypropylene, polyethylene, polypropylene co-polymer, polyethylene co-polymer, polyethylene terephthalate, polybutylene terephthalate, polylactic acid, polyhydroxyalkanoates, polyamide-6, polyamide-6,6, and combinations thereof.
4. The composition of any one of claims 1 to 3, wherein the thermoplastic polymer comprises polypropylene.
5. The composition of any one of claims 1 to 4, comprising 8 wt% to 30 wt% of the oil, based upon the total weight of the composition.
6. The composition of any one of claims 1 to 5, wherein the oil comprises a lipid.
7. The composition of claim 6, wherein the lipid comprises a monoglyceride, diglyceride, triglyceride, fatty acid, fatty alcohol, esterified fatty acid, epoxidized lipid, maleated lipid, hydrogenated lipid, alkyd resin derived from a lipid, sucrose polyester, or combinations thereof.
8. The composition of any one of claims 1 to 5, wherein the oil is selected from the group consisting of soy bean oil, epoxidized soy bean oil, maleated soy bean oil, corn oil, cottonseed oil, canola oil, castor oil, coconut oil, coconut seed oil, corn germ oil, linseed oil, fish oil, olive oil, oiticica oil, palm kernel oil, palm oil, palm seed oil, peanut oil, cottonseed oil,

hempseed oil, rapeseed oil, safflower oil, sperm oil, sunflower seed oil, tall oil, tung oil, whale oil, triolein, trilinolein, 1-stearo- dilinolein, 1-palmito-dilinolein, lauroleic acid, linoleic acid, linolenic acid, myristoleic acid, oleic acid, palmitoleic acid, 1,2-diacetopalmitin, and combinations thereof.

9. The composition of any one of claims 1 to 8, wherein the droplet size of said oil is less than 1 μm .

1/2

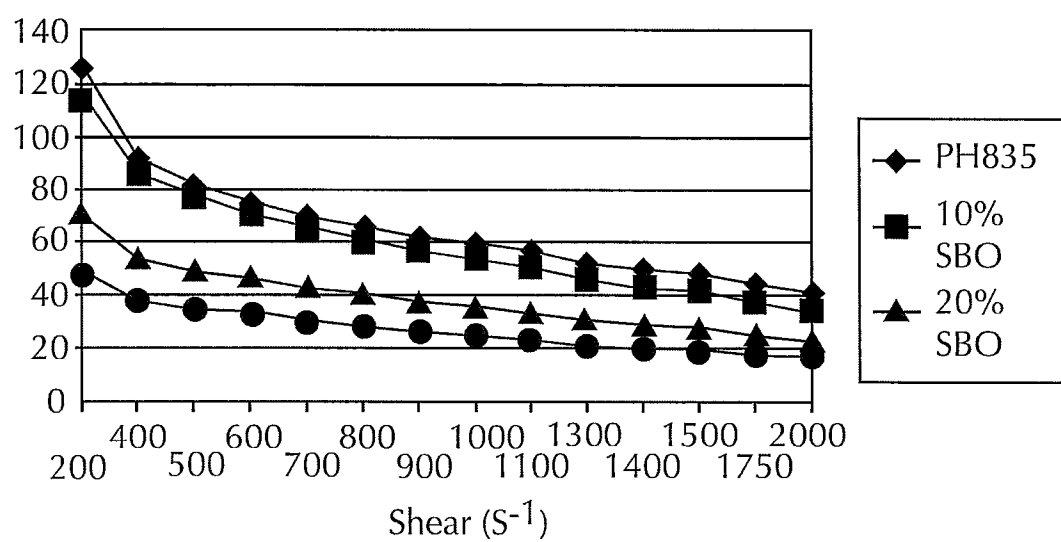


Fig. 1

2/2

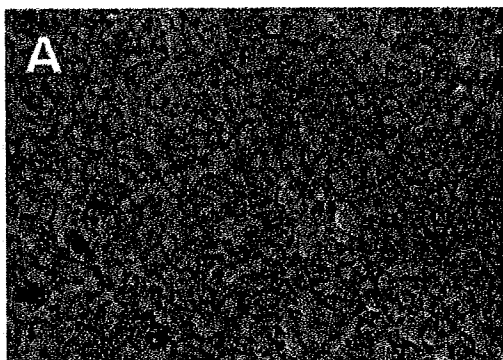


Fig. 2A

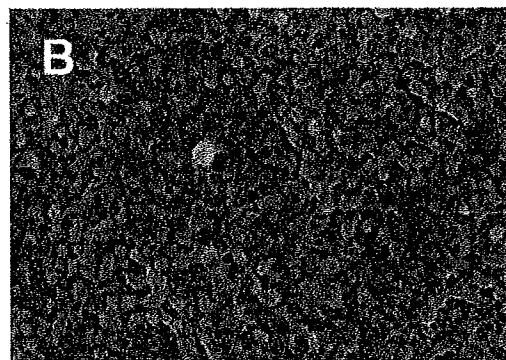


Fig. 2B

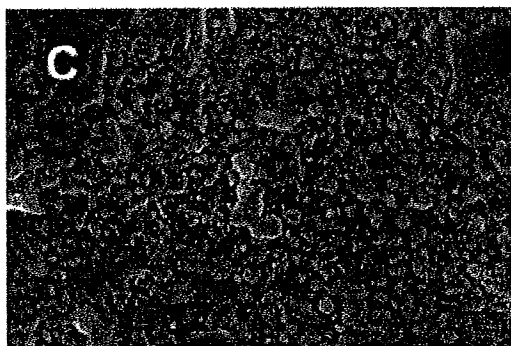


Fig. 2C

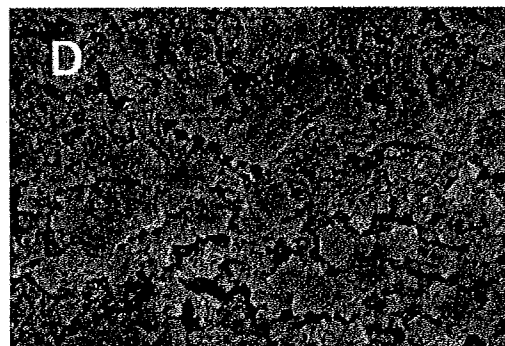


Fig. 2D

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2012/038583

A. CLASSIFICATION OF SUBJECT MATTER
INV. C08K5/01
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
C08K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 01/90230 A1 (NKT RES AS [DK]; ARMAND CHAABANE [DK]) 29 November 2001 (2001-11-29) examples 5-7 claims 1,2,4,5,11,13-15 -----	1-10
X	WO 2007/044803 A1 (PROCTER & GAMBLE [US]; NODA ISAO [US]; SATKOWSKI MICHAEL M [US]; ALLEN) 19 April 2007 (2007-04-19) claims 1,3,5,6 -----	1-10
X	US 5 498 650 A (FLEXMAN EDMUND A [US] ET AL) 12 March 1996 (1996-03-12) claims 1-5 examples; table 1 ----- -/-	1-10



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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"P" document published prior to the international filing date but later than the priority date claimed

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

17 August 2012

Date of mailing of the international search report

30/08/2012

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

Authorized officer

Russell, Graham

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2012/038583

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 539 352 A (CHUNG JAMES Y J [US] ET AL) 3 September 1985 (1985-09-03) example 36; tables VI, IX claims 1,3,4 -----	1-10
X	US 2006/057409 A1 (KLIESCH HOLGER [DE] ET AL) 16 March 2006 (2006-03-16) examples 1-4 claims 1,8-12 -----	1-3,5-8
X	EP 1 443 070 A1 (NUOVA POLIVER DI ODDONE COLOMB [IT]) 4 August 2004 (2004-08-04) examples 2,3 claims 1,4,5 -----	1-3,8

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2012/038583

Patent document cited in search report		Publication date		Patent family member(s)		Publication date
WO 0190230	A1	29-11-2001	AU	6009001 A		03-12-2001
			WO	0190230 A1		29-11-2001

WO 2007044803	A1	19-04-2007	AT	435886 T		15-07-2009
			AT	449875 T		15-12-2009
			AT	481450 T		15-10-2010
			AT	505570 T		15-04-2011
			CA	2625209 A1		19-04-2007
			CA	2625237 A1		19-04-2007
			CA	2625240 A1		19-04-2007
			CA	2625248 A1		19-04-2007
			CN	101283033 A		08-10-2008
			CN	101283034 A		08-10-2008
			CN	101283123 A		08-10-2008
			CN	101283124 A		08-10-2008
			EP	1934280 A1		25-06-2008
			EP	1934389 A1		25-06-2008
			EP	1934390 A1		25-06-2008
			EP	1937768 A1		02-07-2008
			JP	2009511714 A		19-03-2009
			JP	2009511715 A		19-03-2009
			JP	2009511765 A		19-03-2009
			JP	2009511766 A		19-03-2009
			US	2007079945 A1		12-04-2007
			US	2007082573 A1		12-04-2007
			US	2007082981 A1		12-04-2007
			US	2007082982 A1		12-04-2007
			WO	2007044800 A1		19-04-2007
			WO	2007044801 A1		19-04-2007
			WO	2007044802 A1		19-04-2007
			WO	2007044803 A1		19-04-2007

US 5498650	A	12-03-1996	AU	4103496 A		11-09-1996
			US	5498650 A		12-03-1996
			WO	9626239 A1		29-08-1996

US 4539352	A	03-09-1985	NONE			

US 2006057409	A1	16-03-2006	DE	102004044326 A1		16-03-2006
			EP	1634914 A1		15-03-2006
			JP	2006077250 A		23-03-2006
			KR	20060051183 A		19-05-2006
			US	2006057409 A1		16-03-2006

EP 1443070	A1	04-08-2004	NONE			
