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(54) Title: A COMPOSITE MATERIAL, ARTICLES MADE THEREFROM

(57) Abstract: The instant invention provides a composite material, and articles made therefrom. The composite material according to the present invention comprises: at least 90 percent by weight of a thermoplastic polymer; and from 1 to 10 percent by weight of metal oxide lamellae.

A COMPOSITE MATERIAL, ARTICLES MADE THEREFROM

Field of Invention

The instant invention relates to a composite material, and articles made therefrom.

Background of the Invention

Polymeric materials can be converted into various articles via a wide range of converting processes. Many converting processes for converting polymeric materials to desirable articles, especially in the field of packaging and piping, require a secondary heating process for welding and/or shaping of such articles. The typical process employs heat transfer by conduction (seal bars) or infrared heating. Unfortunately, these technologies rely and depend on a perfect heat transfer system throughout the entire structure. In many instances such structures contain actual heat barrier materials while their building block polymeric materials have poor heat transfer capability. For example, process for making carton board/polymer laminates employs aluminum foil as the means for heating via electromagnetic induction. However, the use of such additional components affects the environment and adds additional cost for such lamination processes.

The existence of minerals sensitive to magnetic induction is also known. Minerals based on paramagnetic iron oxides are the preferred choice due to their effectiveness; however, their use has been hindered because such minerals contain residual amounts of other forms of iron leading to polymer degradation at relatively shorter time.

Therefore, there is a need for composite polymeric materials providing improved means for sealing and/or welding in packaging applications.

Summary of the Invention

The instant invention provides a composite material, and articles made therefrom.

In one embodiment, the instant invention provides a composite material comprising: at least 90 percent by weight of a thermoplastic polymer; and from 0.1 to 10 percent by weight of metal oxide lamellae.

In an alternative embodiment, the instant invention further provides a process for forming a seal comprising the steps of: (1) selecting a composite material comprising: (a) at least 90 percent by weight of a thermoplastic polymer; and (b) from 0.1 to 10 percent by weight of metal oxide lamellae; and (2) forming a seal by subjecting the composite material to induction heating or microwave heating.

In another alternative embodiment, the instant invention further provides a seal or a weld comprising the composite material.

In another alternative embodiment, the instant invention further provides multilayer structure comprising at least one layer comprising the composite material.

In an alternative embodiment, the instant invention provides a composite material, a seal, a weld or a multilayer structure, or a method of producing a seal, in accordance with any of the preceding embodiments, except that the metal oxide is iron oxide.

In an alternative embodiment, the instant invention provides a composite material, a seal, a weld or a multilayer structure, or a method of producing a seal, in accordance with any of the preceding embodiments, except that the platelets of a metal oxide have a purity level of greater than 99 percent.

In an alternative embodiment, the instant invention provides a composite material, a seal, a weld or a multilayer structure, or a method of producing a seal, in accordance with any of the preceding embodiments, except that the platelets of a metal oxide have an average size diameter (long axis) in the range of from 2 to 30 μM.

In an alternative embodiment, the instant invention provides a composite material, a seal, a weld or a multilayer structure, or a method of producing a seal, in accordance with any of the preceding embodiments, except that the platelets of a metal oxide have an average aspect ratio (long axis/thickness) in the range of from 2 to 30.

In an alternative embodiment, the instant invention provides a composite material, a seal, a weld or a multilayer structure, or a method of producing a seal, in accordance with any of the preceding embodiments, except that the thermoplastic polymer is an ethylene based polymer or a propylene based polymer.

Brief Description of the Drawings

For the purpose of illustrating the invention, there is shown in the drawings a form that is exemplary; it being understood, however, that this invention is not limited to the precise arrangements and instrumentalities shown.

Fig. 1 is a first photograph of iron oxide lamellae;

Fig. 2 is a second photograph of iron oxide lamellae;

Fig. 3 is a third photograph of iron oxide lamellae;

Fig. 4 is a graph illustrating the relationship between the filler loading in wt% and stress properties in MPa of Inventive Films 3 and 4 and Comparative Films 3 and 4; and

Fig. 5 is a graph illustrating the relationship between the filler loading in wt% and stress properties in MPa of Inventive Films 1 and 2 and Comparative Films 1 and 2.

Detailed Description of the Invention

The instant invention provides a composite material. The composite material according to the present invention comprises at least 90 percent by weight of a thermoplastic polymer; and from 0.1 to 10 percent by weight of metal oxide lamellae.

The composite material according to the present invention comprises at least 90 percent by weight of a thermoplastic polymer, for example, at least 92 weight percent, or at least 94 weight percent, or at least 95 weight percent, or at least 96 weight percent, or at least 97 weight percent, or at least 98 weight percent, or at least 99 weight percent.

Such thermoplastic polymers (materials) include, but are not limited to, polyolefin, e.g. polyethylene and polypropylene; polyamide, e.g. nylon 6; polyvinylidene chloride; polyvinylidene fluoride; polycarbonate; polystyrene; polyethylene terephthalate; polyester, and polyurethanes.

Examples of thermoplastic materials include, but are not limited to, homopolymers and copolymers (including elastomers) of one or more alpha-olefins such as ethylene, propylene, 1-butene, 3-methyl-1-butene, 4-methyl-1-pentene, 3-methyl-1-pentene, 1-heptene, 1-hexene, 1-octene, 1-decene, and 1-dodecene, as typically represented by polyethylene, polypropylene, poly-1-butene, poly-3-methyl-1-butene, poly-3-methyl-1-pentene, poly-4-methyl-1-pentene, ethylene-propylene copolymer, ethylene-l-butene copolymer, and propylene-1-butene copolymer; copolymers (including elastomers) of an alpha-olefin with a conjugated or non-conjugated diene, as typically represented by ethylene-butadiene copolymer and ethylene-ethylidene norbornene copolymer; and polyolefins (including elastomers) such as copolymers of two or more alpha-olefins with a conjugated or non-conjugated diene, as typically represented by ethylene-propylene-butadiene copolymer, ethylene-propylene- dicyclopentadiene copolymer, ethylene-propylene-1,5-hexadiene copolymer, and ethylene-propylene-ethylidene norbornene copolymer; ethylene-vinyl compound copolymers such as ethylene-vinyl acetate copolymer, ethylene-vinyl alcohol copolymer, ethylene-vinyl chloride copolymer, ethylene acrylic acid or ethylene-(meth)acrylic acid copolymers, and ethylene-(meth)acrylate copolymer; styrenic copolymers (including elastomers) such as polystyrene, ABS, acrylonitrile-styrene copolymer, α-methylstyrene-styrene copolymer, styrene vinyl alcohol, styrene

acrylates such as styrene methylacrylate, styrene butyl acrylate, styrene butyl methacrylate, and styrene butadienes and crosslinked styrene polymers; and styrene block copolymers (including elastomers) such as styrene-butadiene copolymer and hydrate thereof, and styrene-isoprene-styrene triblock copolymer; polyvinyl compounds such as polyvinyl chloride, polyvinylidene chloride, vinyl chloride-vinylidene chloride copolymer, polymethyl acrylate, and polymethyl methacrylate; polyamides such as nylon 6, nylon 6,6, and nylon 12; thermoplastic polyesters such as polyethylene terephthalate and polybutylene terephthalate; polyurethane; polycarbonate, polyphenylene oxide, and the like; and glassy hydrocarbon-based resins, including poly-dicyclopentadiene polymers and related polymers (copolymers, terpolymers); saturated mono-olefins such as vinyl acetate, vinyl propionate, vinyl versatate, and vinyl butyrate and the like; vinyl esters such as esters of monocarboxylic acids, including methyl acrylate, ethyl acrylate, n-butyl acrylate, isobutyl acrylate, 2-ethylhexyl acrylate, dodecyl acrylate, n-octyl acrylate, phenyl acrylate, methyl methacrylate, ethyl methacrylate, and butyl methacrylate and the like; acrylonitrile, methacrylonitrile, acrylamide, mixtures thereof; resins produced by ring opening metathesis and cross metathesis polymerization and the like. These resins may be used either alone or in combinations of two or more.

In selected embodiments, thermoplastic material may, for example, comprise one or more polyolefins selected from the group consisting of ethylene-alpha olefin copolymers, propylene-alpha olefin copolymers, and olefin block copolymers. In particular, in select embodiments, the thermoplastic material may comprise one or more non-polar polyolefins.

In specific embodiments, polyolefins such as polypropylene, polyethylene, copolymers thereof, and blends thereof, as well as ethylene-propylene-diene terpolymers, may be used. In some embodiments, exemplary olefinic polymers include homogeneous polymers; high density polyethylene (HDPE); heterogeneously branched linear low density polyethylene (LLDPE); heterogeneously branched ultra low linear density polyethylene (ULDPE); homogeneously branched, linear ethylene/alpha-olefin copolymers; homogeneously branched, substantially linear ethylene/alpha-olefin polymers; and high pressure, free radical polymerized ethylene polymers and copolymers such as low density polyethylene (LDPE) or ethylene vinyl acetate polymers (EVA).

In one embodiment, the ethylene-alpha olefin copolymer may, for example, be ethylene-butene, ethylene-hexene, or ethylene-octene copolymers or interpolymers. In other particular embodiments, the propylene-alpha olefin copolymer may, for example, be a propylene-ethylene or a propylene-ethylene-butene copolymer or interpolymer.

In certain other embodiments, the thermoplastic material may, for example, be a semi-crystalline polymer and may have a melting point of less than 110° C. In another embodiment, the melting point may be from 25 to 100° C. In another embodiment, the melting point may be between 40 and 85° C.

In one particular embodiment, the thermoplastic material is a propylene/α-olefin interpolymer composition comprising a propylene/alpha-olefin copolymer, and optionally one or more polymers, e.g. a random copolymer polypropylene (RCP). In one particular embodiment, the propylene/alpha-olefin copolymer is characterized as having substantially isotactic propylene sequences. "Substantially isotactic propylene sequences" means that the sequences have an isotactic triad (mm) measured by ^{13}C NMR of greater than about 0.85; in the alternative, greater than about 0.90; in another alternative, greater than about 0.92; and in another alternative, greater than about 0.93. Isotactic triads are well-known in the art and are described in, for example, U.S. Patent No. 5,504,172 and International Publication No. WO 00/01745, which refer to the isotactic sequence in terms of a triad unit in the copolymer molecular chain determined by ^{13}C NMR spectra.

The propylene/alpha-olefin copolymer may have a melt flow rate in the range of from 0.1 to 500 g/10 minutes, measured in accordance with ASTM D-1238 (at 230° C / 2.16 Kg). All individual values and subranges from 0.1 to 500 g/10 minutes are included herein and disclosed herein; for example, the melt flow rate can be from a lower limit of 0.1 g/10 minutes, 0.2 g/10 minutes, or 0.5 g/10 minutes to an upper limit of 500 g/10 minutes, 200 g/10 minutes, 100 g/10 minutes, or 25 g/10 minutes. For example, the propylene/alpha-olefin copolymer may have a melt flow rate in the range of from 0.1 to 200 g/10 minutes; or in the alternative, the propylene/ alpha-olefin copolymer may have a melt flow rate in the range of from 0.2 to 100 g/10 minutes; or in the alternative, the propylene/alpha-olefin copolymer may have a melt flow rate in the range of from 0.2 to 50 g/10 minutes; or in the alternative, the propylene/alpha-olefin copolymer may have a melt flow rate in the range of from 0.5 to 50 g/10 minutes; or in the alternative, the propylene/alpha-olefin copolymer may have a melt flow rate in the range of from 1 to 50 g/10 minutes; or in the alternative, the propylene/alpha-olefin copolymer may have a melt flow rate in the range of from 1 to 40 g/10 minutes; or in the alternative, the propylene/alpha-olefin copolymer may have a melt flow rate in the range of from 1 to 30 g/10 minutes.

The propylene/alpha-olefin copolymer has a crystallinity in the range of from at least 1 percent by weight (a heat of fusion of at least 2 Joules/gram) to 30 percent by weight (a heat of

fusion of less than 50 Joules/gram). All individual values and subranges from 1 percent by weight (a heat of fusion of at least 2 Joules/gram) to 30 percent by weight (a heat of fusion of less than 50 Joules/gram) are included herein and disclosed herein; for example, the crystallinity can be from a lower limit of 1 percent by weight (a heat of fusion of at least 2 Joules/gram), 2.5 percent (a heat of fusion of at least 4 Joules/gram), or 3 percent (a heat of fusion of at least 5 Joules/gram) to an upper limit of 30 percent by weight (a heat of fusion of less than 50 Joules/gram), 24 percent by weight (a heat of fusion of less than 40 Joules/gram), 15 percent by weight (a heat of fusion of less than 24.8 Joules/gram) or 7 percent by weight (a heat of fusion of less than 11 Joules/gram). For example, the propylene/alpha-olefin copolymer may have a crystallinity in the range of from at least 1 percent by weight (a heat of fusion of at least 2 Joules/gram) to 24 percent by weight (a heat of fusion of less than 40 Joules/gram); or in the alternative, the propylene/alpha-olefin copolymer may have a crystallinity in the range of from at least 1 percent by weight (a heat of fusion of at least 2 Joules/gram) to 15 percent by weight (a heat of fusion of less than 24.8 Joules/gram); or in the alternative, the propylene/alpha-olefin copolymer may have a crystallinity in the range of from at least 1 percent by weight (a heat of fusion of at least 2 Joules/gram) to 7 percent by weight (a heat of fusion of less than 11 Joules/gram); or in the alternative, the propylene/alpha-olefin copolymer may have a crystallinity in the range of from at least 1 percent by weight (a heat of fusion of at least 2 Joules/gram) to 5 percent by weight (a heat of fusion of less than 8.3 Joules/gram). The crystallinity is measured via DSC method. The propylene/alpha-olefin copolymer comprises units derived from propylene and polymeric units derived from one or more alpha-olefin comonomers. Exemplary comonomers utilized to manufacture the propylene/alpha-olefin copolymer are C_2, and C_4 to C_{10} alpha-olefins; for example, C_2, C_4, C_6 and C_8 alpha-olefins.

The propylene/alpha-olefin copolymer comprises from 1 to 40 percent by weight of one or more alpha-olefin comonomers. All individual values and subranges from 1 to 40 weight percent are included herein and disclosed herein; for example, the comonomer content can be from a lower limit of 1 weight percent, 3 weight percent, 4 weight percent, 5 weight percent, 7 weight percent, or 9 weight percent to an upper limit of 40 weight percent, 35 weight percent, 30 weight percent, 27 weight percent, 20 weight percent, 15 weight percent, 12 weight percent, or 9 weight percent. For example, the propylene/alpha-olefin copolymer comprises from 1 to 35 percent by weight of one or more alpha-olefin comonomers; or in the alternative, the propylene/alpha-olefin copolymer comprises from 1 to 30 percent by weight of one or more alpha-olefin comonomers; or in the

alternative, the propylene/alpha-olefin copolymer comprises from 3 to 27 percent by weight of one or more alpha-olefin comonomers; or in the alternative, the propylene/alpha-olefin copolymer comprises from 3 to 20 percent by weight of one or more alpha-olefin comonomers; or in the alternative, the propylene/alpha-olefin copolymer comprises from 3 to 15 percent by weight of one or more alpha-olefin comonomers.

The propylene/alpha-olefin copolymer has a molecular weight distribution (MWD), defined as weight average molecular weight divided by number average molecular weight (M_w/M_n) of 3.5 or less; in the alternative 3.0 or less; or in another alternative from 1.8 to 3.0.

Such propylene/alpha-olefin copolymers are further described in details in the U.S. Patent Nos. 6,960,635 and 6,525,157, incorporated herein by reference. Such propylene/alpha-olefin copolymers are commercially available from The Dow Chemical Company, under the tradename VERSIFY™, or from ExxonMobil Chemical Company, under the tradename VISTAMAXX™.

In one embodiment, the propylene/alpha-olefin copolymers are further characterized as comprising (A) between 60 and less than 100, preferably between 80 and 99 and more preferably between 85 and 99, weight percent units derived from propylene, and (B) between greater than zero and 40, preferably between 1 and 20, more preferably between 4 and 16 and even more preferably between 4 and 15, weight percent units derived from at least one of ethylene and/or a C_{4-10} α-olefin; and containing an average of at least 0.001, preferably an average of at least 0.005 and more preferably an average of at least 0.01, long chain branches/1000 total carbons. The maximum number of long chain branches in the propylene/alpha-olefin copolymer is not critical, but typically it does not exceed 3 long chain branches/1000 total carbons. The term long chain branch, as used herein with regard to propylene/alpha-olefin copolymers, refers to a chain length of at least one (1) carbon more than a short chain branch, and short chain branch, as used herein with regard to propylene/alpha-olefin copolymers, refers to a chain length of two (2) carbons less than the number of carbons in the comonomer. For example, a propylene/1-octene interpolymer has backbones with long chain branches of at least seven (7) carbons in length, but these backbones also have short chain branches of only six (6) carbons in length. Such propylene/alpha-olefin copolymers are further described in details in the U.S. Provisional Patent Application No. 60/988,999 and International Patent Application No. PCT/US08/082599, each of which is incorporated herein by reference.

In certain other embodiments, the thermoplastic material, e.g. propylene/alpha-olefin copolymer, may, for example, be a semi-crystalline polymer and may have a melting point of less

than 110° C. In preferred embodiments, the melting point may be from 25 to 100° C. In more preferred embodiments, the melting point may be between 40 and 85° C.

In other selected embodiments, olefin block copolymers, e.g., ethylene multi-block copolymer, such as those described in the International Publication No. WO2005/090427 and U.S. Patent Application Publication No. US 2006/0199930, incorporated herein by reference to the extent describing such olefin block copolymers and the test methods for measuring those properties listed below for such polymers, may be used as the thermoplastic material. Such olefin block copolymer may be an ethylene/α-olefin interpolymer:

(a) having a M_w/M_n from about 1.7 to about 3.5, at least one melting point, T_m, in degrees Celsius, and a density, d, in grams/cubic centimeter, wherein the numerical values of T_m and d corresponding to the relationship:

$T_m > -2002.9 + 4538.5(d) - 2422.2(d)^2$; or

(b) having a M_w/M_n from about 1.7 to about 3.5, and being characterized by a heat of fusion, ΔH in J/g, and a delta quantity, ΔT, in degrees Celsius defined as the temperature difference between the tallest DSC peak and the tallest CRYSTAF peak, wherein the numerical values of ΔT and ΔH having the following relationships:

$\Delta T > -0.1299(\Delta H) + 62.81$ for ΔH greater than zero and up to 130 J/g,

$\Delta T \geq 48$°C for ΔH greater than 130 J/g,

wherein the CRYSTAF peak being determined using at least 5 percent of the cumulative polymer, and if less than 5 percent of the polymer having an identifiable CRYSTAF peak, then the CRYSTAF temperature being 30 °C; or

(c) being characterized by an elastic recovery, Re, in percent at 300 percent strain and 1 cycle measured with a compression-molded film of the ethylene/α-olefin interpolymer, and having a density, d, in grams/cubic centimeter, wherein the numerical values of Re and d satisfying the following relationship when ethylene/α-olefin interpolymer being substantially free of a cross-linked phase:

$Re > 1481 - 1629(d)$; or

(d) having a molecular fraction which elutes between 40 °C and 130 °C when fractionated using TREF, characterized in that the fraction having a molar comonomer content of at least 5 percent higher than that of a comparable random ethylene interpolymer fraction eluting between the same temperatures, wherein said comparable random ethylene interpolymer having the same

comonomer(s) and having a melt index, density, and molar comonomer content (based on the whole polymer) within 10 percent of that of the ethylene/α-olefin interpolymer; or

(e) having a storage modulus at 25 °C, G´ (25 °C), and a storage modulus at 100 °C, G´ (100 °C), wherein the ratio of G´ (25 °C) to G´ (100 °C) being in the range of about 1:1 to about 9:1.

Such olefin block copolymer, e.g. ethylene/α-olefin interpolymer may also:

(a) have a molecular fraction which elutes between 40 °C and 130 °C when fractionated using TREF, characterized in that the fraction having a block index of at least 0.5 and up to about 1 and a molecular weight distribution, M_w/M_n, greater than about 1.3; or

(b) have an average block index greater than zero and up to about 1.0 and a molecular weight distribution, M_w/M_n, greater than about 1.3.

The thermoplastic polymers (materials) can further include glass or carbon fibers and/or any other mineral fillers such talc or calcium carbonate. Exemplary fillers include, but are not limited to, natural calcium carbonates, including chalks, calcites and marbles, synthetic carbonates, salts of magnesium and calcium, dolomites, magnesium carbonate, zinc carbonate, lime, magnesia, barium sulphate, barite, calcium sulphate, silica, magnesium silicates, talc, wollastonite, clays and aluminum silicates, kaolins, mica, glass or carbon fiber or powder, wood fiber or powder or mixtures of these compounds. The thermoplastic polymers (materials) can further include one or more antistatic agents, color enhancers, dyes, lubricants, pigments, primary antioxidants, secondary antioxidants, processing aids, and combinations thereof. The thermoplastic polymer (material) may comprise from about 0 to about 10 percent by the combined weight of such additives, based on the weight of the thermoplastic material and such additives.

The composite material comprises from 0.1 to 10, for example from 0.1 to 6, percent by weight of metal oxide lamellae. The metal oxide is preferably iron oxide, for example iron (III) oxide (Fe_2O_3). Exemplary iron oxides have a purity level of 99 percent or greater. In addition, the iron oxide may have a density of approximately 4800 kg/m^3. The iron oxide may have a hardness in the range of 6 to 6.5 Mohs. The lamellae have an average diameter size (long axis) in the range of from 2 to 30 μM, and an average aspect ratio (long axis/thickness) in the range of from 2 to 30. Such metal oxide lamellae are available under the tradename MIOX from karntner Montanindustrie.

The composite material of the present invention is preferably formed into an article via extrusion process. Products that can be manufactured using extrusion process include cast and blown film, multilayer structure, pipes, extrusion coated multilayer structures, extrusion laminated

multilayer structures, fibers, hollow and filled profiles. It can also be used in injection molding fixtures, such as spouts, handles or similar fixtures that need to be sealed into thermoplastic structures.

Examples

The following examples illustrate the present invention but are not intended to limit the scope of the invention.

Inventive Compositions and Films 1-4

Inventive composition 1 comprises 5 percent by weight of MIOX and 95 percent of ELITE™ 5800G, an ethylene/octene copolymer having a density of approximately 0.911 g/cm^3 and melt index (I_2) of 12 g/10 minutes, which is available for The Dow Chemical Company. Inventive composition 1 was formed into a 350 μm film (Inventive Film 1) via cast film extrusion process, using a Haake Polylab 400 coupled to a Rheomex 2552 ¾" PE single screw extrusion setup, with a 10cm wide flat die operated at 1mm die gap. A water-cooled three-roll calendering system was used without chiller. Take-off speed was adjusted to obtain the thickness above. Mechanical properties of Inventive Film 1 were measured and the results are reported in table 1.

Inventive composition 2 comprises 10 percent by weight of MIOX and 90 percent of ELITE™ 5800G, an ethylene/octene copolymer having a density of approximately 0.911 g/cm^3 and melt index (I_2) of 12 g/10 minutes, which is available for The Dow Chemical Company. Inventive composition 2 was formed into a 350 μm film (Inventive Film 2) via cast film extrusion process with conditions as described for Inventive composition 1. Mechanical properties of Inventive Film 2 were measured and the results are reported in table 1.

Inventive composition 3 comprises 5 percent by weight of MIOX and 95 percent of ELITE™ 5800G, an ethylene/octene copolymer having a density of approximately 0.911 g/cm^3 and melt index (I_2) of 12 g/10 minutes, which is available for The Dow Chemical Company. Inventive composition 3 was formed into a 90 μm film (Inventive Film 3) via cast film extrusion process with conditions as described for Inventive composition 1. Mechanical properties of Inventive Film 3 were measured and the results are reported in table 1.

Inventive composition 4 comprises 10 percent by weight of MIOX and 90 percent of ELITE™ 5800G, an ethylene/octene copolymer having a density of approximately 0.911 g/cm^3 and melt index (I_2) of 12 g/10 minutes, which is available for The Dow Chemical Company. Inventive composition 4 was formed into a 90 μm film (Inventive Film 4) via cast film extrusion process with

conditions as described for Inventive composition 1. Mechanical properties of Inventive Film 4 were measured and the results are reported in table 1.

Comparative Compositions and Films 1-4

Comparative composition 1 comprises 100 percent of ELITE™ 5800G, an ethylene/octene copolymer having a density of approximately 0.911 g/cm^3 and melt index (I_2) of 12 g/10 minutes, which is available for The Dow Chemical Company. Comparative composition 1 was formed into a 350 μm film (Comparative Film 1) via cast film extrusion process with conditions as described for Inventive composition 1. Mechanical properties of Comparative Film 1 were measured and the results are reported in table 1.

Comparative composition 2 comprises 15 percent by weight of MIOX and 85 percent of ELITE™ 5800G, an ethylene/octene copolymer having a density of approximately 0.911 g/cm^3 and melt index (I_2) of 12 g/10 minutes, which is available for The Dow Chemical Company. Comparative composition 2 was formed into a 350 μm film (Comparative Film 2) via cast film extrusion process with conditions as described for Inventive composition 1. Mechanical properties of Comparative Film 2 were measured and the results are reported in table 1.

Comparative composition 3 comprises 100 percent of ELITE™ 5800G, an ethylene/octene copolymer having a density of approximately 0.911 g/cm^3 and melt index (I_2) of 12 g/10 minutes, which is available for The Dow Chemical Company. Comparative composition 3 was formed into a 110 μm film (Comparative Film 3) via cast film extrusion process with conditions as described for Inventive composition 1. Mechanical properties of Comparative Film 3 were measured and the results are reported in table 1.

Comparative composition 4 comprises 15 percent by weight of MIOX and 85 percent of ELITE™ 5800G, an ethylene/octene copolymer having a density of approximately 0.911 g/cm^3 and melt index (I_2) of 12 g/10 minutes, which is available for The Dow Chemical Company. Comparative composition 4 was formed into a 100 μm film (Comparative Film 4) via cast film extrusion process with conditions as described for Inventive composition 1. Mechanical properties of Comparative Film 4 were measured and the results are reported in table 1.

Table 1

	Base Polymer	Thickness	Filler Content	Yield Strength	Standard. Deviation	Break Strength	Standard Deviation
		[um]	[%]	[Mpa]		[Mpa]	
Comparative 1	ELITE™ 5800G	350	0	7.01	0.08	14.39	0.62
Inventive 1	ELITE™ 5800G	350	5	6.98	0.34	14.64	0.95
inventive 2	ELITE™ 5800G	350	10	7.09	0.07	14.9	0.64
Comparative 2	ELITE™ 5800G	350	15	6.82	0.2	12.07	0.68
Comparative 3	ELITE™ 5800G	110	0	6.88	0.07	15.69	0.74
Inventive 3	ELITE™ 5800G	90	5	6.31	0.16	14.21	0.91
Inventive 4	ELITE™ 5800G	90	10	6.01	0.27	11.18	1.06
Comparative 4	ELITE™ 5800G	100	15	5.76	0.36	10.77	0.75

Test Methods

Test methods include the following:

Melt index, or I_2, is measured in accordance with ASTM D 1238, Condition 190°C/2.16 kg.

Samples for density measurement are prepared according to ASTM D 1928. Measurements are made within one hour of sample pressing using ASTM D792, Method B.

Yield Strength was measured via ISO 527-1.

Break Strength was measured via ISO 527-1.

The present invention may be embodied in other forms without departing from the spirit and the essential attributes thereof, and, accordingly, reference should be made to the appended claims, rather than to the foregoing specification, as indicating the scope of the invention.

We Claim:

1. A composite material comprising:

at least 90 percent by weight of a thermoplastic polymer; and

from 1 to 10 percent by weight of metal oxide lamellae.

2. The composite material according to Claim 1, wherein said metal oxide is iron oxide.

3. The composite material according to Claim 1, wherein the platelets of a metal oxide have a purity level of greater than 99 percent.

4. The composite material according to Claim 1, wherein platelets of a metal oxide have an average size diameter (long axis) in the range of from 2 to 30 μM.

5. The composite material according to Claim 1, wherein platelets of a metal oxide have an average aspect ratio (long axis/thickness) in the range of from 2 to 30.

6. The composite material of Claim 1, wherein said thermoplastic polymer is an ethylene based polymer or a propylene based polymer.

7. A process for forming a seal comprising the steps of:

selecting a composite material comprising:

at least 90 percent by weight of a thermoplastic polymer; and

from 1 to 10 percent by weight of metal oxide lamellae;

forming a seal by subjecting the composite material to induction heating or microwave heating.

8. A seal comprising the composite material of Claim 1.

9. A multilayer structure comprising at least one layer comprising the composite material of Claim 1.

10. A weld comprising the composite material of Claim 1.

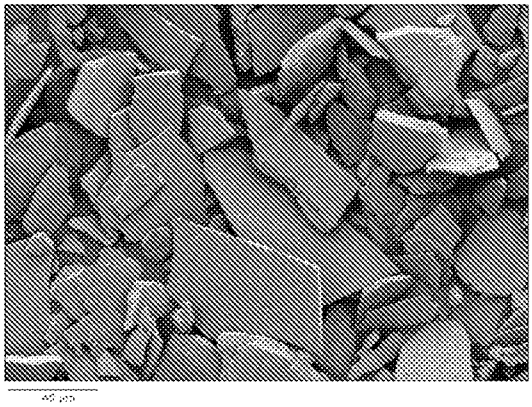

Figure 1

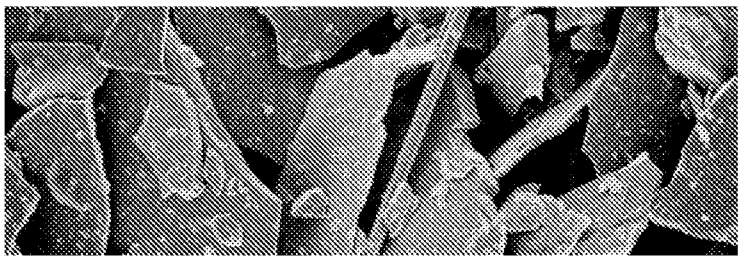

Figure 2

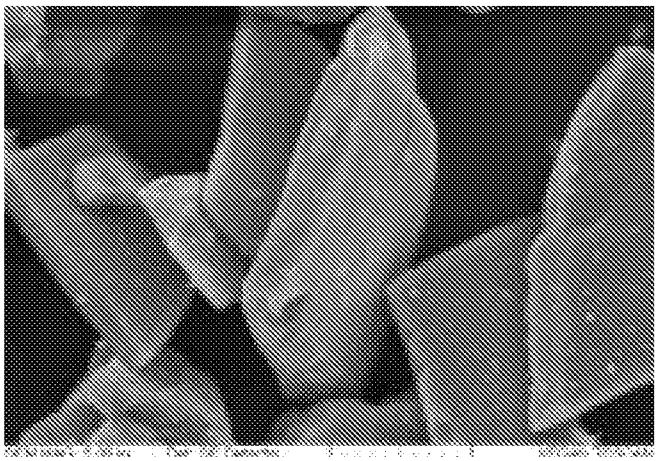

Figure 3

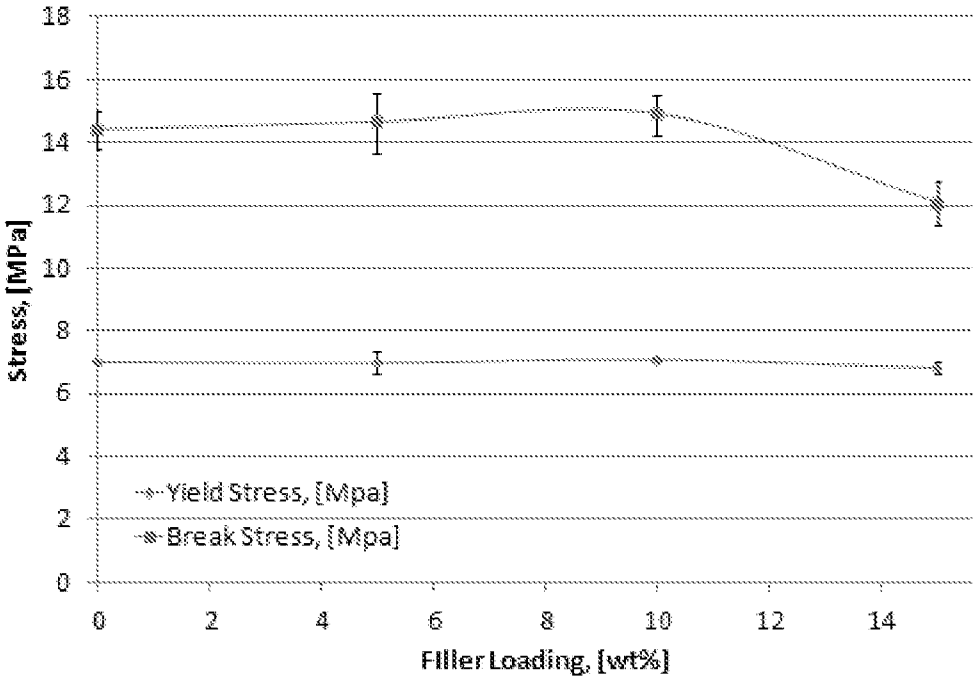

Figure 4

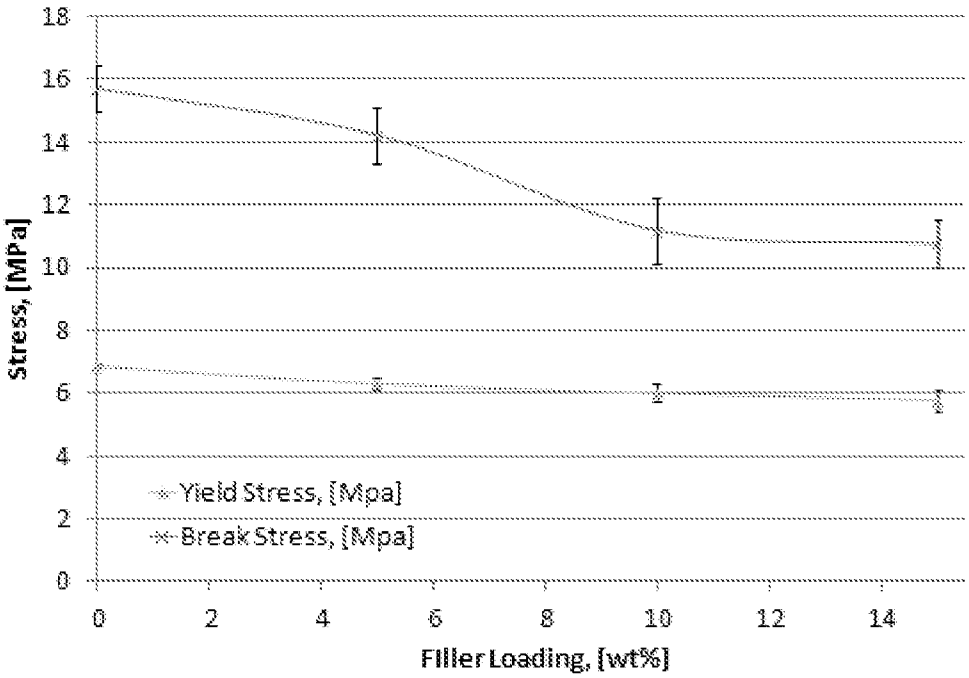

Figure 5

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2014/050010

A. CLASSIFICATION OF SUBJECT MATTER
INV. B32B27/18 C08K3/22 C08K7/00
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)
B32B 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 2013/096696 A1 (DOW GLOBAL TECHNOLOGIES LLC [US]) 27 June 2013 (2013-06-27) page 8, last paragraph - page 9, line 4 page 9, lines 8-9 example 3 example comp. 2 claims	1-6,9
X	US 3 709 775 A (JAMES A) 9 January 1973 (1973-01-09) column 1, line 56 - line 64 column 3, line 48 - line 72 column 6, line 29 - line 32 examples	1-10

-/--

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

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

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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

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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
27 October 2014	03/11/2014

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Behm, Sonja

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2014/050010

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 01/46752 A1 (PPG IND OHIO INC [US]) 28 June 2001 (2001-06-28) abstract page 5, line 2 examples -----	1-10

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2014/050010

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		WO 0146752 A1	28-06-2001