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(54) Title: COMPOSITION COMPRISING AN IONOMER AND POTASSIUM IONS

(57) Abstract: A composition and an article comprising or produced from the composition are disclosed. The composition comprises an ionomer and a reducing static charge-buildup amount of potassium ion wherein the ionomer is neutralized with sodium, zinc, or magnesium ions. The article can be a film including a multilayer film.

COMPOSITION COMPRISING AN IONOMER AND POTASSIUM IONS

The invention relates to a composition comprising an ionomer and potassium ions, a process therefor, and a product or process therewith.

Background of the Invention

An ionomer such as Surlyn® which is readily available commercially from E. I. du Pont de Nemours and Company, Wilmington, Delaware, USA (DuPont), has been used in packaging applications for many years for its heat seal properties and toughness in flexible packaging. It is used in cosmetics packaging for aesthetics such as perfume caps, bottles, or cases. An ionomer is also used to replace PVC in flooring. Ionomers are generally produced by neutralization of ethylene acid copolymers with zinc or sodium metal ions. Such ionomers may have a tendency to pick-up a static charge, more so than alternative materials such as polyethylene. The static charge attracts dust, negatively affecting the appearance of cosmetics packaging and causing contamination of the seal area in flexible packaging thereby affecting the use of such ionomers in the packaging of powdered foods (such as cake mixes, powdered drinks, and shredded cheese) due to the static nature of Surlyn®. Dust accumulation can detract from the appearance of the packages. By reducing the tendency of an ionomer to attract dust, one can grow the use of ionomer in packaging market.

Surface resistivities (for electric current flowing across a surface as the ratio of the DC voltage drop per unit length to the surface current per unit length) covering the range from highly conductive materials to insulators include highly conductive: 10^{-6} to 10 Ohms/square; conductive: 10^{2} to 10^{4} Ohms/sq; dissipative: 10^{4} to 10^{11} Ohms/sq; and insulating: 10^{11} to 10^{16} Ohms/sq.

Ionomers made with potassium ions exhibit antistatic properties for they reduce the surface resistivity and static decay times of the polymer so that they may be suited for demanding applications such as the packaging of electronic components.

Antistatic resins, such as a highly neutralized potassium ionomers MK400, available from DuPont-Mitsui (MDP), Tokyo, Japan, have surface resistivities of about 10^8 to 10^{11} Ohms/sq. Antistatic resins may have poor mechanical properties, poor thermal instabilities, etc. For example, highly neutralized potassium ionomers may be susceptible to moisture pick-up, which affects its physical properties. In potassium neutralized ionomers, very high levels of potassium ions (as high as 70% neutralized) are needed to achieve such properties.

It is therefore desirable to develop a new ionomer composition that does not require such high potassium neutralization but capable of reducing the ionomer's tendency to build up charges.

Summary of the Invention

A composition comprises an ionomer and a static charge-buildup reduction amount of potassium ion wherein the ionomer has the carboxylic acid or a portion thereof in corresponding acid copolymer neutralized with sodium ions, zinc ions, magnesium ions, or combinations of two of more thereof.

A process for producing comprises contacting a static charge-buildup reduction amount of potassium ion with an ionomer wherein the ionomer can be the same as that disclosed above.

An article comprises or produced from a composition which can be the same as the composition disclosed above and the article can be a film including a multilayer film, which can be converted to a shaped article.

Detailed Description of the Invention

An ionomer can be produced by any means known to one skilled in the art by neutralization of an ethylene acid copolymer with one or more metal ions. An ethylene acid copolymer is a polymer that can comprise repeat units derived from ethylene and about 1 to about 50%, or about 5 to about 40%, or 10 to 25%, by weight of a comonomer such as acrylic acid, methacrylic acid, ethacrylic acid, or combinations of two or more thereof, based on the total weight of the ethylene copolymer. Ionomer is well known to one skilled in the art (see e.g., US 3,264,272) and the description of which is omitted for the interest of brevity.

An ethylene acid copolymer may comprise up to 35 wt % of an optional comonomer such as carbon monoxide, sulfur dioxide, acrylonitrile, maleic anhydride, maleic acid diesters, maleic acid, maleic acid monoesters, itaconic acid, fumaric acid, fumaric acid monoester, a salt of these acids, glycidyl acrylate, glycidyl methacrylate, and glycidyl vinyl ether, methyl acrylate, ethyl acrylate, isopropyl acrylate, butyl acrylate, pentyl acrylate, methyl methacrylate, ethyl methacrylate, propyl methacrylate and butyl methacrylate, pentyl methacrylate, or combinations of two or more thereof where the alky group can be linear or branched.

The neutralization, for example, can range from about 0.1 to about 100, or about 10 to about 90, or about 20 to about 80, or about 20 to about 40 percent, based on the total carboxylic acid content, with a metallic ion. The metallic ions can be monovalent, divalent, trivalent, multivalent, or combinations of two or more thereof. Examples include Li, Na, Ag, Hg, Cu, Be, Mg, Ca, Sr, Ba, Cd, Sn, Pb, Fe, Co, Zn, Ni, Al, Sc, Hf, Ti, Zr, Ce, and combinations of two or more thereof. If the metallic ion is multivalent, a complexing agent, such as stearate, oleate, salicylate, and phenolate radicals can be included, as disclosed in US 3,404,134. Frequently used ions include Na, Zn, or combinations thereof. Of interest here is an ionomer that is neutralized with sodium or zinc ions such as NaOH, $NaHCO_3$, Na_2CO_3, $NaHSO_4$, NaH_2PO_4, Na_2HPO_3, sodium stearate, sodium oleate, sodium salicylate, sodium phenolate, $Zn(OH)_2$, $ZnCO_3$, $ZnCO_3$, $ZnSO_4$, $ZnHPO_4$, $ZnHPO_3$, zinc oxide, zinc stearate, zinc oleate, zinc salicylate, zinc phenolate, $Mg(OH)_2$, $MgCO_3$, $MgCO_3$, $MgSO_4$, $MgHPO_4$, $MgHPO_3$, magnesium stearate, magnesium oleate, magnesium salicylate, magnesium phenolate, or combinations of two or more thereof.

The ionomer can be a blend of an ionomer having a greater than 20% neutralization and, for example, a second ethylene acid copolymer to achieve the desired degree of neutralization. For example, the ionomer can comprise about 1 to about 50, about 5 to about 40, or about 10 to about 25 weight % of an acid copolymer disclosed above.

The ionomer can also be a blend of an ionomer and about 1 to about 50 weight% of an ethylene alkyl (meth)acrylate copolymer.

Examples of such alkyl (meth)acrylate include methyl acrylate, ethyl acrylate, methyl methacrylate, ethyl methacrylate, propyl acrylate, propyl methacrylate, butyl acrylate, butyl methacrylate, 2-ethylhexyl acrylate, 2-ethylhexyl methacrylate, lauryl acrylate, lauryl methacrylate, 2-hydroxyethyl acrylate, 2-hydroxyethyl methacrylate, glycidyl acrylate, glycidyl methacrylate, as well as one or more of those alkylacrylates disclosed above, or combinations of two or more thereof.

For example, an ethylene alkyl acrylate copolymer can comprise from 1 to 30 weight % of at least one E/X/Y copolymer wherein E comprises ethylene; X is a monomer selected from the group consisting of vinyl acetate and alkyl (meth)acrylic esters; and Y is one or more optional comonomers disclosed above; X is from 0 to 50 weight % of the E/X/Y copolymer, Y is from 0 to 35 weight % of the E/X/Y copolymer, wherein the weight % of X and Y cannot both be 0, and E being the remainder.

The ionomer can also be a blend of the ionomer and a copolymer comprising repeat units derived from ethylene, about 4 to about 30 weight % of a vinyl alkanoate or an ester including alkyl (meth) acrylate, and about 0.5 to about 20 weight % of an unsaturated monocarboxylic acid including (meth)acrylic acid. Such copolymers include ethylene acrylate copolymer comprising copolymer having repeat units derived from ethylene, vinyl acetate, and methacrylic acid or from ethylene, alkyl acrylate, and acrylic acid. See, e.g., US 4,346,196 and US 4,469,754 (entire disclosures are incorporated herein by reference).

Examples of commercially available ethylene acid copolymer includes Nucrel®; ionomer includes Surlyn® disclosed above; ethylene copolymer includes Appeel® and Elvaloy®, all from DuPont.

The processes for producing an ethylene acid copolymer and ethylene alkylacrylate copolymer are well known to one skilled in the art and the description of which is omitted herein for the interest of brevity.

A sodium-, magnesium-, or zinc-neutralized ionomer can have about 5 to about 90, or about 10 to about 70, or about 15 to about 60, % of the carboxylic acid in the ionomer's corresponding acid copolymer neutralized. A commercially available sodium-neutralized ionomer is

Surlyn®1601 from DuPont which can be used in conventional blown and cast film extrusion and coextrusion equipment designed to process polyethylene resins.

Any potassium ions can be used. Frequently used potassium ions include KOH, $KHCO_3$, K_2CO_3, $KHSO_4$, KH_2PO_4, K_2HPO_3, potassium stearate, potassium oleate, potassium salicylate, potassium phenolate, or combinations of two or more thereof.

The potassium ions can be present in the composition in an amount that is capable of reducing the tendency to build up static charge of an article such as a film comprising or produced from the ionomer. For example, the amount can be about 0.01 to about 5, 0.1 to about 5, or about 0.5 to about 4, or about 1 to about 3, % of the weight of the ionomer. The tendency to build up static charge by the composition may be substantially reduced to a level that, as measured by static decay times and the ash test without being in the regime of dissipative or antistat polymers, and still maintain the physical properties of the ionomer. For example, the tendency to build up static charge of the invention composition can be substantially the same as a polyethylene, which has surface conductivities of about 10^{12} Ohms/square or higher.

The composition can further comprise one or more monobasic, dibasic, or polybasic carboxylic acids having fewer than 36 carbon atoms, or salts thereof. The acids can be present in the composition from about 1 to about 50 weight %. Examples of such organic acids include caproic acid, caprylic acid, capric acid, lauric acid, stearic acid, isostearic acid, behenic acid, erucic acid, oleic acid, and linoleic acid. Naturally derived organic fatty acids such as palmitic, stearic, oleic, erucic, behenic acids, or combinations of two or more thereof. Saturated organic acids, such as stearic acid and behenic acid, may reduce organoleptic properties of the composition.

Acids substituted with substituents including C_1-C_8 alkyl, OH, and OR^1 in which each R^1 is independently C_1-C_8 alkyl, C_1-C_6 alkoxyalkyl or COR^2; and each R^2 is independently H or C_1-C_8 alkyl with at least one C_{1-8}

alkyl group are branched acids. Saturated, linear organic acids include behenic acid.

If the composition comprises one or more organic acids disclosed above, greater than 70%, 80% or 90% (or even 100%) of acidic groups in the ionomer and organic acids can be neutralized with metal ions and the metal ions present in the mixture can comprise at least 50 mole % Na or K ions and the preponderance of the other metal ions are alkali metal ions.

Alternatively, a composition having the property of reducing static charges can be made by directly neutralizing an acid copolymer with both Na ions (or Zn ions or Mg ions or combinations of two or more thereof) and K ions; blending Na- ionomer with K-ionomer; or contacting K-ions to a Na-ionomer or contacting Na ions to a K-ionomer. The Na-ionomer can also be Zn-ionomer or Mg-ionomer (or combinations of two or more of the three) wherein the final concentration of the potassium ions can be the same as disclosed above.

The amount of K ions is also the amount that does not decrease or substantially decrease the ionomer's properties of heat seal, hot tack, tensile, impact toughness, or other properties for packaging applications. Such amount can also reduce the cake mix collected on a film comprising or produced from a sodium- or zinc-neutralized ionomer.

The composition can be produced by any means known to one skilled in the art such as, for example, mixing the K ions that can be in a liquid or an aqueous solution with a sodium- or zinc-neutralized ionomer; or mixing a potassium ionomer with a sodium, zinc or magnesium ionomer. Mixing can be carried out by means known in the art. One method is to mix the components in a compounding extruder. Another is to mix ionomers in an extruder with an appropriate mixing screw in-line while making film, sheet or other articles.

A process for reducing the tendency of an ionomer to buildup static charge comprises contacting an ionomer disclosed above with potassium ions, which can be in a liquid or an aqueous solution and the quantity of the potassium ions can be the same as that disclosed above.

Alternatively, the process for reducing the tendency of an ionomer to buildup static charge can comprise neutralizing an acid copolymer with both Na ions (or Zn ions or Mg ions or combinations of two or more thereof) and K ions; contacting Na- ionomer with K-ionomer; or contacting K-ions to a Na- ionomer. The Na-ionomer can also be Zn-ionomer or Mg-ionomer (or combinations of two or more of the three) wherein the final concentration of the potassium ions can be the same as disclosed above.

An article such as a film (including multilayer film or sheet) having reduced or substantially reduced static charge buildup can be produced from the composition. The article can be used for packaging as disclosed below.

A multilayer structure may comprise at least one layer comprising the composition disclosed herein and at least one layer comprising or produced from any other polymer such as the well known polyolefin, polyamide, polyester, ethylene alkyl (meth)acrylate copolymer, ethylene acid copolymer, vinyl acetate copolymer, polyvinyl alcohol, polyvinylidene chloride, or combinations of two or more thereof. A multilayer film can include up to 10 or more layers.

Appropriate amounts of various additives can be present in the composition and/or the film. Additives can include plasticizers, stabilizers such as hydrolytic stabilizers, radiation stabilizers, thermal stabilizers, ultraviolet light stabilizers, antioxidants, ultraviolet ray absorbers, colorants, dyes or pigments, delustrants such as TiO_2, fillers, fire-retardants, lubricants, reinforcing agents such as glass fiber and flakes, processing aids such as antiblock agents, release agents, anti-slip agents, slip agents such as talc, anti-block agents, other processing aids, elastomers, or mixtures thereof.

A film (including multilayer film) can be made from the composition by melt-processing using known processes such as co-extrusion, sheet extrusion, extrusion casting, extrusion coating, thermal lamination, blown film methods, powder coating and sintering, or like processes. The film can be further processed into articles disclosed below with uniaxial or biaxial stretching, axial heat sealing, thermoforming, vacuum forming,

sheet folding, heat sealing, compression molding, or combinations of two or more thereof.

A film including multilayer film can also be sealed to itself to form a container or package, optionally including a sealant such as ethylene polymer including low density polyethylene, linear low density polyethylene, and metallocene polyethylene; ethylene vinyl acetate copolymer, ethylene alkyl (meth)acrylate copolymer; ethylene acid copolymer or an ionomer therefrom, polyester, polyamide, or combinations of two or more thereof

A film or multilayer film or sheet comprises or derived from the composition can be formed into a shaped article such as a tray, cup, bottle, cap, lid, blister pack, any container, flooring materials, or combinations of two or more thereof that can be ideal packaging for cosmetics, powder food medicine, beverage, juice, milk, meats, cheese, fish, poultry, nuts, coffee, sauce, stews, dried fruit, food paste, soups or soup concentrate spice, condiment, personal care product (toothpaste, shaving foam, soap, shampoo, lotion), fragrances, electronic component, chemical (fragrant laundry detergent, fragrant fabric softener), or combinations of two or more thereof.

Because the processes for making films and the shaped articles are well known to one skilled in the art, the description of which is omitted herein for the interest of brevity.

Shaped articles such as tray, cup, bottle, cap, lid, blister pack, container, cosmetics case, housing or other parts of household appliances (e.g., handle for electric iron and housing for hair dryer, vacuum cleaner, kitchen appliance, and telephone), or combinations of two or more thereof can be produced from a composition disclosed above by virtually any method of extrusion processing or thermoforming known to those skilled in this art. A melt extrusion process such as injection molding, compression molding, blow molding and profile extrusion can be used. As such, the articles can be injection molded, compression molded, blow molded, or profile extruded. The shaped articles may comprise layers of polymers other than the composition disclosed herein. A film or sheet (or even a

blow molded article such as bottle), the layers can be made by coextrusion or lamination). In an injection molded part, there can be co-injection molding, which is similar to coextrusion, or overmolding. The film or sheet or blow molded article can comprises a layer comprising the composition as a distinct layer and other optional layer(s) comprising other polymers.

EXAMPLES

The examples are provided to illustrate, but is not to be construed to unduly limit the scope of, the invention.

2-mil films of an ethylene acid copolymer (Nucrel®0903 (9 wt% methacrylic acid or MAA) from DuPont), and two ionomers (a Surlyn®-Na ionomer (a sodium ionomer with about 10% acid and 55% neutralized with sodium salts) and a Surlyn® zinc ionomer) were made on a laboratory blown film line equipped with a ¾-inch (1.905 cm) diameter extruder and 1-inch (2.54 cm) diameter die (see description below).

Surface resistivity of the films made from the acid copolymer, and two ionomers were measured by following ASTM D257. All films had about the same resistivity of about 2.5×10^{16} Ohms/sq. The films were then loaded with a charge and static decay time was measured. The films did not decay in a time frame that could be measured. Static decay times were then measured with films made from blends of K-ionomer and Na-ionomer. Further testing consisted of rubbing films and conducting an ash test, where the charged films are held close to a pile of cake mix and the amount of powder collected onto the film was measured.

In Table 1, films were made from compositions comprising (1) 100% MK400 potassium ionomer (available as Entira™ AS MK400 from DuPont), (2) blend 1 included 40% MK400 and 60% Surlyn®-Na ionomer, and (3) blend 2 included 60% MK400 potassium ionomer and 40% Surlyn®-Na ionomer. The blends were made in-line while making the films (pellet blended, fed to the extruder and relying on the mixing screw to complete the blending process.)

2-mil (0.05 mm) blown film samples were made on a Brabender 0.75 inch (1.905 cm) extruder with 1 inch (2.54 cm) die and a single stage mixing screw to test static decay properties. The films were 3.25 inch x 5

inch (8.26 cm x 12.7 cm). An Elecro-Tech Systems model 406C was used for measuring the time for a charged voltage of 5 DC Kilovolts (5kV) to decay, following Federal Test Method 101, Method 4046.

For the first set of measurements the films were equilibrated at each test environment for approximately 30 minutes. The static decay times of the films are shown below. A-10% decay is the time for the charge to reach 10% of its original value, not the time to decay by 10%.

Table 1

	Static Decay Time			
	21°C and 50% relative humidity		21°C and 15% relative humidity	
Film Specimen	50% decay (sec)	10% decay (sec)	50% decay (sec)	10% decay (sec)
MK400	0.01 or less	0.01 or less	0.01 or less	0.01 or less
Blend 1	1.4	135	6s to reach 2 kv*	
Blend 2	0.01 or less	0.01 or less	0.08	12.6

* The charge on this sample decayed to 2kv and then held constant.

The films were then measured at 15% relative humidity after equilibrating for 24 hours. The two blends didn't take a charge of 5 kv and the MK400 took on average 50 seconds to reach 5 kv charge and an average of 10.8 seconds to reach 50% decay.

A second set of tests was carried out where the films were equilibrated at the given relative humidity for 24 hours before measuring, as shown in Table 2 below.

Table 2. Static Decay Time (seconds)[A]

Film	23°C 30.5% RH		23°C, 48.8% RH		23°C, 70.2% RH	
Decay	50%	10%	50%	10%	50%	10%
Blend 3	1.75kv max.	1.75 kv max.	1.5kv max.	1.5kv max.	0.11	1.54
Blend 4	1.75kv max.	1.75 kv max.	0.23	7.47	0.01	0.01
Blend 5	10.6*	139*	0.01	0.02	0.01	0.01
Sample 6	0.00	0.01	0.01	0.01	0.01	0.01

[A] Blend 3, 20% MK400 and 80% Surlyn® sodium ionomer; Blend 4, 40% MK400 and 60% Surlyn® sodium ionomer; Blend 5, 60% MK400 and 40% Surlyn® sodium ionomer; and Sample 6, 100% MK400.

* Required 1.5 minutes to reach +5 DC kv

For those values listed as 1.5 or 1.75kv max, the films did not hold a charge of 5kv (as specified by the measurement protocol) and we did not measure the decay.

The following films, all prepared on a Brabender blown film extruder as disclosed above with the exception of the DuPont DPE 1645 PE (polyethylene) film which was cast on a 28mm twin screw extruder with a 10 inch (25.4 cm) coat hanger die were measured for static buildup. The films were 3.25 inch x 5 inch (8.26 cm x 12.7 cm) and approximately 2 mils (0.05 mm) in thickness. The test involved inducing a static charge on the film by rubbing a cotton cloth against the film with ten forward and backward strokes and then placing it in direct contact with Betty Crocker Super Moist vanilla cake mix purchased in a local grocery store. They were then weighed to determine the amount of cake mix build-up on the film.

The testing conditions were at 69.4°F (20.8°C) and 31.7% relative humidity. Results shown in Table 3 were the average of three specimens per sample.

Table 3*

Specimen Tested	Average gain (g)	Standard Dev.
100% DuPont DPE 1645	0.15	0.03
Sample 7	0.21	0.02
Blend 8	0	0
Blend 9	0.14	0.008
Blend 10	0.05	0.01
Blend 11	0.0008	0.0001

* DuPont DPE 1645 is LDPE (low density polyethylene); Sample 7, 100% Surlyn® sodium ionomer; Sample 8, 100% MK400; Blend 9, 20% MK400 and 80% Surlyn®-Na ionomer; Blend 10, 40% MK400 and 60% Surlyn®-Na ionomer; and Blend 11, 60% MK400 and 40% Surlyn®-Na ionomer.

Samples shown in Table 4 were films produced on a Brabender blown film extruder as discussed above and tested using the cake mix test described for Table 3. The testing conditions were 72.8°F and 57.5% relative humidity.

Table 4*

Example	Specimen Tested	Avg gain (g)	Std. Dev.
LDPE control	100% DPE 1645 PE	0.09	0.02
Sample 12	100% MK400 K-ionomer	0	0
Sample 13	100% Surlyn®-Na 1	0.08	0.02
Blend 14	20% MK400 / 80% Surlyn®-Na 1	0.06	0.001
Blend 15	40% MK400 / 60% Surlyn®-Na 1	0.006	0.003
Blend 16	60% MK400 / 40% Surlyn®-Na 1	0	0
Sample 17	100% Surlyn®-Na 2	0.06	0.004
Blend 18	20% MK400 / 80% Surlyn®-Na 2	0.07	0.002
Blend 19	40% MK400 / 60% Surlyn®-Na 2	0.05	0.01
Blend 20	60% MK400 / 40% Surlyn®-Na 2	0.03	0.01
Sample 21	100% Surlyn® Zn 1	0.19	0.03
Blend 22	20% MK400 / 80% Surlyn®-Zn 1	0.14	0.02
Blend 23	40% MK400 /60% Surlyn®-Zn 1	0.11	0.02
Blend 24	60% MK400 / 40% Surlyn®-Zn 1	0.09	0.006
Sample 25	100% Surlyn®-Zn 2	0.1	0.006
Blend 26	20% MK400 / 80% Surlyn®-Zn 2	0.07	0.009
Blend 27	40% MK400 / 60% Surlyn®-Zn 2	0.06	0.009
Blend 28	60% MK400 / 40% Surlyn®-Zn 2	0.05	0.002

* Surlyn®-Na 1 is a sodium ionomer with about 10% acid and 55% neutralized with sodium salts, Surlyn®-Na 2 is a sodium ionomer with about 15% acid and 50% neutralized with sodium salts, Surlyn®-Zn 1 is zinc ionomer with about 9% acid and 20% neutralized with zinc salts, and Surlyn®-Zn 2 is a zinc ionomer with about 15% acid and 50% neutralized with zinc salts.

Table 5 shows three ionomers prepared by neutralizing 80% of the acid groups of a nominal 15% acid copolymer by adding NaOH and K_2CO_3 in an extruder with sufficient mixing, residence time and temperature to complete the neutralization reaction. Films were produced from these ionomers on a Brabender blown film extruder as discussed above and tested using the cake mix test described for Table 3. The testing conditions were 73°F and 26% relative humidity.

Table 5

Example	Specimen Tested	Avg gain (g)	Std. Dev.
LDPE control	DuPont DPE 1640	0.09	0.03
Sample 29	E/15%MAA - 80% Neutralized; 75:25 K to Na	0	0
Sample 30	E/15%MAA - 80% Neutralized; 50:50 K to Na	0.0014	0.0005
Sample 31	E/15%MAA - 80% Neutralized; 25:75 K to Na	0.0016	0.0002
Blend 32	20% MK400 / 80% Surlyn®-Na 1	0.21	0.001
Blend 33	40% MK400 / 60% Surlyn®-Na 1	0.16	0.02

The static charge during film fabrication was measured using a Pro Stat Electrostatic Fieldmeter Model PFM 711A. The meter was mounted 2-inches from the film surface (unless otherwise noted) about 5-inches ahead of the film wind-up on the Brabender blown film line described

earlier. Processing conditions and the measured static charge are given in Table 6 below in which "Neu" denotes neutralization or neutralized.

Table 6

Example	Sample 34	Sample 35	Sample 36	Blend 37	Blend 38	Control
Sample ID	E/15%MAA, 80% Neut, 75:25 K:Na	E/15%MAA, 80% Neu, 50:50 K:Na	E/15%MAA, 80% Neu, 25:75 K:Na	40% MK 400/60% Surlyn® Na 1	20% MK 400/80% Surlyn® Na 1	DPE 1640 LDPE
Heat Zone (°C)						
1	179	180	180	180	180	180
2	205	205	205	205	205	205
3	210	210	210	210	210	210
4	210	210	210	210	210	210
Melt Temp (°C)	218	218	219	219	221	219
Extruder Volts	55	60	60	60	60	57
Extruder Amps	3	3.2	3.4	2.9	2.9	1.8
Extruder screw speed, rpm	32	34	34	34	34	34
Extruder exit pressure, psi	510	600	680	640	620	310
Air Ring Air Speed	maximum	maximum	maximum	maximum	maximum	8
Takeoff Speed, rpm	100	100	100	100	100	102
Takeoff Speed, ft/min	6.5	6.5	6.5	6.5	6.5	6.5
Static Charge kv/in.	-2.2 to -3.0	-14 to -18	-16 to -30	-26 to -38	-30 to -48*	-6.0 to -7.0

*Measured at 3-inches from film surface instead of 2-inches.

Four ionomers shown in Table 7 were prepared by neutralizing 55% of the acid groups of a nominal 10% acid copolymer by adding NaOH, K_2CO_3 or both in an extruder with sufficient mixing, residence time and temperature to complete the neutralization reaction. These have similar acid level and % neutralization as the Surlyn® Na 1 ionomer. The physical properties are compared in Table 7 below in which the melt index (MI) was measured according to ASTM D1238, 190°C /2.16 Kg; Vicat was measured according to ASTM D1525; freezing and melting points were measured according to ASTM D3418 (DSC); the Instron was used to measure tensile properties according to ASTM D638 (elongation at break, yield strength and tensile strength) and D790 (flex modulus); and Tabor was a well known abrasion test.

Table 7

Composition	Method	Sample 39 E/10%MAA, 55% Neu	Sample 40 E/10%MAA, 55% Neu	Sample 41 E/10%MAA, 55% Neu	Sample 42 E/10%MAA, 55% Neu
Ratio of K:Na ions	Mass balance	0:100	25:75	50:50	75:25
MI (g/10min)		0.98	1.36	0.87	1.06
Freezing Point (C)	DSC	58.94	59.30	57.48	58.92
Melting Point (C)	DSC	96.62	95.53	96.10	95.52
Flex Modulus (PSI)	Instron	28790 +/- 433	27232 +/- 448	26198 +/- 772	30323 +/- 3648
Yield Strength (PSI)	Instron	1814 +/- 40	1813 +/- 18	1855 +/- 26	1796 +/- 42
Break Elongation (%)	Instron	406 +/- 34	426 +/- 3	395 +/- 21	432 +/- 9
Tensile Strength (PSI)	Instron	4054 +/- 280	4224 +/- 44	3967 +/- 170	3987 +/- 95
Softening Point	Vicat	71.7	71.6	71.2	72.2
Abrasion	Tabor	0.1891	0.2074	0.1950	0.1732
Abrasion %wt. Loss		0.78	0.85	0.77	0.71

Films of 2-mils in thickness were made from the resins in shown in Table 8 on a MPM Blown Film line. Heat seal strength of the films sealed to themselves was measured on a Precision Bar heat sealer Packaging Industries at 1-s dwell and 4 lb per in^2 of seal jaw pressure. The seal jaw width was 1 inch. Both jaws were heated to the given jaw temperature. Actual temperature at the film interface was measured using a 5 mil chromel-alumel thermocouple. Results of heat seal measurements are given in the table below where "peel" refers to a clean failure between the two film surfaces and "tear" indicates that the seal strength was sufficiently strong so that the films tore while they were being pulled apart. In the former the peel strength was less than the tear strength, in the latter the peel strength exceeded the tear strength and the films tore in failure.

Table 8

Sample	Heat Seal Jaw Temp (C)	Interface (C)	Seal Strength, g/in	Comments
39	80	76.9	9	peel
39	100	94.6	1249	tear
39	120	111	1930	tear
39	140	131.5	2020	tear
39	160	152.3	2170	tear
39	180	170.9	1848	tear
39	200	187.4	2111	tear
40	80	78.7	36	peel
40	100	93.6	1371	tear
40	120	112.2	1303	tear
40	140	131.2	1589	tear
40	160	152.8	1566	tear
40	180	170.6	1975	tear
40	200	188.5	2138	tear
41	80	74	36	peel
41	100	94.7	1330	tear
41	120	11.3	1194	tear
41	140	131.7	1757	tear
41	160	151.9	1961	tear
41	180	170.5	2120	tear
41	200	187.5	1898	tear
42	80	74.2	41	peel
42	100	95.2	1357	tear
42	120	113.5	1462	tear
42	140	133.2	1389	tear
42	160	152.4	1662	tear
42	180	170.1	1807	tear
42	200	188.5	1666	tear

Three ionomers were prepared by neutralizing 80% of the acid groups of a nominal 10% acid copolymer by adding NaOH, potassium K_2CO_3 or both in an extruder with sufficient mixing, residence time and temperature to complete the neutralization reaction. The physical properties are compared in Table 9 below where the melt index, freezing point and melting point were measure as in Table 8.

Table 9

	Sample 43	Sample 44	Sample 45
Composition	E/10%MAA, 80% Neu	E/10%MAA, 80% Neu	E/10%MAA, 80% Neu
Ratio of K:Na ions	0:100	50:50	100:0
MI (g/10min)	3.30	2.18	0.67
Freezing Point (C)	55.00	53.13	52.18
Melting Point (C)	93.17	92.67	90.75
Flex Modulus (PSI)	28692 +/- 316	24479 +/- 626	17222 +/- 280
Yield Strength (PSI)	1893 +/- 34	1899 +/- 53	1631 +/- 64
Break Elongation (%)	308 +/- 18	311 +/- 7	257 +/- 25
Tensile Strength (PSI)	3349 +/- 115	3480 +/- 54	2547 +/- 154
Softening Point	66.2	64.6	60.7
Abrasion	0.3125	0.4479	0.4674
Abrasion %wt. Loss	1.27	1.73	1.83
Shore D	60	60	54
Haze	0.4	0.5	0.8
Gloss 20	89.9	109.1	80.1
Gloss 60	138.1	140.8	132.5
Tear (MD)	12.31	15.00	6.15
Tear (TD)	13.91	10.32	13.33

Films of 2-mils thickness were made from the resins in samples 43-45 in the same way as for samples 39-42. Heat seal strength of the films sealed to themselves was measured as described above as given in Table 10.

Table 10

Sample	Heat Seal Jaw Temp (°C)	Interface (°C)	Seal Strength (g/in)	Comments
43	80	78.1	5	peal
43	100	95.3	64	peal
43	120	114.4	931	tear
43	140	132.2	1044	tear
43	160	151.6	1112	tear
43	180	170	1353	tear
44	80	78	5	peal
44	100	94.7	209	peal
44	120	112.2	1003	tear
44	140	132.8	1598	tear
44	160	151.8	1557	tear
44	180	170.9	1130	tear
45	80	77.9	45	peal
45	100	96	490	peal
45	120	113.2	1235	tear
45	140	133.3	1071	tear
45	160	152.1	1444	tear
45	180	171	976	tear

CLAIMS

1. A composition comprising an ionomer and potassium ion wherein the ionomer is present in an effective amount to reduce static charge buildup of the composition; the ionomer has carboxylic acid or a portion thereof in its corresponding acid copolymer neutralized with sodium ions, zinc ions, magnesium ions, or combinations of two of more thereof; and about 1 to about 70 % of the carboxylic acid is neutralized with sodium ions, zinc ions, magnesium ions, or combinations of two or more thereof.

2. The composition of claim 1 wherein the ionomer is produced from an ethylene acid copolymer.

3. The composition of claim 1 or 2 wherein the ionomer comprises or is produced from about 1 to about 50 weight % of the acid copolymer and, optionally, about 1 to about 50 weight% of an ethylene alkyl (meth)acrylate copolymer; and the alkyl (meth)acrylate includes methyl acrylate, ethyl acrylate, methyl methacrylate, ethyl methacrylate, propyl acrylate, propyl methacrylate, butyl acrylate, butyl methacrylate, pentyl methacrylate, pentyl acrylate, 2-ethylhexyl acrylate, 2-ethylhexyl methacrylate, lauryl acrylate, lauryl methacrylate, 2-hydroxyethyl acrylate, 2-hydroxyethyl methacrylate, glycidyl acrylate, glycidyl methacrylate, glycidyl vinyl ether, or combinations of two or more thereof and the alkyl group includes linear or branched alkyl group.

4. The composition of claim 1 wherein the amount of potassium ions is in the range of about 0.01 to about 5, about 0.1 to about 5, or about 0.5 to about 4, or about 1 to about 3, % of the weight of the ionomer.

5. The composition of claim 1, 2, 3, or 4 further comprises one or more carboxylic acids having fewer than 36 carbon atoms, or salts thereof wherein the acid includes caproic acid, caprylic acid, capric acid, lauric acid, stearic acid, isostearic acid, behenic acid, erucic acid, oleic acid, linoleic acid, or combinations of two or more thereof.

6. The composition of claim 5 wherein greater than 80%, or 100%, of acid groups in the composition are neutralized with a metal ion.

7. A process comprising contacting an ionomer with potassium ions to produce an antistatic composition wherein the ionomer is as characterized in claim 1, 2, 3, 4, 5, or 6.

8. An article comprises or produced from a composition wherein the article includes film, sheet, multilayer film, multilayer sheet, or shaped article; the shaped article includes tray, cup, bottle, cap, lid, blister pack, any container, flooring materials, or combinations of two or more thereof; the composition is as characterized in claim 1, 2, 3, 4, 5, or 6.

9. The article of claim 8 wherein the article is the shaped article and comprises cosmetics, powder food medicine, beverage, juice, milk, meats, cheese, fish, poultry, nuts, coffee, sauce, stews, dried fruit, food paste, soups, soup concentrate, spice, condiment, personal care product, fragrances, electronic component, chemical, or combinations of two or more thereof.

10. The article of claim 8 wherein the article includes injection molded articles including tray, cup, bottle, cap, lid, blister pack, container, cosmetics case, housing or other parts of household appliances, or combinations of two or more thereof.

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2006/048586

A. CLASSIFICATION OF SUBJECT MATTER
INV. C08K3/00

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 practical, 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.
A	US 2004/072629 A1 (KELLER VIKTOR M [US] ET AL KELLER VIKTOR [US] ET AL) 15 April 2004 (2004-04-15) the whole document	1-10
A	US 2003/004012 A1 (KENNEDY THOMAS J [US] ET AL KENNEDY III THOMAS J [US] ET AL) 2 January 2003 (2003-01-02) the whole document	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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"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

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Date of the actual completion of the international search	Date of mailing of the international search report
4 May 2007	14/05/2007

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2006/048586

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2004072629 A1	15-04-2004	NONE	
US 2003004012 A1	02-01-2003	US 2003078115 A1	24-04-2003
		US 2004132545 A1	08-07-2004