

CORONA DISCHARGE TREATED FILMS HAVING EXCELLENT COEFFICIENTS OF FRICTION

Field of the Invention

This invention relates to films that have been subjected to corona discharge treatment, yet obtain at least a 20% difference in the coefficients of friction of the two surfaces.

Background of the Invention

Corona discharge treatment is typically used on polyethylene films to improve printability, cling performance and other attributes relying on a polar film surface. Normally, the polyethylene film is corona treated in line with the production. The most commonly used method is to guide the film through a corona discharge unit, installed between the first extruder nip rolls and the film winder. This surface treatment is typically used if the film will be printed on or will be adhesive laminated to a substrate of similar or different material. In general, this treatment process will increase the surface polarity, and hence improve the required adhesion of inks and glue. Further the coefficient of friction (COF) is typically reduced after corona discharge treatment because slip and other additive molecules will tend to migrate towards the corona treated surface thus creating an unclean surface for printing and the like. (See a publication by Esso Chemicals entitled Surface treatment of Low Density Polyethylene) The migrating slip molecules can also consume adhesive molecules, hence more adhesive may be required to achieve the same level of tack or a different COF will be obtained after lamination. Thus there is a need in the art for a film that can be corona treated, yet does not have the slip migration problems. Further there is a need in the art for a film that can be corona treated that maintains its coefficient of friction. The invention herein described addresses these needs.



US Patent 4,425,268 discloses corona discharge treatment of a stretch film to increase cling performance on the surface opposite to the treated surface by driving the cling additives to the other surface. However films with slip additives are not disclosed.

EP Patent Application 0 597 502 discloses oriented films of metallocene polyethylenes subjected to corona discharge treatment, but does not disclose the presence of additives.

Summary of the Invention

This invention relates to a film comprising:

- (1) a Surface Friction Modifying Additive,
- (2) at least one surface layer comprising mPE, wherein the mPE is a homopolymer of ethylene or a copolymer of ethylene and a C₃ to C₂₀ olefin (preferably octene or hexene) having an Mw/Mn of 6 or less and a CDBI of 50% or more, and
- (3) optionally other additives,

wherein the surface layer comprising mPE has been subjected to corona treatment and thereafter there is at least a 20% difference between in the coefficients of friction of the two surfaces of the film when tested according to ASTM D-1894 after seven days of storage at 23 °C and 50% relative humidity and the COF of the corona treated mPE surface is higher than the other surface.

In a preferred embodiment there is a 30 - 60 % difference between in the coefficients of friction of the two surfaces of the film when tested according to ASTM D-1894 after seven days of storage at 23 °C and 50% relative humidity and the COF of the corona treated mPE surface is higher than the other surface, preferably a 50 -60 % difference.

Surface Friction Modifying Additive (SFMA) is defined to be a substance that when present in a 50 micron thick monolayer blown film of:

- (1) a low density polyethylene homopolymer (produced in a high pressure process having a density of about 0.922 g/cc and a melt index of about 2 g/10 min) and

(2) 1000 ppm of natural silica with an average particle size between 3 and 10 microns, at a concentration of 250 ppm will cause at least a 20 % decrease in the coefficient of friction (COF) as measured by ASTM D - 1894 (after seven days of storage in a room at 23 °C and 50 % relative humidity) as compared to the COF of polymer (1) with 1000 ppm natural silica with an average particle size between 3 and 10 microns and no SFMA present.

Brief Description of the Drawings

Figure 1 is a graph of the coefficient of friction for the films of Example 2, structures 12, 13 and 3 identified as Ziegler-Natta (1), Ziegler-Natta (2) and Metallocene, respectively.

Detailed Description of the Invention.

The films of this invention typically comprise at least one surface layer comprising "mPE" which is a homopolymer of ethylene or copolymer of ethylene and a C₃ to C₂₀ alpha-olefin, preferably a C₃ to C₁₂ alpha-olefin. In a preferred embodiment the homopolymer or copolymer has an Mw/Mn of 6 or less, preferably 3 or less, even more preferably between 1.5 and 3. In another preferred embodiment the copolymer has a CDBI of 50 % or more, preferably 60% or more. In one preferred embodiment the mPE has a CDBI between 65% and 85%. In another preferred embodiment the mPE has a CDBI of 80% or more, even more preferably 90 % or more. In another preferred embodiment the mPE has a density a density of 0.86 g/cm³ to 0.96 g/cm³, preferably 0.88 to 0.94 g/cm³, more preferably between 0.88 g/cm³ and 0.935 g/cm³, more preferably between 0.910 g/cm³ and 0.930 g/cm³, more preferably between 0.915 g/cm³ and 0.935 g/cm³.

In a particularly preferred embodiment the mPE has a CDBI of 65 to 85 %, a density of 0.89 to 0.96, preferably 0.90 to 0.935 g/cm³ and a Mw/Mn between 1 and 2.5.

In another preferred embodiment the mPE has a density of 0.86 to 0.925 g/cm³ and a CDBI of over 80%, preferably between 80 and 99%.

In another preferred embodiment the first surface layer comprises a homopolymer of ethylene having an Mw/Mn of 3 or less, preferably between 2.5 and 1.

CDBI is a measure of the composition distribution of monomer within the polymer chains and is measured by the procedure described in PCT publication WO 93/03093, published February 18, 1993 including that fractions having a molecular weight (Mw) below 15,000 are ignored when determining CDBI.

In a preferred embodiment, the mPE homopolymers or copolymers are produced using mono or bis cyclopentadienyl transition metal catalysts in combination with an activator of alumoxane and/or a non-coordinating anion in solution, slurry or gas phase. The catalyst may be supported or unsupported and the cyclopentadienyl rings by may substituted or unsubstituted. The polymerization may take place in single or multiple reactors, in series or in parallel. Several commercial products produced with such catalyst/activator combinations are commercially available from Exxon Chemical Company in Baytown Texas under the tradenames EXCEED™ and EXACT™. For more information on the methods and catalysts/activators to produce such mPE homopolymers and copolymers see WO 94/26816; WO 94/03506; EPA 277,003; EPA 277,004; US 5,153,157; US 5,198,401; US 5,240,894; US 5,017,714; CA 1,268,753; US 5,324,800; EPA 129,368; US 5,264,405; EPA 520,732; WO 92 00333; US 5,096,867; US 5,507,475; EPA 426 637; EPA 573 403; EPA 520 732; EPA 495 375; EPA 500 944; EPA 570 982; WO 91/09882; WO 94/03506 and US 5,055,438.

The mPE homopolymer or copolymer are typically formed into mono-or multilayer films and may have a Surface Friction Modifying Additive incorporated in any of the layers. In a particularly preferred embodiment the Surface Friction Modifying Additive (SFMA) is combined with a core layer of a multilayer film prior to corona discharge treatment. Typically the Surface Friction Modifying Additive is present at levels between 50 and 5000 ppm. As is known by one of ordinary skill in the art, the selected level of SFMA

will be chosen as a function of the film thickness, overall material compositions and desired COF. Likewise the presence of other additives should also be considered when selecting the SFMA levels. In a particularly preferred embodiment, additional additives may be present. For example other migrating additives such antifog may be present and in a preferred embodiment both the SFMA, such as a slip additive, and antifog additives are present in the same film structure.

Preferred Surface Friction Modifying Additives include typical slip additives such as, unsaturated and saturated aliphatic amides. The most commonly used products are ecrumamide and oleamide.

Other additives such as antiblock, antioxidants, pigments, fillers, antifog, UV stabilizers, antistats, polymer processing aids, neutralizers, lubricants, surfactants, pigments, dyes, nucleating agents, may also be present in the films. Preferred additives include silicon dioxide, synthetic silica, titanium dioxide, polydimethylsiloxane, calcium carbonate, metal stearates, calcium stearate, zinc stearate, talc, BaSO₄, diatomaceous earth, wax, carbon black, flame retarding additives, low molecular weight resins, glass beads and the like. The additives may be present in the typically effective amounts well known in the art. In a particularly preferred embodiment the antifog agent is present at 0.001 weight % to 10 weight %.

In a preferred embodiment the surface layer comprising mPE may further comprise one or more additional polymers. The mPE homopolymers or copolymers described above for use as a surface layer may be used alone, may be blended with other mPE homopolymers or copolymers, or they may be blended with other polyolefin homopolymers and copolymers, including but not limited to, homopolypropylene, propylene copolymerized with up to 50 weight % of ethylene or a C₄ to C₂₀ α -olefin, polybutene, ethylene vinyl acetate, low density polyethylene (density 0.915 to less than 0.935 g/cm³) linear low density polyethylene, ultra low density polyethylene (density 0.86 to less than 0.90 g/cm³), very low density polyethylene (density 0.90 to less than 0.915 g/cm³), medium



density polyethylene (density 0.935 to less than 0.945 g/cm³), high density polyethylene (density 0.945 to 0.97 g/cm³), ethylene vinyl acetate, EMA, copolymers of ethylene and acrylates and/or meth-acrylates, copolymers of acrylic acid, polymethylmethacrylate or any other polymers polymerizable by a high-pressure free radical process, polyvinylchloride, polybutene, isotactic polybutene, ABS resins, elastomers such as ethylene-propylene rubber (EPR), vulcanized EPR, EPDM, block copolymer elastomers such as SBS, nylons, polycarbonates, PET resins, crosslinked polyethylene, copolymers of ethylene and vinyl alcohol (EVOH), polymers of aromatic monomers such as polystyrene, poly-1 esters, high molecular weight polyethylene having a density of 0.94 to 0.98 g/cm³, low molecular weight polyethylene having a density of 0.94 to 0.98 g/cm³, graft copolymers generally, polyacrylonitrile homopolymer or copolymers, thermoplastic polyamides, polyacetal, polyvinylidene fluoride and other fluorinated elastomers, polyethylene glycols, polyisobutylene, and the like.

In a preferred embodiment the mPE, is present in the blend at from 10 to 99 weight %, based upon the weight of the polymers in the blend, preferably the mPE is present at 20 to 95 weight %, even more preferably at least 30 to 90 weight %, even more preferably at least 40 to 90 weight %, even more preferably at least 50 to 90 weight %, even more preferably at least 60 to 90 weight %, even more preferably at least 70 to 90 weight %.

The blends described above may be produced by mixing the two, three or more polymers together, by connecting reactors together in series to make reactor blends or by using more than one catalyst in the same reactor to produce multiple species of polymer. The polymers can be mixed together prior to being put into the extruder or may be mixed in the extruder. Additives may be added directly to the polymer to be extruded or may be added using a masterbatch of the additives.

In another embodiment the mPE surface layer is combined with one or more other layers. The other layer(s) may be any layer typically included in multilayer film structures. For example the other layer or layers may be:

1. Polyolefins

Preferred polyolefins include homopolymers or copolymers of C₂ to C₄₀ olefins, preferably C₂ to C₂₀ olefins, preferably a copolymer of an α -olefin and another olefin or α -olefin (ethylene is defined to be an α -olefin for purposes of this invention). Preferably homopolyethylene, homopolypropylene, propylene copolymerized with ethylene and or butene, ethylene copolymerized with one or more of propylene, butene or hexene, and optional dienes. Preferred examples include thermoplastic polymers such as ultra low density polyethylene, very low density polyethylene, linear low density polyethylene, low density polyethylene, medium density polyethylene, high density polyethylene, polypropylene, isotactic polypropylene, highly isotactic polypropylene, syndiotactic polypropylene, random copolymer of propylene and ethylene and/or butene and/or hexene, elastomers such as ethylene propylene rubber, ethylene propylene diene monomer rubber, neoprene, and blends of thermoplastic polymers and elastomers, such as for example, thermoplastic elastomers, rubber toughened plastics, and other mPE's.

2. Polar polymers

Preferred polar polymers include homopolymers and copolymers of esters, amides, acetates, anhydrides, copolymers of a C₂ to C₂₀ olefin, such as ethylene and/or propylene and/or butene with one or more polar monomers such as acetates, anhydrides, esters, alcohol, and or acrylics. Preferred examples include polyesters, polyamides, EVOH, polyethylene terephthalate, ethylene vinyl acetate copolymers, and polyvinyl chloride. Polymers grafted with moieties having polar groups are also preferred.

3. Cationic polymers

Preferred cationic polymers include polymers or copolymers of geminally disubstituted olefins, alpha-heteroatom olefins and/or styrenic monomers. Preferred geminally disubstituted olefins include isobutylene, isopentene, isoheptene, isohexane, isooctene, isodecene, and isododecene. Preferred alpha-heteroatom olefins include vinyl ether and vinyl carbazole, preferred styrenic monomers include styrene, alkyl styrene, para-alkyl

styrene, alpha-methyl styrene, chloro-styrene, and bromo-para-methyl styrene. Preferred examples of cationic polymers include butyl rubber, isobutylene copolymerized with para methyl styrene, polystyrene, and poly- α -methyl styrene.

4. Miscellaneous

Other preferred layers can be paper, wood, cardboard, metal, metal foils (such as aluminum foil and tin foil), metallized surfaces, glass (including silicon oxide (SiO_2) coatings applied by evaporating and depositing silicon oxide onto a film surface), fabric, spunbonded fibers, and non-wovens (particularly polypropylene spun bonded fibers or non-wovens), and substrates coated with inks, dyes, pigments, PVDC and the like.

In addition, the multilayer structures can have more than one layer of the polyethylene or polypropylene homopolymer or copolymers, particularly the mPE homopolymers or copolymers. Further any of the above layers may be oriented before or after being combined with the surface layer.

The films may vary in thickness depending on the intended application, however films of a thickness from 10 to 250 μm are usually suitable. Films intended for packaging are usually from 10 to 60 μm thick. The thickness of the sealing layer is typically 0.2 to 50 μm . There may be a sealing layer on both the inner and outer surfaces of the film or the sealing layer may be present on only the inner or the outer surface.

These films may be formed by any of the conventional technique known in the art including extrusion, co-extrusion, lamination, blowing and casting. The film may be obtained by the flat film or tubular process which may be followed by orientation in an uniaxial direction or in two mutually perpendicular directions in the plane of the film. Particularly preferred methods to form the mPE homopolymers or copolymers into films include extrusion or coextrusion on a blown or cast film line. In addition, the multilayer

structures can have more than one layer of the mPE homopolymers or copolymers or blends thereof.

mPE surface layers in these films are typically subjected to corona treatment or other treatment to increase surface tension and after treatment generally have a surface tension of 38 dynes/cm or more, preferably 42 dynes/cm or more, even more preferably 44 dynes/cm or more, as measured by ASTM D-2578/94. The mPE homopolymer and copolymer films described herein are typically subjected to corona discharge treatment by any of the conventional means known in the art. In another embodiment the surface treatment can be conducted by bringing the film in contact with a highly oxidizing flame or electrical discharge or electronic treating. The films produced herein may also be treated by passing them through an ozone rich environment.

The films described herein may also comprise from 1 to 60 weight %, based upon the weight of the polymer and the resin, of a hydrocarbon resin. The resin may be combined with the polymer of the surface layer or may be combined with the polymer in a core layer. The resin preferably has a softening point above 100 °C, even more preferably from 130 to 180 °C. Preferred hydrocarbon resins include those described in EPA 288 227 and EPA 247 898. These films comprising a hydrocarbon resin may be oriented in uniaxial or biaxial directions to the same or different degrees.

In a preferred embodiment the films produced herein are laminated to another polyolefin film, such as a polyamide or polyester film. In another preferred embodiment the mPE is coextruded with another polyolefin, with the SFMA being present in either layer. Preferred polyolefins include polyesters, polyamides, polyethylenes, polypropylenes, and the like.

The films produced herein may be used for laminating feedstock, packaging, heavy duty packaging, freezer bags, high quality printed films.



All documents described herein are incorporated by reference herein, including any priority documents and/or testing procedures. As is apparent from the foregoing general description and the specific embodiments below, while forms of the invention have been illustrated and described, various modifications can be made without departing from the spirit and scope of the invention. Accordingly, it is not intended that the invention be limited thereby.

Examples

MATERIALS:

ECD 103 is an ethylene hexene copolymer having approximately 7.6 weight % hexene, a melt index of 1 g/10min, a Mw/Mn of 2.3 and a CDBI of 67% and a density of 0.918 g/cm³, sold under the tradename EXCEED™ by Exxon Chemical Company in Baytown Texas.

LD 362 is an ethylene vinyl acetate copolymer having approximately 4.5 weight % vinyl acetate and a melt index of about 2 g/10min produced by a high pressure process using peroxide as the initiator sold under the tradename ESCORENE™ LD 362 by Exxon Chemical Belgium in Brussels Belgium.

LD 158 is a polyethylene homopolymer having a density of approximately 0.9250 g/cm³ and a melt index of about 2 produced in a high pressure process with peroxide sold under the tradename ESCORENE™ LD 158.

LD 185 is a polyethylene homopolymer having a density of approximately 0.922 g/cm³ and a melt index of about 2 produced in a high pressure process with peroxide sold under the tradename ESCORENE™ LD 185.

LD 100 is a polyethylene homopolymer having a density of approximately 0.922 g/cm³ and a melt index of about 2 produced in a high pressure process with peroxide sold under the tradename ESCORENE™ LD 100.

ECD 202 is an ethylene hexene copolymer having approximately 7.6 weight % hexene, a melt index of about 2.4 g/10min, an Mw/Mn of 2.3 and a CDBI of 67% and a density of about 0.917 g/cm³, sold under the tradename EXCCED™ ECD 202 by Exxon Chemical Company in Baytown Texas.

AL3004YB is an ethylene hexene copolymer produced by traditional Ziegler-Natta catalysis having a melt index of about 2.8 g/10 min and a density of about 0.917 g/cc sold by Exxon Chemical Belgium under the trade name **ESCORENE™ AL3004YB**.

AL3108 ZD is an ethylene hexene copolymer produced by traditional Ziegler-Natta catalysis having a melt index of about 0.8 g/10 min and a density of about 0.921 g/cc sold by Exxon Chemical Belgium under the tradename **ESCORENE™ AL3108ZD**.

LLN 1002 YB is an ethylene butene copolymer produced by traditional Ziegler-Natta catalysis having a melt index of about 2 g/10 min and a density of about 0.918 g/cc sold by Exxon Chemical Belgium under the trade name **ESCORENE™ LLN1002YB**.

DOW NG 5056 E01 and **Dow 5056 E** are ethylene octene copolymers having about 11.6 weight % octene, an Mw/Mn of about 3.1, a melt index of about 1g/10min, a density of about 0.919 g/cm³, and a CDBI of about 45% produced by and available from Dow Chemical Company in Zurich, Switzerland. E differs from E01 in that slip and antiblock additives are included in E01.

DSM Stamylex 09-016F is a copolymer of ethylene and octene having a density of about 0.914 g/cc and melt index of about 1.1 g/10min having no slip or antiblock supplied by DSM Kunststoffen B.V. in the Netherlands.

LL 1001 XI and **XV** are ethylene butene copolymers produced by traditional Ziegler-Natta catalysis having a melt index of about 1 g/10 min and a density of about 0.918 g/cc sold by Exxon Chemical Belgium under the trade name **ESCORENE™ LL 1001 XI** and **XV**. XV indicates that no surface modifying additives are present and XI indicates that slip is present at about 1000 ppm and antiblock is present at about 3000 ppm.

TESTING METHODS:

Surface Tension was measured according to ASTM D-2578/94 "Standard test method for wetting tension of polyethylene and polypropylene films." Care was taken that the portion of the film to be tested was not touched or rubbed and was completely free of any contamination. A series of test solutions (mixtures of formamide and ethylene glycolmonoethyl ether) with gradually increasing surface tension were applied to the surface until a mixture was found that just wets the film surface. The solution was



considered as wetting the test specimen when it remains intact as a continuous film line for 2 seconds. The surface tension of this mixture was the determined wetting tension of the film sample.

Coefficient of friction (COF) of the film was measured according to ASTM D1894. Film samples were conditioned at $23 \pm 2^\circ\text{C}$ and $50 \pm 5\%$ humidity for not less than 40 hours prior to testing. For each measurement samples of 360 mm in MD, 140 mm in TD were cut from a template and a 60 mm wide and 150 mm long with an incision for fixing the moving sled was cut again using a template. Care was taken that the portion of the film to be tested was not touched or rubbed and was completely free of any contamination. The film specimen was fixed on the horizontal plane and the sled respectively without stretching or wrinkles. The frictional force was the resisting force that arises when one surface slides over the adjoining surface. This was measured using a Zwick Tensile Tester. All samples were placed with the same surface towards each other and in the same orientation, i.e. machine direct on machine direction with inside on inside or outside on outside (relative to the film bubble during extrusion).

The static coefficient of friction is calculated as follows:

Static COF = Initial peak reading (g) to initiate movement of sledge over the fixed surface divided by sled weight (g).

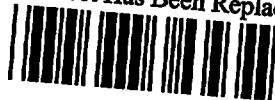
The kinetic coefficient of friction is calculated as follows:

Static COF = Average of the curve reading during uniform sliding of the film surface (g) divided by sled weight (g) over a distance of at least 10 cm.

Composition Distribution Breadth Index (CDBI) is a measure of the composition distribution of monomer within the polymer chains and is measured by the procedure described in PCT publication WO 93/03093, published February 18, 1993 including that fractions having a molecular weight (M_w) below 15,000 are ignored when determining CDBI

Melt Index (MI) was measured according to ASTM 28398, condition E.

Density was measured according to ASTM D1505.



Mw and Mn were measured by GPC (Gel Permeation Chromatography) on a Waters 150 gel permeation chromatograph equipped with a differential refractive index (DRI) detector and a Chromatix KMX-6 on line light scattering photometer. The system was used at 135 °C with 1,2,4-trichlorobenzene as the mobile phase. Shodex (Showa Denko America, Inc) polystyrene gel columns 802, 803, 804 and 805 were used. This technique is discussed in "in "Liquid Chromatography of Polymers and Related Materials III", J. Cazes editor, Marcel Dekker. 1981, p. 207, which is incorporated herein by reference. No corrections for column spreading were employed; however, data on generally accepted standards, e.g. National Bureau of Standards Polyethylene 1484 and anionically produced hydrogenated polyisoprenes (an alternating ethylene-propylene copolymer) demonstrated that such corrections on Mw/Mn (= MWD) were less than 0.05 units. Mw/Mn was calculated from elution times. The numerical analyses were performed using the commercially available Beckman/CIS customized LALLS software in conjunction with the standard Gel Permeation package. Calculations involved in the characterization of polymers by ^{13}C NMR follow the work of F. A. Bovey in "Polymer Conformation and Configuration" Academic Press, New York, 1969.

PRODEDURE:

Films 1 to 4 of table 1 were produced on a monolayer extruder (Dolci, barrier screw 60 mm diameter, die diameter of 200 mm, die gap of 1.5 mm, a blow up ratio of 2.5 with a film thickness of 50 microns and an output of about 80 kg/hr). The temperatures were set at 140 to 170 °C from beginning to end along the barrel. The frost line height was kept at 500 mm. Films 5-13 were extruded on a under the same conditions are films 1-4, except that output was 70 kg/hr, blowup ratio was 2.2 and the frost line height was 450 mm and the temperatures were set starting at 170 to 210 °C. Some films were in line treated with corona discharge to yield a surface tension of about 44 dynes/cm for films labeled medium and about 48 dynes/cm for films labeled high.

Films of Table 2 were produced on a Barmag three layer coextrusion line equipped with 3 identical extruders each with a 45 mm barrier screw, a die having a diameter of 250 mm, a

gap of 1.6 mm, and with a blow up ratio of 2.2. For films 1, 2, 11, 12, 13, 49, 50, 53, and 54 all three extruders were set at a temperature profile of 170 - 210 °C. For films 3-9, the outside and inside layer extruders were set at 170 - 210 °C and the middle layer extruder was set at 170-190 °C. For film 10, all three extruders were set at 170-190 °C. For films 95 and 96 all three extruders were set at a temperature profile starting at 140 - 170 °C. The output for the films in Table 3 was between 94 and 100-kg/hr. Some films were in line treated with corona discharge to yield a surface tension of about 46-48 dynes/cm immediately after production.

Films of Table 3 were produced on a Barmag three layer coextrusion line equipped with 3 identical extruders each with a 45 mm barrier screw, a diameter of 250 mm, a die gap of 1.6 mm, and a blow up ratio of 2.2. For all eight films the temperature settings for the middle and outside layers were 190-210 °C and the inner layer was set at 170-200 °C. The output was between 100 and 104 kg/hr. Some films were in line treated with corona discharge to yield a surface tension of about 46-48 dynes/cm immediately after production.

In all the Tables below the additives indicated were either present in the base resin or were added via commercially available masterbatches. All additive levels in Tables 1-3 are present in ppm in the indicated layer. "Ins" means inside and "out" means outside of the film bubble. All thicknesses are expressed in μm .

TABLE 1 (MONOLAYER FILM STRUCTURES)

TABLE 1 (MONOLAYER FILM STRUCTURES)													
Ref.				Thickness	Treatment	COF @ 1 day		COF @ 7 days		COF @ 14 days		COF @ 100 days	
	Polymer	Additives		μm									
		Anti-block	Slip			Ins/ Ins	Out/ Out	Ins/ Ins	Out/ Out	Ins/ Ins	Out/ Out	Ins/ Ins	Out/ Out
1	66 % LD 185 BW	1000	250	50	no			0.18		0.19	0.21		
	34 % LD 100 BR												
2	66 % LD 185 BW	1000	250	50	medium			0.21		0.19	0.23		
	34 % LD 100 BR												
3	34 % LD 185 BW	1000	250	50	no			0.25		0.25	0.27		
	34 % LLN 1001 XV												
	33 % LD 100 BR												
4	34 % LD 185 BW	1000	250	50	medium			0.20		0.27	0.21		
	34 % LLN 1001 XV												
	33 % LD 100 BR												
5	ECD 103	0	0	50	no	Jumping				jumping			
6	ECD 103	0	0	50	medium	Jumping				jumping			
7	ECD 103	0	0	50	high	Jumping				jumping			
8	ECD 103	0	500	50	no	0.47	0.47			0.4	0.48	0.42	0.48
9	ECD 103	0	500	50	medium	0.46	0.55			0.48	0.81		
10	ECD 103	0	500	50	high	0.46	0.50			0.45	0.84	0.4	0.47
11	ECD 103	0	1000	50	no	0.19	0.15			0.26	0.24	0.19	0.20
12	ECD 103	0	1000	50	medium	0.21	0.16			0.25	0.40		
13	ECD 103	0	1000	50	high	0.20	0.21			0.21	0.34	0.21	0.68

TABLE 2 (COEXTRUDED FILM STRUCTURES)

Ref	Inside Layer			Thickness	Middle Layer			Thickness	Outside Layer			Thickness	Treatment	COF @ 1 days		COF @ 7 days		COF @ 14 days		COF @ 100 days		COF @ 200 days	
	Polymer	Additives			Polymer	Additives			Polymer	Additives													
		Anti-block	Slip			Anti-block	Slip			Anti-block	Slip			Ins/ Ins	Out/ Out	Ins/ Ins	Out/ Out	Ins/ Ins	Out/ Out	Ins /Ins	Out/ Out	Ins/ Ins	Out/ Out
1	ECD 103	2500	0	6	ECD 103	0	2000	13	ECD 103	2500	0	6	yes					0.14	0.39			0.13	0.46
2	ECD 103	2500	0	6	ECD 109	0	2000	13	ECD 103	2500	0	6	yes					0.12	0.30			0.16	0.40
3	ECD 103	2500	0	6	ECD 202	0	2000	13	ECD 103	2500	0	6	yes					0.12	0.31			0.15	0.32
4	ECD 103	2500	0	6	AL 3004 YB	0	2000	13	ECD 103	2500	0	6	yes					0.12	0.43			0.16	0.50
5	ECD 103	2500	0	17	AL 3004 YB	0	2000	17	ECD 103	2500	0	17	no	0.31	0.20			0.19	0.14				
6	ECD 103	2500	0	17	AL 3004 YB	0	2000	17	ECD 103	2500	0	17	yes	0.29	0.46			0.22	0.26				
7	ECD 103	2500	0	13	AL 3004 YB	0	2000	25	ECD 103	2500	0	13	no	0.15	0.12			0.13	0.11				
8	ECD 103	2500	0	13	AL 3004 YB	0	2000	25	ECD 103	2500	0	13	yes	0.13	0.46			0.12	0.23				
9	30 % LD 362 BW	2500	0	6	ECD 202	0	2000	13	30 % LD 362 BW	2500	0	6	yes					0.15	0.21			0.16	0.17
10	70 % ECD 103	2500	0			0	2000		70 % ECD 103	2500	0												
	70 % LD 362 BW	2500	0	6	AL 3004 YB	0	2000	13	70 % LD 362 BW	2500	0	6	yes					0.14	0.14			0.16	0.13
	30 % ECD 103	2500	0			0	2000		30 % ECD 103	2500	0												
11	AL 3108 XV	2500	0	6	AL 3108 XV	0	2000	13	AL 3108 XV	2500	0	6	yes					0.14	0.14			0.26	0.14
12	DOW 5056E01	2500	0	6	LLN 1002 YB	0	2000	13	DOW 5056E01	2500	0	6	yes					0.18	0.16			0.19	0.19
13	DSM 09-016 F	2500	0	6	LLN 1002 YB	0	2000	13	DSM 09-016 F	2500	0	6	yes					0.27	0.19			0.28	0.27
49	LLN 1001 XV	3000	0	17	LLN 1001 XI	3000	1000	17	LLN 1001 XV	3000	0	17	no					0.27	0.24	0.20	0.19		
50	LLN 1001 XV	3000	0	17	LLN 1001 XI	3000	1000	17	LLN 1001 XV	3000	0	17	yes					0.36	0.16	0.39	0.23		
53	LLN 1001 XV	3000	0	17	LLN 1001 XI	3000	2000	17	LLN 1001 XV	3000	0	17	no					0.33	0.26	0.32	0.26		

TABLE 2 CONTINUED (COEXTRUDED FILM STRUCTURES)

Ref	Inside Layer			Thickness	Middle Layer			Thickness	Outside Layer			Thickness	Treatment	COF @		COF @		COF @		COF @		COF @	
														1 days	7 days	14 days	100 days	200 days					
	Polymer	Additives			Polymer	Additives			Polymer	Additives													
		Anti-block	Slip			Anti-block	Slip			Anti-block	Slip			Ins/Ins	Out/Out	Ins/Ins	Out/Out	Ins/Ins	Out/Out	Ins/Ins	Out/Out	Ins/Ins	Out/Out
54	LLN 1001 XV	3000	0	17	LLN 1001 XI	3000	2000	17	LLN 1001 XV	3000	0	17	yes					0.40	0.26	0.40	0.25		
95	LD 185 BW	1000	0	17	LD 185 BW	1000	0	17	LD 185 BW	1000	0	17	no	0.54	0.56	0.50	0.53						
96	LD 100 BR	1000	750	17	LD 185 BW	1000	0	17	LD 185 BW	1000	0	17	no	0.24	0.28	0.24	0.26						

TABLE 3 (COEXTRUDED FILM STRUCTURES CONTAINING ANTIFOG ADDITIVES)

Ref	Inside Layer				Thickness	Middle Layer			Thickness	Outside Layer			Thickness	Treatment	COF @ 1 days		COF @ 4 days		COF @ 7 days		COF @ 4 days	
	Polymer	Additives				Polymer	Additives			Polymer	Additives				Ins/ Ins	Out/ Out	Ins/ Ins	Out/ Out	Ins/ /Ins	Out/ Out	Ins/ Ins	Out/ Out
		Anti- block	Slip	Anti- fog			Anti- block	Slip			Anti- block	Slip										
1	LD 362	2000	400	20000	17	LD 150 AC	450	900	17	ECD 103	0	0	17	no	0.38	2.26	0.42	1.65	0.38	1.94	0.41	1.61
2	LD 362	2000	400	20000	17	LD 150 AC	450	900	17	ECD 103	0	0	17	yes	0.37	1.81	0.38	1.5	0.38	1.50	0.38	1.35
3	LD 362	2000	400	20000	17	LD 150 AC	450	900	17	80 %ECD 103 20 % LD 150 BW	0	0	17	no	0.41	1.69	0.45	1.54	0.38	1.61	0.40	1.54
4	LD 362	2000	400	20000	17	LD 150 AC	450	900	17	80 % ECD 103 20 % LD 150 BW	0	0	17	yes	0.38	2.24	0.40	1.54	0.40	1.48	0.34	1.53
5	LD 362	2000	400	20000	17	LD 150 AC	450	900	17	60 %ECD 103 40 % LD 150 BW	0	0	17	no	0.39	1.79	0.43	2.29	0.39	1.64	0.42	1.57
6	LD 362	2000	400	20000	17	LD 150 AC	450	900	17	60 % ECD 103 40 % LD 150 BW	0	0	17	yes	0.39	2.16	0.41	1.76	0.41	1.49	0.41	1.47
7	LD 362	2000	400	20000	17	LD 150 AC	450	900	17	AL 3108 XV	0	0	17	no	0.45	0.66	0.43	1.64	0.37	1.10	0.40	1.25
8	LD 362	2000	400	20000	17	LD 150 AC	450	900	17	AL 3108 XV	0	0	17	yes	0.40	0.45	0.41	0.44	0.40	0.47	0.38	0.41

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What is claimed is:



1. A film comprising:
 - (1) a Surface Friction Modifying Additive, and
 - (2) at least one surface layer comprising mPE, wherein the mPE is a homopolymer of ethylene or a copolymer of ethylene and a C₃ to C₂₀ olefin (preferably octene or hexene) having an Mw/Mn of 4 or less, and a CDBI of 50% or more,wherein at least one surface has been treated by corona discharge and there is at least a 20% difference between in the coefficients of friction of the two surfaces of the film when tested according to ASTM D-1894 after seven days of storage 23 °C and 50% relative humidity and the coefficient of friction of the corona treated mPE surface is higher than the other surface.
2. The film of claim 1 wherein the layer comprising mPE comprises a blend of mPE and another polymer.
3. The film of claim 2 wherein the mPE is present in the surface layer at 80 weight % or more.
4. The film of claim 1 wherein at least one surface layer of mPE is treated by corona discharge and thereafter there is at least a 60 % increase in the coefficient of friction of the treated mPE surface layer as compared to the COF prior to corona discharge treatment when tested according to ASTM D-1894 after seven days of storage 23 °C and 50% relative humidity.
5. The film of claim 1 further comprising additives selected from the group consisting of antiblock agents, antioxidants, pigments, fillers, antifog agents, UV



stabilizers, antistats, polymer processing aids, neutralizers, lubricants, surfactants, pigments, flame retarding additives, low molecular weight resins, dyes, and nucleating agents.

6. The film of claim 1 further comprising additives selected from the group consisting of silicon dioxide, synthetic silica, titanium dioxide, polydimethylsiloxane, calcium carbonate, metal stearates, calcium stearate, zinc stearate, talc, BaSO₄, diatomaceous earth, wax, carbon black, and glass beads.
7. The film of claim 1 further comprising antifog agent at 0.001 weight % to 10 weight % of antifog agent.
8. The film of claim 1 wherein the mPE has a CDBI between 65 and 85 %, a density of 0.89 to 0.935 g/cm³ and an Mw/Mn between 1 and 2.5.
9. The film of claim 1 wherein the SFMA is an aliphatic amide.
10. The film of claim 1 wherein the SFMA is a slip agent.
11. The film of claim 1 wherein the SFMA is ecruamide, oleamide or both.
12. The film of claim 1 wherein the film is laminated to a polyamide or polyester film.
13. The film of claim 1 further comprising at least one other layer.
14. The film of claim 13 wherein the other layer comprises one or more of homopolyethylene, homopolypropylene, propylene copolymerized with ethylene and or butene, ethylene copolymerized with one or more of propylene, butene or hexene, and optional dienes.



15. The film of claim 13 wherein the other layer comprises one or more of ultra low density polyethylene, very low density polyethylene, linear low density polyethylene, low density polyethylene, medium density polyethylene, high density polyethylene, polypropylene, isotactic polypropylene, highly isotactic polypropylene, syndiotactic polypropylene, random copolymer of propylene and ethylene and/or butene and/or hexene, ethylene propylene rubber, ethylene propylene diene monomer rubber, and neoprene.
16. The film of claim 13 wherein the other layer comprises one or more of homopolymers and copolymers of esters, amides, acetates, anhydrides, and copolymers of a C₂ to C₂₀ olefin.
17. The film of claim 13 wherein the other layer comprises one or more of polyesters, polyamides, EVOH, polyethylene terephthalate, ethylene vinyl acetate copolymers, and polyvinyl chloride.
18. The film of claim 13 wherein the other layer comprises one or more of butyl rubber, isobutylene copolymerized with para methyl styrene, polystyrene, and poly- α -methyl styrene.
19. The film of claim 13 wherein the other layer comprises one or more of paper, wood, cardboard, metal, metal foils, metallized surfaces, glass, fabric, spunbonded fibers, and non-wovens.
20. The film of claim 13 wherein the layers are coextruded.
21. The film of claim 13 wherein the layers are laminated.

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