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[54] **ROLL WRAP FILM**

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[52] **U.S. Cl.** **428/213**; 428/352

[58] **Field of Search** .... 428/352, 354, 428/355 AC, 355 EN, 515, 516, 520, 213, 220; 53/399, 441

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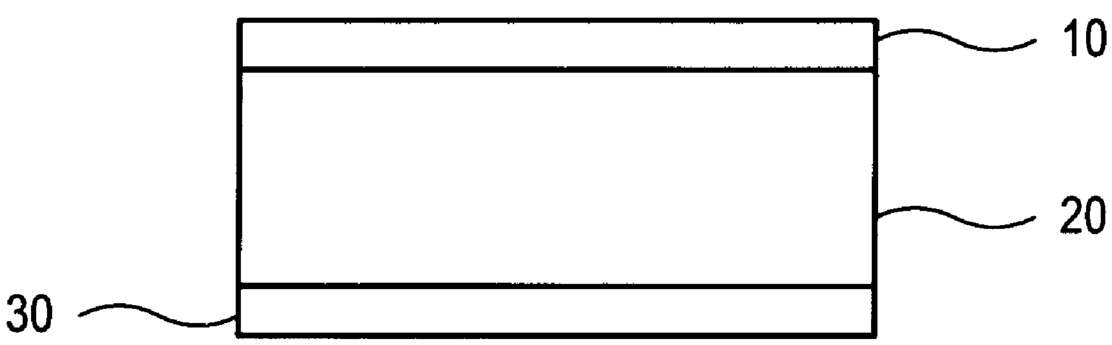
[57] **ABSTRACT**

A multilayer, thermoplastic roll wrap film containing at least three polymeric film layers and comprised of an outer cling layer, a non-cling outer layer, and at least one inner polymeric layer. The roll wrap film has at least one inner polymeric layer, located between the outer cling layer and then non-cling outer layer. The non-cling outer layer is preferably comprised of a high pressure, low density polyethylene resin having a melt index of from about 0.5 to about 6. The inner polymeric layer comprises a low polydispersity polymer. The low polydispersity polymer has a polydispersity of from about 1 to about 4, a melt index (I_2) of from about 0.5 to about 10 g/10 min., and a melt flow ratio (I_{20}/I_2) of from about 12 to about 22. The roll wrap film has a transverse tear resistance of at least 400 grams/mil as measured by ASTM D1922, a machine direction tear resistance as measured by ASTM D1922 of at least 150 grams/mil and a F-50 dart drop of at least 600 grams. It is contemplated that additional layers may be added to the present invention.

80 Claims, 1 Drawing Sheet



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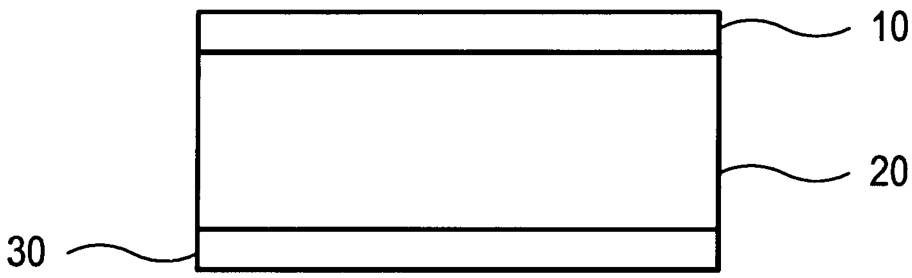

FIG. 1

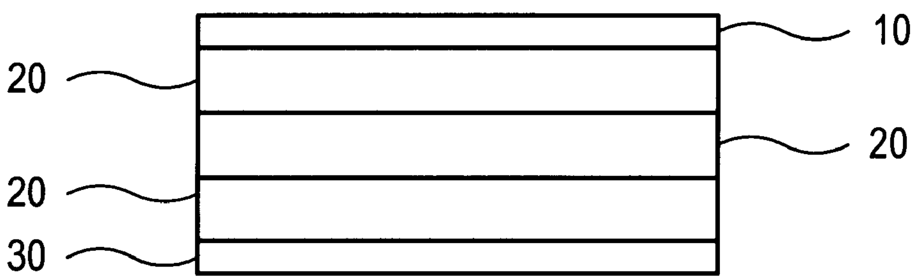

FIG. 2

ROLL WRAP FILM

FIELD OF INVENTION

The present invention is directed to roll wrap film and methods for their use. In particular, the present invention is directed to roll wrap film having higher tensile strength, enhanced tear resistance, abrasion resistance, uniform stretching characteristics, superior puncture resistance, high total energy dart drop, superior optical qualities, and overall strength.

BACKGROUND OF THE INVENTION

The use of thermoplastic roll wrap films for protecting goods, and in particular, large paper roll stock is a significant commercially important application of polymer film, including generically, polyethylene. However, a factor affecting their acceptance is the machine performance of the roll wrap films.

In one commercial application, roll wrap film of the present invention is used as primary protection of a mill roll of fine paper. In this application, the roll wrap film is typically applied in multiple layers around such fine paper. These rolls of fine paper typically include bar codes which contain information such as product type, purchase order number and weight. Roll wrap film may be applied in conjunction with pre-stretch machines and non pre-stretch machines. The use of a pre-stretch machine tends to cause severe "tiger striping" in many roll wrap films because of the lack of uniform stretching.

Tiger striping is a condition in the stretched films where bands or patterns across the films have not been stretched as compared to a remainder of the roll wrap film. This condition is caused by the high strain on the stretched roll wrap film. This non-uniform stretching results in a "wrinkling" pattern in the roll wrap film which can cause distortion in the scanned reading on the above-described bar codes. In addition, the tiger-striped film has less effective cling properties and may even cause damage to the wrapped product.

Some of the properties desired of a good roll wrap film are as follows: good cling or cohesion properties, high puncture resistance, good machine direction tear resistance, good transparency, low haze, low stress relaxation with time, high resistance to transverse tear especially when under machine direction tension, low specific gravity and thus high yield in area per pound, good tensile toughness, high machine direction ultimate tensile strength, high machine direction ultimate elongation, and low modulus of elasticity.

A need exists to develop superior roll wrap films having excellent machine performance with excellent stretched clarity and uniform stretched gauge, while still maintaining other important roll wrap film properties.

SUMMARY OF THE INVENTION

The present invention is a multilayered roll wrap film which has excellent machine performance, excellent puncture resistance, higher tensile strength, enhanced tear resistance, abrasion resistance, uniform stretching characteristics, good cling properties, good optical qualities, and overall strength.

The inventive film comprises a cling layer, at least one inner polymeric layer and a non-cling layer. The cling layer may be constructed of olefin polymer resins. The cling layer is preferably constructed with a ethyl methyl acrylate copolymer.

The inner polymeric layer, located at a position between the cling layer and the non-cling layer, comprises a polymer

having a low polydispersity. The low polydispersity polymer has a polydispersity of from about 1 to about 4, a melt index (I_2) of from about 0.5 to about 10 g/10 min., and a melt flow ratio (I_{20}/I_2) of from about 12 to about 22. The inner polymeric layer(s) are preferably produced utilizing metallocene catalyst polymerization techniques. The inner polymeric layer may comprise the low polydispersity polymer with other resins.

The non-cling layer is located as an outer layer adjacent to the inner polymeric layer. The non-cling layer is preferably comprised of a high pressure, low density polyethylene (HPLDPE) having a density in the range of from about 0.88 to about 0.935 with a melt index of from about 0.5 to about 6, and preferably from about 1 to about 3 g/10 min.

The film is constructed with at least three layers; additional layers are contemplated. For instance, additional inner polymeric layers may be incorporated into the film between the cling layer and the non-cling layer, where such layers are constructed with the same or different metallocene-catalyzed polyethylene resins as the first inner polymeric layer.

The multilayer film of the present invention has a transverse tear resistance of at least 400 grams/mil as measured by ASTM D1922, a machine direction tear resistance as measured by ASTM D1922 of at least 150 grams/mil, and a F-50 dart drop of at least 600 grams as measured by ASTM D1709.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** shows a three layer film constructed according to one embodiment of the present invention; and

FIG. **2** shows a five layer film constructed according to one embodiment of the present invention.

DESCRIPTION OF ILLUSTRATIVE EMBODIMENTS

The multilayer roll wrap films of the present invention are constructed with a cling layer, at least one inner polymeric layer and a non-cling layer. The multilayer roll wrap films of the present invention can be prepared as cast films by conventional coextrusion techniques.

Cling Layer

The cling layer of the roll wrap films of the present invention may be constructed of olefin polymer resins. Suitable polyethylene resins are those ethylenic copolymers that comprise a major proportion by weight of ethylene copolymerized with a minor proportion by weight of an alpha olefin monomer containing about 3 to about 12, preferably about 4 to about 10, and more preferably about 4 to about 8 carbon atoms. These resins have a polydispersity which is preferably in the range of from about 3 to about 7.

The cling layer is preferably comprised of ethyl methyl acrylate (EMA). EMA has a melt index of from about 2 to about 7, and preferably from about 3 to 5 g/10 min. as measured by ASTM D1238. The EMA resins have a density of from about 0.88 to about 0.94 g/cm^3 and preferably from about 0.90 to about 0.92 g/cm^3. These EA polymers generally have an acrylate content between about 2 to about 40%, preferably between about 10 to about 35%, by weight of the EA polymer. The acrylates useful in these polymers are those generally known in the art, preferably methyl, ethyl, and n-butyl acrylate. Ethylene-acrylate (EA) polymer films as shown in U.S. Pat. No. 5,049,423, which is incorporated herein by reference in its entirety, are contemplated for the cling layer. It is also contemplated that resins such as ethyl vinyl acetate (EVA) copolymer, high pressure low density polyethylene (HPLDPE) may be used in forming the cling layer of the roll wrap films of the present invention.

Other examples of ethylenic copolymers which may be used are those commonly referred to as linear low density polyethylenes (LLDPE) and very low density polyethylenes (VLDPE) may also comprise the cling layer. Preferably the ethylenic copolymers employed are those having from about 1 to about 20, preferably from about 1 to about 10 weight percent of said higher alpha olefin monomer copolymerized therein. In addition, the alpha olefin monomer employed in the ethylenic copolymer is selected from the group consisting of 1-butene, 3-methyl-1-butene, 3-methyl-1-pentene, 1-hexene, 4-methyl-1-pentene, 3-methyl-1-hexene, 1-octene and 1-decene. Particularly preferred are the 1-hexene alpha olefins. The LLDPE resins are prepared at relatively low pressures employing coordination-type catalysts. Reference may be made to U.S. Pat. Nos. 3,645,992, 4,076,698, 4,011,382, 4,163,831, 4,205,021, 4,302,565, 4,302,566, 4,359,561 and 4,522,987 for more details of the manufacture and properties of LLDPE resins including those which are particularly useful herein.

Common LLDPE resins that may be used to form such a cling layer include those having a relatively high weight percentage of n-hexane extractibles, as measured by the n-hexane extractibles method of 21 C.F.R. 177.1520. Generally, the LLDPE used in the cling layer herein will contain from about 2 to about 10, preferably from about 2 to about 8, more preferably from about 2.5 to about 5, weight percent of n-hexane extractibles.

The LLDPE resins that can be used in the cling layer herein have a density ranging from about 0.890 to about 0.940 g/cm^3, more commonly from about 0.90 to about 0.93 g/cm^3, and a melt index (I_2) of from about 1 to about 10 g/10 min., as determined by ASTM D1238. Preferred LLDPE resins possessing densities within the range from about 0.917 to about 0.920 gm/cm^3 and a melt index of from about 2.0 to about 5.0 g/10 min., as determined by ASTM D1238. Examples of such LLDPE resins include those set forth in U.S. Pat. No. 5,273,809, which is incorporated herein by reference in its entirety.

The VLDPE resins that may be used in the cling layer herein have a density ranging from about 0.875 to about 0.912 g/cm^3, more commonly from about 0.89 to about 0.91 g/cm^3, and a melt index of from about 0.5 to about 5 g/10 min., preferably from about 1 to about 3 g/10 min.

The LLDPE and VLDPE resins that can be used in the cling layer herein may also contain known and conventional cling additives to augment the cling property that, at least in the case of the particularity preferred resins, is inherently exhibited. Examples of useful cling additives include polyisobutylenes having a number average molecular weight in the range from about 1,000 to about 3,000, preferably about 1,200 to about 1,800, as measured by vapor phase osmometry, amorphous atactic polypropylenes, e.g., those having an average molecular weight of about 2000, and polyterpenes and ethylene-vinyl acetate copolymers containing from about 5 to about 15 weight percent copolymerized vinyl acetate. The optional cling additive can be present in the cling layer in a concentration of from about 0.5 to about 10 weight percent of the resin. Of course, other conventional film additives such as antioxidants, UV stabilizers, pigments, dyes, etc., may be present in the usual amounts.

Other known cling layers are contemplated for the present invention. In addition, the above-described resins may be blended in forming the cling layer of the present invention.

The cling layer of the film can be treated by such known and conventional postforming operations as corona discharge, chemical treatment, flame treatment, etc., to modify the printability or ink receptivity of the surface(s) or to impart other desirable characteristics thereto.

INNER POLYMERIC LAYER

The multilayer roll wrap films of the present invention are constructed with at least one inner polymeric layer comprising a polymer resin having a low polydispersity and located between the outer layers. The inner polymeric layer comprises a polymer having a low polydispersity. The low polydispersity polymer may be prepared from a partially crystalline polyethylene resin that is a polymer prepared with ethylene and at least one alpha olefin monomer, e.g., a copolymer or terpolymer. The alpha olefin monomer generally has from about 3 to about 12 carbon atoms, preferably from about 4 to about 10 carbon atoms, and more preferably from about 6 to about 8 carbon atoms. The alpha olefin comonomer content is generally below about 30 weight percent, preferably below about 20 weight percent, and more preferably from about 1 to about 15 weight percent. Exemplary comonomers include propylene, 1-butene, 1-pentene, 1-hexene, 3-methyl-1-pentene, 4-methyl-1-pentene, 1-octene, 1-decene, and 1-dodecene.

The low polydispersity polymer generally has the characteristics associated with an LLDPE material, however it has improved properties as explained more fully below. The low polydispersity polymer defined herein will have a density of from about 0.88 to about 0.94 g/cm^3, preferably from about 0.88 to about 0.93 g/cm^3, and more preferably from about 0.88 to about 0.925 g/cm^3.

The average molecular weight of the copolymer can generally range from about 20,000 to about 500,000, preferably from about 50,000 to about 200,000. The molecular weight is determined by commonly used techniques such as size exclusion chromatography or gel permeation chromatography. The low polydispersity polymer should have a molecular weight distribution, or polydispersity, (M_w/M_n, "MWD") within the range of about 1 to about 4, preferably about 1.5 to about 4, more preferably about 2 to about 4, and even more preferably from about 2 to about 3. The ratio of the third moment to the second moment, M_z/M_w, is generally below about 2.3, preferably below about 2.0, and more typically in the range of from about 1.6 to about 1.95. The melt flow ratio (MFR) of these resins, defined as I_{20}/I_2 and as determined in accordance to ASTM D-1238, is generally from about 12 to about 22, preferably from about 14 to about 20, and more preferably from about 16 to about 18. The melt index (MI), defined as the I_2 value, should be in the range of from about 0.5 to about 10 g/10 min., preferably from about 1 to about 5 g/10 min. If additional resin materials are to be incorporated with the low polydispersity polymer, it is preferred to maintain the level of the low polydispersity polymer to at least about 60 weight percent of the inner polymeric layer.

Useful low polydispersity polymers are available from, among others, Dow Chemical Company and Exxon Chemical Company who are producers of single site or constrained geometry catalyzed polyethylenes. These resins are commercially available as the AFFINITY and EXXACT polyethylenes (see Plastics World, p.33–36, January 1995), and also as the ENHANCED POLYETHYLENE and EXCEED line of resins. The manufacture of such polyethylenes, generally by way of employing a metallocene catalyst system, is set forth in, among others, U.S. Pat. Nos. 5,382,631, 5,380,810, 5,358,792, 5,206,075, 5,183,867, 5,124,418, 5,084,534, 5,079,205, 5,032,652, 5,026,798, 5,017,655, 5,006,500, 5,001,205, 4,937,301, 4,925,821, 4,871,523, 4,871,705, and 4,808,561, each of which is incorporated

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