

POLYPROPYLENE FILM AND PROCESS FOR MAKING SAME

This invention relates to a polypropylene film and to a process for making the same. More particularly, the invention relates to an antifog agent coated, heat sealable polypropylene film structure that has good clarity, antifogging characteristics, and excellent heat sealability.

Polyolefin films are resistant to moisture upon prolonged contact with water. Among them, biaxially oriented polypropylene film is the most resistant to water vapour penetration. Consequently, when these films are employed to package refrigerated moisture-producing materials, particularly fresh produce, they cause moisture to condense on their inner surface thereby fogging the package and either eliminating or substantially reducing the visibility of the food.

While various approaches have provided various degrees of success in reducing fogging, they have not provided a film that provides a transparent, fog-resistant, film that may be readily heat-sealed to a variety of materials.

According to one aspect of the present invention there is provided a biaxially oriented film comprising a longitudinally oriented film containing polypropylene; and a coating layer of a polyglycerol ester or sorbitan ester of a fatty acid of 10 to 20 carbon atoms; wherein said coating layer is provided on a surface of said polyolefin-containing oriented film, prior to transverse orientation of the film, and wherein said coating layer is effective to reduce the fogging on said surface in the biaxially oriented film on exposure to water at a temperature below 10°C.

The film of the present invention may be readily heat-sealed to polymers, copolymers and terpolymers of olefins, to polyethylene, to paper and to itself. Thus, the present invention provides a significant advantage over the prior art in that it can be employed either alone or in conjunction with other materials to provide packages for refrigerated foods.

Preferably the fatty acid ester contains 12 to 18 carbon atoms, and is selected from the group consisting of lauric, palmitic, oleic and stearic acid.

In one embodiment polyolefin-containing film is a polypropylene homopolymer.

In another embodiment the polyolefin-containing film is a blend of a polypropylene homopolymer and another olefinic polymer.

In another embodiment the polypropylene-containing film is a coextrusion of a core layer of a polypropylene homopolymer and skin layer of another olefinic polymer, copolymer or terpolymer. In this embodiment it is preferred that the polypropylene-containing film comprises a coextrusion of a polypropylene homopolymer and an ethylene-propylene copolymer.

The skin layer, which is heat-sealable, may be provided on one or both sides of the core layer. The skin layer can be a high density polyethylene, an ethylene-propylene copolymer, an ethylene-propylene-butene terpolymer or any other ethylene copolymer. The skin layer can be homopolymers of ethylene or copolymers of ethylene with one or more C_3-C_{10} alpha-olefins. Thus, ethylene copolymers having one type of alpha-olefin monomeric units are possible, as well as terpolymers having ethylene and two types of alpha-olefin monomeric units. Particular examples of such polymers include ethylene/propylene copolymers,

ethylene/1-butene copolymers, ethylene/1-hexene copolymers, ethylene/1-octene copolymers, ethylene/4-methyl-1-pentene copolymers, ethylene/1-butene/1-hexene terpolymers, ethylene/propylene/1-hexene terpolymers and ethylene/propylene /1-butene terpolymers. The ethylene copolymers preferably contain at least about 80 percent by weight of ethylene units.

It is preferred that the polypropylene-containing film does not include non-olefinic polymers, such as polyethylene terephthalate and polyvinyl chloride.

The polypropylene-containing film may be part of a composite film wherein the polypropylene-containing film is laminated onto, or supported by, another film ply which may be a plastic, paper or metal film. In a particularly preferred embodiment, the composite film of the present invention is a laminate of the polypropylene-containing film and a olefin terpolymer. Alpha olefins which can be polymerized with ethylene to produce the terpolymers can contain 3 to 8 carbon atoms. Suitable alpha olefins include propylene, butene-1, pentene-1, hexene-1, 4-methylpentene-1, heptene-1 and octene-1. The preferred alpha olefin is hexene-1.

The antifog agent (ie the polyglycerol or sorbitan ester) can be either coated as an aqueous dispersion on a heat sealable skin layer of the film or compounded into the heat sealable skin resin prior to the film extrusion.

As noted above and in accordance with the invention, two modes of substantially eliminating polypropylene fogging characteristics with the coating layer esters may be undertaken. One involves the application of an aqueous dispersion of the ester to the film during orientation.

The proportion of the fatty acid ester in the dispersion can range from 1 to 10% by weight depending on the coating method employed. The coating layer can be applied as an aqueous dispersion composition, in which the dispersant comprises water. The use of water as the vehicle for dispersing the fatty acid ester minimizes cost while, at the same time, optimizes safety and minimizes environmental concerns. Those skilled in the art would be aware that organic solvents create the possibility of explosion, fire and environmental problems. These concerns are eliminated by the use of water.

Alternatively, the fatty acid ester can be compounded with components of the film prior to film extrusion and orientation. In this embodiment the fatty acid ester is preferably compounded into a skin layer prior to the film extrusion. As noted above, in a preferred embodiment the polypropylene is a core layer in a multilayer coextruded film, which contains a polypropylene core layer and at least one heat sealable skin layer on at least one side of the core layer. The amount of the fatty acid ester which is compounded is an amount to substantially eliminate fogging tendencies of the polypropylene. Practically, this amount ranges from 0.5 to 5 p. hr.

According to another aspect of the invention there is provided a process for making a thermoplastic film comprising orienting a film containing polypropylene in the longitudinal direction to form a monoaxially oriented film; coating said film with a layer of a polyglycerol ester or sorbitan ester of a fatty acid of 10 to 20 carbon atoms; and orienting said coated film in the transverse direction to form a biaxially oriented film.

Preferably the polypropylene-containing film comprises a first layer of a thermoplastic resin containing polypropylene and a second layer of a resin containing ethylene units; the first and second layers are coextruded prior to said longitudinal orientation; and the coating is disposed on said resin containing ethylene units.

The thermoplastic resin may be selected from the group consisting of a polypropylene homopolymer, a blend of a polypropylene homopolymer and another olefinic polymer, a coextrusion of a polypropylene homopolymer and another olefinic polymer and mixtures thereof.

Desirably the step of extruding said resin into a sheet comprises melting said polypropylene-containing resin; extruding said melt through a slit die; and casting said melt onto a cooling drum.

The film is preferably stretched in the longitudinal direction between substantially 3 and substantially 7 times its original length; and is preferably stretched in the transverse direction between substantially 6 times and substantially 10 times its original width.

Preferably the surface of the longitudinally stretched film is treated to improved surface wettability and adhesive prior to said coating step. In addition, or instead the uncoated side of said biaxially oriented film may have its surface treated to improve its wettability and adhesion.

Preferably the treatment constitutes a corona treatment.

After completion of the coating operation, but before the transverse orientation, the film is preferably subjected to heating to accelerate drying of the coating which, as is discussed below, is applied as

an aqueous dispersion or solution composition. Drying involves exposure of the film to elevated temperature. Depending upon the temperature employed in drying the coated monoaxially oriented film, the film may or may not be cooled or heated to obtain optimum temperature conditions during the next step, transverse orientation.

The coated biaxially oriented film is preferably annealed by exposing said film to elevated temperature. As in all heating steps, preferred temperatures are a function of the identity and constituency of the polypropylene-containing thermoplastic resin constituting the film.

Heat sealability of the resulting films can be measured by crimp seal strengths at 240, 260, and 280 °F (116, 127 and 138 °C) in terms of grams/cm. The sealer is set for 20 psi (138KPa) and 0.75 second dwell.

Antifog characteristics of the films are measured by a refrigeration fog test described as follows: Put 200 ml of water in a 600 ml beaker and cover with a sample of the test film. Place the beaker in a refrigerator at 4 °C. Observe and record the appearance of the film over a period of 14 days. Ratings 1 to 5 are given based on the antifog performance described below:

<u>Description</u>	<u>Performance</u>	<u>Rating</u>	<u>Comments</u>
An opaque layer of visibility fine fog droplets	very poor	1	near zero
An opaque layer of visibility large droplets	poor	2	low
A complete layer of visibility large transparent drops	fair	3	medium
Randomly scattered discontinuous film or of water parent drops	good	4	
A transparent film displaying no visible water drops	excellent	5	completely transparent

The following examples are given to illustrate the scope of the present invention. Because these examples are given for illustrative purposes only, the invention should not be limited thereto.

EXAMPLE 1

An aqueous dispersion containing 1.0% by weight of a sorbitan ester (Atmer 100 obtained from ICI Americas Inc.) was coated on a three-layer coextruded polypropylene film using a #8 Mayer rod on a pilot scale coater. The film comprises an ethylene-propylene-

butene-1 terpolymer skin layer as the side to be coated, a polypropylene homopolymer core layer, and another terpolymer skin layer at a weight ratio of 3/94/3. The film surface was treated with corona discharge immediately prior to the coating application for improved surface wettability.

The resultant coated film had good clarity, excellent heat sealability (126 g/cm at 280 °F {138 °C}), and excellent antifog characteristics (an antifog rating of 5), and a coefficient of friction of 0.39.

EXAMPLE 2

An aqueous dispersion containing 0.8% by weight of a sorbitan ester (Atmer 100 obtained from ICI Americas Inc.) was coated in a manner similar to that of Example 1 on the three-layer coextruded polypropylene film. The resultant coated film had good clarity, excellent heat sealability (124 g/cm at 280 °F {138°C}), and good antifog characteristics (an antifog rating of 4) and a coefficient of friction of 0.37.

EXAMPLE 3

An aqueous dispersion containing 1.0% by weight of sorbitan palmitate (Glycomul P obtained from Lonza Inc.) was coated in a manner similar to Example 1 on the three-layer coextruded polypropylene film. The resultant coated film had good clarity, good heat sealability, good antifog characteristics (an antifog rating of 4), and a coefficient of friction of 0.34.

EXAMPLE 4

An aqueous dispersion containing 4.0% by weight of a polyglycerol ester (Glycolube AFA-1 obtained from Lonza) was placed in a gravure coater, which was located between the machine direction (MD) orienter and

the transverse direction (TD) orienter of a pilot scale film orienter. An additive-free ethylene-propylene-butene-1 terpolymer skin resin (Sumitomo WS709N), a homopolymer core resin (Exxon 4252), and a terpolymer skin resin containing wax additives (Chisso 7703) were coextruded at a weight ratio of 3/94/3 through a flat sheet die at 250 C, cast onto a cooling drum and quenched at 30 C. The sheet, measured about 30 mil (0.76mm) thick, was reheated to 140 °C and stretched 5-fold in the MD, then corona treated for improved surface wettability. When passing through the gravure coater, the MD-oriented film web, now about 6 mil (0.15mm) thick, was coated on the additive-free terpolymer skin with the aqueous dispersion. The coated web was dried in pre-heat zones at 160 °C, then stretched 8-fold in the TD and annealed at 160 °C. The biaxially stretched film, measured 0.8 mil (0.02mm), may be corona treated on the uncoated side to improve the wettability and adhesion of inks and adhesives that might be applied later on. The resultant coated film had excellent antifog characteristics (an antifog rating of 5).

EXAMPLE 5

An aqueous dispersion containing 3.5% by weight of Glycolube AFA-1 was applied to an MD-oriented, three-layer coextruded polypropylene film in a manner similar to that of Example 4. The film is composed of a wax modified ethylene-propylene-butene-1 terpolymer skin resin (XPM 7880) as the side to be coated, a homopolymer core resin (Exxon 4252), and an ethylene-propylene resin containing antiblocking and slip additives (Fina 8573XA) at a weight ratio of 3/94/3. The resultant film had good antifog characteristics (an antifog rating of 4) and good heat

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seal strength (152 g/cm at 280 °F {138 °C} by crimp seal).

EXAMPLE 6

An aqueous dispersion containing 3.5% by weight of Glycolube AFA-1 and 0.25% by weight of sodium lauryl sulfate was applied to an MD-oriented, three-layer coextruded polypropylene film in the same manner as described in Example 4. The resultant film had good antifog characteristics (an antifog rating of 4) and good heat seal strength (150 g/cm at 280 °F {138 °C} by crimp seal).



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CLAIMS:

1. A biaxially oriented film comprising a longitudinally oriented film containing polypropylene; and a coating layer of a polyglycerol ester or sorbitan ester of a fatty acid of 10 to 20 carbon atoms; wherein said coating layer is provided on a surface of said polypropylene-containing film, prior to transverse orientation of the film, and wherein said coating layer is effective to reduce the fogging on said surface in the biaxially oriented film on exposure to water at a temperature below 10°C.
2. A film according to claim 1, wherein the fatty acid ester contains 12 to 18 carbon atoms.
3. A film according to claim 1, wherein the fatty acid is selected from the group consisting of lauric, palmitic, oleic and stearic acid.
4. A film according to claim 1, wherein said polypropylene-containing film is selected from the group consisting of a polypropylene homopolymer; a blend of polypropylene homopolymer and another olefin polymer; and a coextrusion of a polypropylene homopolymer and another olefin polymer, copolymer or terpolymer, which is preferably an ethylene-propylene copolymer.
5. A film according to claim 1, wherein the coating layer is provided as a lamina.
6. A film according to claim 1, wherein coating layer is provided as an aqueous dispersion.

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7. A film according to claim 4, wherein the coating layer is compounded into said other olefin of said coextrusion.

8. A process for making a thermoplastic film comprising orienting a film containing polypropylene in the longitudinal direction to form a monoaxially oriented film; coating said film with a layer of a polyglycerol ester or sorbitan ester of a fatty acid of 10 to 20 carbon atoms; and orienting said coated film in the transverse direction to form a biaxially oriented film.

9. A process according to claim 8, wherein said polypropylene-containing film comprises a first layer of a thermoplastic resin containing polypropylene and a second layer of a resin containing ethylene units; coextruding said first and second layers prior to said longitudinal orientation; and providing the coating on said resin containing ethylene units.

10. A process according to claim 8, wherein said thermoplastic resin is selected from the group consisting of a polypropylene homopolymer, a blend of a polypropylene homopolymer and another olefinic polymer, a coextrusion of a polypropylene homopolymer and another olefinic polymer and mixtures thereof.

11. A process according to claim 8, wherein said step of extruding said resin into a sheet comprises melting said polypropylene-containing resin; extruding said melt through a slit die; and casting said melt onto a cooling drum.

12. A process according to claim 8, wherein said step of longitudinally orienting said sheet into a film comprises stretching said cast sheet

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to between substantially 3 and substantially 7 times its original length.

13. A process according to claim 8, wherein said step of transversely orienting said coated film comprises stretching said longitudinally oriented film to between substantially 6 times and substantially 10 times its original width.

14. A process according to claim 8, comprising the step of treating the surface of the longitudinally stretched film to improved surface wettability and adhesive prior to said coating step, and/or the uncoated side of said biaxially oriented film is surface treated to improve its wettability and adhesion.

15. A process according to claim 14, wherein said surface treatment constitutes a corona treatment.

16. A process according to claim 8, comprising annealing said coated biaxially oriented film by exposing said film to elevated temperature.

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