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(71) Applicant: **Total Petrochemicals Research Feluy
7181 Seneffe (Feluy) (BE)**

(72) Inventor: **The designation of the inventor has not
yet been filed**

(74) Representative: **Selg, Peter
Total Petrochemicals Research Feluy
Patent Department
Zone Industrielle C
7181 Seneffe (Feluy) (BE)**

(54) **Polypropylene woven fabric**

(57)   The present application relates to a woven fabric comprising a yarn, said yarn in turn comprising filaments comprising a metallocene polypropylene. Further, the present application relates to articles comprising such a woven fabric. In addition, the present application relates to a process for the production of such woven fabric and to a process for the production of such articles comprising said woven fabric.

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Description

Field of the invention

[0001]   The present application relates to a woven fabric comprising a yarn, said yarn in turn comprising filaments comprising a metallocene polypropylene. Further, the present application relates to articles comprising such a woven fabric. In addition, the present application relates to a process for the production of such woven fabric and to a process for the production of such articles comprising said woven fabric.

The technical problem and the prior art

[0002]   Due to good mechanical and chemical properties in combination with good economics polypropylene has become the material of choice for a large number of applications, such as injection-molded cups and containers, biaxially oriented films (BOPP) and spunbonded nonwovens.

[0003]   Polypropylene has also been used in a number of applications, wherein fibers or yarns were used to produce woven fabrics. Such woven fabrics in turn have been used for example in undergarments or in bags and sacks for the transport and storage of bulk goods.

[0004]   For environmental reasons industry is more and more interested in reducing the weight of the woven fabric. There is therefore a need for improved woven fabrics, preferably with the added benefit of easier production of such woven fabrics.

[0005]   Thus, it is an object of the present application to provide a woven fabric that has improved properties.

[0006]   Particularly, it is an object of the present application to provide a woven fabric that has the same mechanical properties, such as for example tensile strength or elongation at yield or break, at lower weight than a conventional woven fabric.

[0007]   It is a further object of the present application to provide a yarn for use in the production of a woven fabric, said yarn being easily produced.

Brief description of the invention

[0008]   Any of the above objects may be achieved either alone or in combination by the woven fabric disclosed in the present application.

[0009]   Thus, the present application provides the woven fabric, which comprises yarn, said yarn in turn comprising filaments, said filaments in turn comprising a component A, said component A comprising a metallocene polypropylene

[0010]   Further, the present application provides an article comprising said woven fabric.

[0011]   Additionally, the present application provides a process for producing such woven fabric and a process for producing an article comprising such woven fabric.

Detailed description of the invention

[0012]   Throughout the present application the terms "polypropylene" and "propylene polymer" may be used synonymously.

[0013]   Throughout the present application the melt flow index of polypropylene and polypropylene compositions is determined according to ISO 1133, condition L, at 230°C and 2.16 kg.

[0014]   Throughout the present application the melt index of polyethylene and polyethylene compositions is determined according to ISO 1133, condition D, at a temperature of 190°C and a load of 2.16 kg.

[0015]   The present inventors have found that a woven fabric, which comprises a yarn, said yarn in turn comprising filaments, said filaments in turn comprising a component A, said component A comprising a metallocene polypropylene can fulfill at least one of the above-mentioned objectives.

[0016]   Preferably the filaments comprise a further component B, which covers at least 50 % of the surface of said filaments, more preferably at least 70 % or 80 %, even more preferably at least 90 % or 95 %, still even more preferably at least 99%, and most preferably component B covers the entire surface of the filaments, said component B comprising a metallocene polyethylene.

[0017]   It is preferred that component A comprises at least 50 wt%, relative to the total weight of component A, of a metallocene polypropylene, more preferably of at least 75 wt% or 90 wt%, even more preferably of at least 95 wt% or 97 wt%, and still even more preferably of at least 99 wt%. Most preferably, component A consists of the metallocene polypropylene.

[0018]   Component B preferably comprises at least 50 wt%, relative to the total weight of component B, of a metallocene polyethylene, more preferably of at least 75 wt% or 90 wt%, even more preferably of at least 95 wt% or 97 wt%, and

still even more preferably of at least 99 wt%. Most preferably, component B consists of a metallocene polyethylene.

[0019] By the terms "metallocene polypropylene" and "metallocene polyethylene", which in the following may also simply be referred to as "polypropylene" resp. "polyethylene", it is meant that the polypropylene resp. the polyethylene has been produced with a metallocene-based polymerization catalyst. The use of such a specific polymerization catalyst will also impart characteristics to the polypropylene resp. the polyethylene that clearly distinguish it from polypropylenes resp. polyethylenes produced with other types of polymerization catalysts, such as for example Ziegler-Natta polymerization catalysts, and in consequence also result in different processing behavior as well as different properties of the final article produced therewith.

POLYPROPYLENE

[0020] The polypropylene used herein preferably has a melt flow index of at least 5 dg/min, more preferably of at least 7 dg/min and most preferably of at least 10 dg/min. The polypropylene used herein preferably has a melt flow index of at most 100 dg/min, more preferably of at most 75 dg/min, even more preferably of at most 50 dg/min, still even more preferably of at most 40 dg/min, and most preferably of at most 30 dg/min.

[0021] Preferably, the polypropylene used herein has a molecular weight distribution (MWD), defined as M_w/M_n, i.e. the ratio of weight average molecular weight M_w over number average molecular weight M_n, of at least 1.0, more preferably of at least 1.5 and most preferably of at least 2.0. Preferably, the polypropylene used herein has a molecular weight distribution, defined as M_w/M_n, of at most 4.0, more preferably of at most 3.5, even more preferably of at most 3.0, and most preferably of at most 2.5. Molecular weights can be determined by size exclusion chromatography (SEC) as described in the examples.

[0022] Preferably, the polypropylene used herein is characterized by high isotacticity, for which the content of mmmm pentads is a measure. Preferably, the content of mmmm pentads is at least 90 %, more preferably at least 95 %, and most preferably at least 97 %. Isotacticity may be determined by ^{13}C-NMR analysis as described in the test methods.

[0023] Preferably, the polypropylene used herein is characterized by a low content of xylene solubles. Preferably, the polypropylene used herein has at most 3.0 wt% of xylene solubles, relative to the total weight of the polypropylene, more preferably at most 2.5 wt% and most preferably at most 2.0 wt%.

[0024] The polypropylene used herein preferably is a propylene homopolymer or a random copolymer of propylene and up 6.0 wt% of at least one comonomer, relative to the total weight of said random copolymer, though propylene homopolymer is preferred. The preferred random copolymer is a random copolymer of propylene and up to 5.0 wt%, more preferably up to 4.5 wt%, and most preferably up to 4.0 wt% of at least one comonomer, relative to the total weight of said random copolymer. The comonomer is different from propylene and preferably is an α-olefin having from one to 10 carbon atoms. Examples of suitable α-olefins are ethylene, butene-1, pentene-1, hexene-1, octene-1 and 3-methyl-pentene-1. The preferred comonomers are ethylene and butene-1. The most preferred comonomer is ethylene.

[0025] Preferably, the polypropylene used herein is characterized by a melting temperature T_{melt} of at most 160°C. The determination of melting temperatures is generally done by first heating to a temperature above the melting temperature, e.g. to 200°C, and keeping the sample at this temperature for a certain time, e.g. for 3 minutes, so as to erase the thermal history of the sample. After cooling the sample is then reheated for the measurement of the melting temperature. For the determination of the melting temperature T_{melt} the heating and cooling rate used herein is 20°C/min.

[0026] Preferably, the polypropylene used herein is characterized by a percentage of 2,1-insertions relative to the total number of propylene molecules in the polymer chain of at least 0.1 %. Preferably, the percentage of 2,1-insertions is at most 1.5 %, more preferably at most 1.3 %, even more preferably at most 1.2 %, still even more preferably at most 1.1 %, and most preferably at most 1.0 %. A detailed description on the determination of the percentage of 2,1-insertions is given in the description of the examples.

[0027] The polypropylene used herein may also comprise further additives, such as by way of example, antioxidants, light stabilizers, acid scavengers, lubricants, antistatic additives, and colorants. An overview of such additives may be found in Plastics Additives Handbook, ed. H. Zweifel, 5th edition, 2001, Hanser Publishers.

[0028] The polypropylene used herein is a metallocene polypropylene, i.e. it is produced with a metallocene-based polymerization catalyst, with the metallocene-based polymerization catalyst comprising a bridged metallocene component, a support and an activating agent. Such metallocene-based polymerization catalysts are generally known in the art and need not be explained in detail.

[0029] The metallocene component can be described by the following general formula
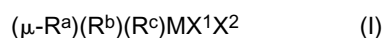
$$(\mu\text{-}R^a)(R^b)(R^c)MX^1X^2 \qquad (I)$$

wherein R^a, R^b, R^c, M, X^1 and X^2 are as defined below.

R^a is the bridge between R^b and R^c, i.e. R^a is chemically connected to R^b and R^c, and is selected from the group consisting of —$(CR^1R^2)_p$—, —$(SiR^1R^2)_p$—, — $(GeR^1R^2)_p$—, —$(NR^1)_p$—, —$(PR^1)_p$—, —$(N^+R^1R^2)_p$— and —

$(P^+R^1R^2)_p$—, and p is 1 or 2, and wherein R^1 and R^2 are each independently selected from the group consisting of hydrogen, C_1-C_{10} alkyl, C_5-C_8 cycloalkyl, C_6-C_{15} aryl, alkylaryl with C_1-C_{10} alkyl and C_6-C_{15} aryl, or any two neighboring R may form a cyclic saturated or non-saturated C_4-C_{10} ring; each R^1 and R^2 may in turn be substituted in the same way. Preferably R^a is —$(CR^1R^2)_p$— or —$(SiR^1R^2)_p$— with R^1, R^2 and p as defined above. Most preferably R^a is —$(SiR^1R^2)_p$— with R^1, R^2 and p as defined above. Specific examples of R^a include Me_2C, ethanediyl ($-CH_2-CH_2-$), Ph_2C and Me_2Si.

[0030] M is a metal selected from Ti, Zr and Hf, preferably it is Zr.

[0031] X^1 and X^2 are independently selected from the group consisting of halogen, hydrogen, C_1-C_{10} alkyl, C_6-C_{15} aryl, alkylaryl with C_1-C_{10} alkyl and C_6-C_{15} aryl. Preferably X^1 and X^2 are halogen or methyl.

[0032] R^b and R^c are selected independently from one another and comprise a cyclopentadienyl ring.

[0033] Preferred examples of halogen are Cl, Br, and I. Preferred examples of C_1-C_{10} alkyl are methyl, ethyl, n-propyl, iso-propyl, n-butyl, iso-butyl, and tert-butyl. Preferred examples of C_5-C_7 cycloalkyl are cyclopentyl, cyclohexyl, cycloheptyl and cyclooctyl. Preferred examples of C_6-C_{15} aryl are phenyl and indenyl. Preferred examples of alkylaryl with C_1-C_{10} alkyl and C_6-C_{15} aryl are benzyl ($-CH_2-Ph$), and $-(CH_2)_2-Ph$.

[0034] Preferably, R^b and R^c may both be substituted cyclopentadienyl, or may be independently from one another unsubstituted or substituted indenyl or tetrahydroindenyl, or R^b may be a substituted cyclopentadienyl and R^c a substituted or unsubstituted fluorenyl. More preferably, R^b and R^c may both be the same and may be selected from the group consisting of substituted cyclopentadienyl, unsubstituted indenyl, substituted indenyl, unsubstituted tetrahydroindenyl and substituted tetrahydroindenyl. By "unsubstituted" is meant that all positions on R^b resp. R^c, except for the one to which the bridge is attached, are occupied by hydrogen. By "substituted" is meant that, in addition to the position at which the bridge is attached, at least one position on R^b resp. R^c is occupied by a substituent other than hydrogen.

[0035] A substituted cyclopentadienyl may for example be represented by the general formula $C_5R^3R^4R^5R^6$. A substituted indenyl may for example be represented by the general formula $C_9R^7R^8R^9R^{10}R^{11}R^{12}R^{13}R^{14}$. A substituted 4,5,6,7-tetrahydroindenyl may for example be represented by the general formula $C_9H_8R^{15}R^{16}R^{17}R^{18}$. A substituted fluorenyl may for example be represented by the general formula $C_{13}R^{19}R^{20}R^{21}R^{22}R^{23}R^{24}R^{25}R^{26}$. Each of the substituents R^3 to R^{26} may be independently selected from the group consisting of hydrogen, C_1-C_{10} alkyl, C_5-C_7 cycloalkyl, C_6-C_{15} aryl, and alkylaryl with C_1-C_{10} alkyl and C_6-C_{15} aryl, or any two neighboring R may form a cyclic saturated or non-saturated C_4-C_{10} ring; provided, however, that not all substituents simultaneously are hydrogen.

[0036] Preferred metallocene components are those having C_2-symmetry or those having C_1-symmetry. Most preferred are those having C_2-symmetry.

[0037] Particularly suitable metallocene components are those wherein R^b and R^c are the same and are substituted cyclopentadienyl, preferably wherein the cyclopentadienyl is substituted in the 2-position, the 3-position, or simultaneously the 2-position and the 3-position.

[0038] Particularly suitable metallocene components are also those wherein R^b and R^c are the same and are selected from the group consisting of unsubstituted indenyl, unsubstituted tetrahydroindenyl, substituted indenyl and substituted tetrahydroindenyl. Substituted indenyl is preferably substituted in the 2-position, the 3-position, the 4-position, the 5-position or any combination of these, more preferably in the 2-position, the 4-position or simultaneously in the 2-position and the 4-position. Substituted tetrahydroindenyl is preferably substituted in the 2-position, the 3-position, or simultaneously the 2-position and the 3-position.

[0039] Particularly suitable metallocene components may also be those wherein R^b is a substituted cyclopentadienyl and R^c is a substituted or unsubstituted fluorenyl. The substituted cyclopentadienyl is preferably substituted in the 2-position, the 3-position, the 5-position or simultaneously any combination of these, more preferably in the 3-position or the 5-position or both simultaneously, most preferably in the 3-position only, with a bulky substituent. Said bulky substituent may for example be $-CR^{27}R^{28}R^{29}$ or $-SiR^{27}R^{28}R^{29}$ with R^{27}, R^{28} and R^{29} independently selected from group consisting of C_1-C_{10} alkyl, C_5-C_7 cycloalkyl, C_6-C_{15} aryl, and alkylaryl with C_1-C_{10} alkyl and C_6-C_{15} aryl, or any two neighboring R may form a cyclic saturated or non-saturated C_4-C_{10} ring. it is preferred that R^{27}, R^{28} and R^{29} are methyl.

[0040] Examples of particularly suitable metallocenes are:

dimethylsilanediyl-bis(2-methyl-cyclopentadienyl)zirconium dichloride,
dimethylsilanediyl-bis(3-methyl-cyclopentadienyl)zirconium dichloride,
dimethylsilanediyl-bis(3-tert-butyl-cyclopentadienyl)zirconium dichloride,
dimethylsilanediyl-bis(3-tert-butyl-5-methyl-cyclopentadienyl)zirconium dichloride,
dimethylsilanediyl-bis(2,4-dimethyl-cyclopentadienyl)zirconium dichloride,
dimethylsilanediyl-bis(indenyl)zirconium dichloride,
dimethylsilanediyl-bis(2-methyl-indenyl)zirconium dichloride,
dimethylsilanediyl-bis(3-methyl-indenyl)zirconium dichloride,
dimethylsilanediyl-bis(3-tert-butyl-indenyl)zirconium dichloride,
dimethylsilanediyl-bis(4,7-dimethyl-indenyl)zirconium dichloride,
dimethylsilanediyl-bis(tetrahydroindenyl)zirconium dichloride,

dimethylsilanediyl-bis(benzindenyl)zirconium dichloride,
dimethylsilanediyl-bis(3,3'-2-methyl-benzindenyl)zirconium dichloride,
dimethylsilanediyl-bis(4-phenyl-indenyl)zirconium dichloride,
ethanediyl-bis(indenyl)zirconium dichloride,
ethanediyl -bis(tetrahydroindenyl)zirconium dichloride,
isopropylidene-(3-tert-butyl-cyclopentadienyl)(fluorenyl) zirconium dichloride
isopropylidene-(3-tert-butyl-5-methyl-cyclopentadienyl)(fluorenyl) zirconium dichloride.

[0041] The metallocene may be supported according to any method known in the art. In the event it is supported, the support used herein may be any organic or inorganic solid, particularly porous supports such as talc, inorganic oxides, and resinous support material such as polyolefin. Preferably, the support material is an inorganic oxide in its finely divided form.

[0042] The polymerization of propylene and one or more comonomers in presence of a metallocene-based catalytic system can be carried out according to known techniques in one or more polymerization reactors. The metallocene polypropylene used in the present invention is preferably produced by polymerization in liquid propylene at temperatures in the range from 20°C to 100°C. Preferably, temperatures are in the range from 60°C to 80°C. The pressure can be atmospheric or higher. It is preferably between 25 and 50 bar. The molecular weight of the polymer chains, and in consequence the melt flow of the metallocene polypropylene, is regulated by the addition of hydrogen to the polymerization medium.

POLYETHYLENE

[0043] The polyethylene preferably is a homopolymer of ethylene or a copolymer of ethylene and at least one comonomer, said comonomer being a C_3 to C_{10} alpha-olefin, such as 1-butene, 1-pentene, 1-hexene, 1-octene, 1-methylpentene, with 1-butene and 1-hexene being the preferred comonomers and 1-hexene being the most preferred comonomer.

[0044] Preferably, the polyethylene used herein has a molecular weight distribution (MWD), defined as M_w/M_n, in the range from 2 to 7, and most preferably in the range from from 2 to 5. Molecular weights can be determined by size exclusion chromatography (SEC) as described in the examples.

[0045] Preferably, the polyethylene has a melt index in the range of at least 1 dg/min, preferably of at least 5 dg/min, even more preferably of at least 7 dg/min, still even more preferably at least 10 dg/min, and most preferably of at least 20 dg/min. Preferably, the polyethylene has a melt index of at most 150 dg/min, more preferably of at most 100 dg/min, even more preferably of at most 75 dg/min and most preferably of at most 50 dg/min.

[0046] Preferably, the polyethylene has a density of at least 0.920 g/cm^3, more preferably of at least 0.925 g/cm^3, even more preferably of at least 0.927 g/cm^3, still even more preferably of at least 0.930 g/cm^3, and most preferably of at least 0.932 g/cm^3. It has a density of at most 0.965 g/cm^3, preferably of at most 0.955 g/cm^3, more preferably of at most 0.950 g/cm^3, even more preferably of at most 0.945 g/cm^3, and most preferably of at most 0.940 g/cm^3. The density is measured at 23°C following the method described in ASTM D 1505.

[0047] The polyethylene used herein is a metallocene polyethylene, i.e. it is a polyethylene produced with a metallocene-based polymerization catalyst, with the metallocene-based polymerization catalyst comprising a metallocene component, a support and an activating agent. Such metallocene-based polymerization catalysts are generally known in the art and need not be explained in detail.

[0048] The metallocene component can be described by the following general formula

$$(\mu\text{-}R^a)_n(R^b)(R^c)MX^1X^2 \qquad (II)$$
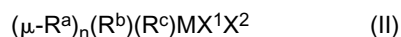
wherein
n = 0 or 1, and R^a is the bridge, i.e. n = 1, between R^b and R^c, i.e. R^a is chemically connected to R^b and R^c, and is selected from the group consisting of —$(CR^1R^2)_p$—, —$(SiR^1R^2)_p$—, —$(GeR^1R^2)_p$—, —$(NR^1)_p$—, —$(PR^1)_p$—, —$(N^+R^1R^2)_p$— and —$(P^+R^1R^2)_p$—, and p is 1 or 2, and wherein R^1 and R^2 are each independently selected from the group consisting of hydrogen, C_1-C_{10} alkyl, C_5-C_8 cycloalkyl, C_6-C_{15} aryl, alkylaryl with C_1-C_{10} alkyl and C_6-C_{15} aryl, or any two neighboring R may form a cyclic saturated or non-saturated C_4-C_{10} ring; each R^1 and R^2 may in turn be substituted in the same way. Preferably R^a is —$(CR^1R^2)_p$— or —$(SiR^1R^2)_p$— with R^1, R^2 and p as defined above. Most preferably R^a is —$(CR^1R^2)p$— with R^1, R^2 and p as defined above. Specific examples of R^a include Me_2C, ethanediyl (-CH_2-CH_2-), Ph_2C and Me_2Si.

[0049] M is a metal selected from Ti, Zr and Hf, preferably it is Zr.

[0050] X^1 and X^2 are independently selected from the group consisting of halogen, hydrogen, C_1-C_{10} alkyl, C_6-C_{15} aryl, alkylaryl with C_1-C_{10} alkyl and C_6-C_{15} aryl. Preferably X^1 and X^2 are halogen or methyl.

[0051] R^b and R^c are selected independently from one another and comprise a cyclopentadienyl ring.

[0052] Preferred examples of halogen are Cl, Br, and I. Preferred examples of C_1-C_{10} alkyl are methyl, ethyl, n-propyl, iso-propyl, n-butyl, iso-butyl, and tert-butyl. Preferred examples of C_5-C_7 cycloalkyl are cyclopentyl, cyclohexyl, cyclohep-tyl and cyclooctyl. Preferred examples of C_6-C_{15} aryl are phenyl and indenyl. Preferred examples of alkylaryl with C_1-C_{10} alkyl and C_6-C_{15} aryl are benzyl (-CH_2-Ph), and -(CH_2)$_2$-Ph.

[0053] It is, however, preferred to use a metallocene component of the following general formula, wherein

- n is 1;
- R^a is —(CR^1R^2)$_p$— or —(SiR^1R^2)$_p$—, most preferably R^a is —(CR^1R^2)$_p$— with R^1, R^2 and p as defined above;
- M is a metal selected from Ti, Zr and Hf, preferably it is Zr;
- X^1 and X^2 are the same and are halogen or methyl, preferably chlorine or methyl, and most preferably chlorine; and
- R^b and R^c are selected independently from one another and comprise an indenyl or tetrahydroindenyl.

[0054] Preferably, the indenyl or tetrahydroindenyl, if substituted, is symmetrically substituted in positions 2 and/or 4, and more preferably they are unsubstituted.

[0055] Examples of particularly suitable metallocene components include the following: bis(n-butylcyclopentadienyl) zirconium dichloride,
ethanediyl-bis(1-indenyl)zirconium dichloride,
ethanediyl-bis(2-methyl-1-indenyl)zirconium dichloride,
ethanediyl-bis(4-methyl-1-indenyl)zirconium dichloride,
ethanediyl-bis(4,5,6,7-tetrahydro-1-indenyl)zirconium dichloride.

[0056] The polymerization of ethylene and optionally one or more comonomers in presence of a metallocene-based polymerization catalyst can be carried out according to known techniques in one or more polymerization reactors. The metallocene polyethylene used herein is preferably produced by polymerization in a liquid diluent, which is inert under polymerization conditions, such as an alkane, at temperatures in the range from 20°C to 100°C. Preferably, temperatures are in the range from 60°C to 80°C. The pressure can be atmospheric or higher. It is preferably between 25 and 50 bar. The molecular weight of the polymer chains, and in consequence the melt index of the metallocene polyethylene, is controlled by the addition of hydrogen to the polymerization medium.

YARN AND WOVEN FABRIC

[0057] The yarn comprising filaments, said filaments in turn comprising a component A as defined above, is produced by commonly known production methods, such as for example described in Polypropylene Handbook, ed. Nello Pasquini, 2nd edition, Hanser, 2005, pages 397-403, by

    (a) providing a polymer blend comprising a metallocene polypropylene,
    (b) feeding the polymer blend of step (a) to an extruder,
    (c) subsequently melt-extruding the polymer blend to obtain a molten polymer stream,
    (d) extruding the molten polymer stream of step (c) from a number of fine capillaries of a spinneret, thus obtaining filaments of molten polymer,
    (e) cooling the filaments obtained in step (d) to form solidified filaments, and
    (f) combining a number of the solidified filaments of step (e) to form a yarn.

[0058] Generally, a polymer blend comprising a metallocene polypropylene as defined above is provided, and then fed to an extruder. In the extruder the polymer blend is melt-extruded, i.e. extruded at a temperature above its melting temperature, thus obtaining a molten polymer stream. Preferably, the melt-extrusion is done at a temperature of the molten polymer blend in the range from 200 °C to 300 °C, more preferably in the range from 220 °C to 280 °C. Subsequently, the molten polymer stream is extruded from a number of fine capillaries of a spinneret, thus obtaining filaments of molten polymer. Alternatively, the molten polymer stream may pass through a manifold to direct the flow of molten polymer stream to more than one spinneret, for example to between 4 and 20 spinnerets. Optionally, the molten polymer stream may pass through a gear pump and/or a filter pack before each spinneret. Each spinneret has a number, preferably from 20 to 500, of fine capillaries, which for example may have a diameter from 0.2 mm to 1.0 mm.. The capillaries may be for example circular, triangular, trilobal, tetralobal, or cross-shaped. the filaments of molten polymer are cooled to form solidified filaments, which may optionally be drawn. A number of solidified filaments is then combined to form a yarn. Preferably, the solidified filaments obtained in step (e) have a titer in the range from 1 dtex to 100 dtex, preferably from 2 dtex to 90 dtex and most preferably from 5 dtex to 80 dtex. A number of filaments is combined to form a yarn.

[0059] Preferably, the yarn has a titer in the range from 10 dtex to 2000 dtex. For some applications the yarn might even have an even higher denier. Spinning speeds, i.e. the speed at which the solidified filaments are withdrawn before any optional drawing, may for example be in the range from 300 m/min to 6000 m/min.

[0060] The production of the yarn comprising filaments, said filaments in turn comprising a component A and a component B as defined above are produced by

(a1) providing a first polymer blend comprising a metallocene polypropylene,
(a2) providing a second polymer blend comprising a metallocene polyethylene,
(b1) providing the first polymer blend of step (a1) to a first extruder,
(b2) providing the second polymer blend of step (a2) to a second extruder,
(c1) melt-extruding the first polymer blend of step (a1) through a number of fine capillaries of a spinneret,
(c2) melt-extruding the second polymer blend of step (a2) through a number of fine openings surrounding said capillaries of step (c1),
(d) combining the extrudates of steps (c1) and (c2) to form single filaments of molten polymer,
(e) cooling the filaments obtained in step (d) to form solidified filaments, and
(f) combining a number of solidified filaments of step (e) to form a yarn.

[0061] In a further step the yarn is used to produce the woven fabric by weaving methods well-known to the person skilled in the art.
[0062] The woven fabrics described above are characterized by improved mechanical properties, such as increased tensile strength and elongation, with respect to woven fabrics of the same basis weight produced with yarns of the same specifications, i.e. same number of filaments and same titer. In addition, these woven fabrics show increased cohesion of the woven fabric under changing load, i.e. they have an increased life time, for example when used as sacks and bags. Additionally, the yarns used in the production of the woven fabric can be produced at higher spinning speeds, thus rendering their production more economic. The woven fabrics as described herein are also characterized by lower volatiles content and by lower extractibles content.
[0063] Woven fabrics comprising filaments, which in turn comprise a component A and a component B as defined above, are also found to have superior softness as well as improved UV-stability. In addition, the filaments, and in consequence the yarn and woven fabrics, show reduced abrasion and thus can be more easily processed.
[0064] The woven fabric in turn is used to produce articles such as for examples bags and sacks of various sizes; nets and netting, such as for example fishing nets or anti-insect netting (commonly also referred to as "mosquito nets"); clothing, such as undergarments, socks, liners, sportswear; drapes; woven belts and straps, such as lifting straps; and upholstery for furniture and car seats.

Examples

TEST METHODS

[0065] Melt flow index of polypropylene and polypropylene compositions is determined according to ISO 1133, condition L, at 230°C and 2.16 kg.
[0066] Molecular weights are determined by Size Exclusion Chromatography (SEC) at high temperature (145°C). A 10 mg PP sample is dissolved at 160°C in 10 ml of trichlorobenzene (technical grade) for 1 hour. Analytical conditions for the GPCV 2000 from WATERS are :

- Injection volume: +/- 400 μl
- Concentration of injected sample: 1 mg ml^{-1}
- Automatic sample preparation and injector temperature: 160°C
- Column temperature: 145°C
- Detector temperature: 160°C
- Column set: 2 Shodex AT-806MS and 1 Styragel HT6E
- Flow rate: 1 ml/min
- Detector: Infrared detector (2800-3000 cm^{-1})
- Calibration: Narrow standards of polystyrene (commercially available)
- Calculation for polypropylene: Based on Mark-Houwink relation ($\log_{10}(M_{PP}) = \log_{10}(M_{PS}) - 0.25323$); cut off on the low molecular weight end at $M_{PP} = 1000$.
- Calculation for polyethylene: Based on Mark-Houwink relation ($\log_{10}(M_{PE}) = 0.965909 \cdot \log_{10}(M_{PS}) - 0.28264$); cut off on the low molecular weight end at $M_{PE} = 1000$.

[0067] The molecular weight distribution (MWD) is then calculated as M_w/M_n.
[0068] Xylene solubles (XS), i.e. the xylene soluble fraction, are determined as follows: Between 4.5 and 5.5 g of propylene polymer are weighed into a flask and 300 ml xylene are added. The xylene is heated under stirring to reflux

for 45 minutes. Stirring is continued for 15 minutes exactly without heating. The flask is then placed in a thermostat bath set to 25°C +/- 1°C for 1 hour. The solution is filtered through Whatman n° 4 filter paper and exactly 100 ml of solvent are collected. The solvent is then evaporated and the residue dried and weighed. The percentage of xylene solubles ("XS"), i.e. the amount of the xylene soluble fraction, is then calculated according to

XS (in wt%) = (Weight of the residue / Initial total weight of PP) * 300 with all weights being in the same unit, such as for example in grams.

[0069]   The ^{13}C-NMR analysis is performed using a 400 MHz Bruker NMR spectrometer under conditions such that the signal intensity in the spectrum is directly proportional to the total number of contributing carbon atoms in the sample. Such conditions are well known to the skilled person and include for example sufficient relaxation time etc. In practice the intensity of a signal is obtained from its integral, i.e. the corresponding area. The data is acquired using proton decoupling, 4000 scans per spectrum, a pulse repetition delay of 20 seconds and a spectral width of 26000 Hz. The sample is prepared by dissolving a sufficient amount of polymer in 1,2,4-trichlorobenzene (TCB, 99%, spectroscopic grade) at 130°C and occasional agitation to homogenize the sample, followed by the addition of hexadeuterobenzene (C_6D_6, spectroscopic grade) and a minor amount of hexamethyldisiloxane (HMDS, 99.5+ %), with HMDS serving as internal standard. To give an example, about 200 mg of polymer are dissolved in 2.0 ml of TCB, followed by addition of 0.5 ml of C_6D_6 and 2 to 3 drops of HMDS.

[0070]   Following data acquisition the chemical shifts are referenced to the signal of the internal standard HMDS, which is assigned a value of 2.03 ppm.

[0071]   The isotacticity is determined by ^{13}C-NMR analysis on the total polymer. In the spectral region of the methyl groups the signals corresponding to the pentads mmmm, mmmr, mmrr and mrrm are assigned using published data, for example A. Razavi, Macromol. Symp., vol. 89, pages 345-367. Only the pentads mmmm, mmmr, mmrr and mrrm are taken into consideration due to the weak intensity of the signals corresponding to the remaining pentads. For the signal relating to the mmrr pentad a correction is performed for its overlap with a methyl signal related to 2,1-insertions. The percentage of mmmm pentads is then calculated according to

$$\% \text{ mmmm} = \text{AREA}_{\text{mmmm}} \ / \ (\text{AREA}_{\text{mmmm}} + \text{AREA}_{\text{mmmr}} + \text{AREA}_{\text{mmrr}} + \text{AREA}_{\text{mrrm}}) \cdot 100$$

[0072]   Determination of the percentage of 2,1-insertions for a metallocene propylene homopolymer: The signals corresponding to the 2,1-insertions are identified with the aid of published data, for example H.N. Cheng, J. Ewen, Makromol. Chem., vol. 190 (1989), pages 1931-1940. A first area, AREA1, is defined as the average area of the signals corresponding to 2,1-insertions. A second area, AREA2, is defined as the average area of the signals corresponding to 1,2-insertions. The assignment of the signals relating to the 1,2-insertions is well known to the skilled person and need not be explained further. The percentage of 2,1-insertions is calculated according to

$$2,1\text{-insertions (in \%)} = \text{AREA1} / (\text{AREA1} + \text{AREA2}) \cdot 100$$

with the percentage in 2,1-insertions being given as the molar percentage of 2,1-inserted propylene with respect to total propylene.

[0073]   The determination of the percentage of 2,1-insertions for a metallocene random copolymer of propylene and ethylene is determined by two contributions:

(i) the percentage of 2,1-insertions as defined above for the propylene homopolymer, and
(ii) the percentage of 2,1-insertions, wherein the 2,1-inserted propylene neighbors an ethylene,

thus the total percentage of 2,1-insertions corresponds to the sum of these two contributions. The assignments of the signal for case (ii) can be done either by using reference spectra or by referring to the published literature.

[0074]   Melting temperatures T_{melt} were measured on a DSC Q2000 instrument by TA Instruments based on ISO 3146. To erase the thermal history the samples were first heated to 200°C and kept at 200°C for a period of 3 minutes. The reported melting temperatures T_{melt} were then determined with heating and cooling rates of 20°C/min.

[0075]   Filament tenacity and elongation were measured on a Lenzing Vibrodyn according to norm ISO 5079:1995 with a testing speed of 10 mm/min.

PRODUCTION OF YARN

Example

[0076]   A commercially available metallocene propylene homopolymer, produced with a metallocene polymerization catalyst comprising dimethylsilyl-bridged bis(indenyl)zirconium dichloride as metallocene component, said metallocene polypropylene having a melt flow index of 25 dg/min, a molecular weight distribution, defined as M_w/M_n, of 2.8, a melting temperature of 152 °C and 0.8 % of 2,1-insertions, was spun into filaments on a Busschaert pilot line equipped with two circular dies of 112 holes, each of a diameter of 0.5 mm. Melt temperature was kept at 250 °C. Throughput per hole was kept constant at 0.5 g/hole/min. Take-up speed was kept at 1700 m/min. No additional drawing step was performed. Properties were then determined on single filaments and are reported in table 1.

Comparative example

[0077]   A commercially available propylene homopolymer, produced with a Ziegler-Natta catalyst, said propylene homopolymer having a melt flow index of 25 dg/min, a molecular weight distribution, defined as M_w/M_n, of 4.1, a melting temperature of 162 °C and no 2,1-insertions, was spun into filaments as described in the example above. Properties were determined on single filaments and are reported in table 1

Table 1

		Example	Comparative example
Fiber titer	dtex	2.9	3.0
Tenacity at F_{max}	cN/tex	25.5	19.5
Elongation at break	%	198	222

PRODUCTION OF WOVEN FABRIC

[0078]   The yarn obtained as described above may be woven on a 1 m wide ribbon loom. The thus obtainable woven fabrics are expected to have excellent mechanical properties, particularly tensile strength. They are also expected to be characterized by good softness and good draping behavior.

Claims

1. Woven fabric, which comprises yarn, said yarn in turn comprising filaments, said filaments in turn comprising a component A, said component A comprising a metallocene polypropylene.

2. Woven fabric according to claim 1, wherein the metallocene polypropylene has a molecular weight distribution, defined as M_w/M_n, of at least 1.0 and of at most 4.0.

3. Woven fabric according to any of the preceding claims, wherein the metallocene polypropylene has a melt flow index in the range from 5.0 dg/min to 50 dg/min as determined in accordance with ISO 1133, condition L, at 230°C and 2.16 kg.

4. Woven fabric according to any of the preceding claims, wherein the metallocene polypropylene is a propylene homopolymer or a random copolymer of propylene and up to 6.0 wt%, relative to the total weight of said random copolymer, of at least one further alpha-olefin, said at least one further alpha-olefin being different from propylene.

5. Woven fabric according to any of the preceding claims, wherein the metallocene polypropylene has a melting temperature of at most 160°C.

6. Woven fabric according to any of the preceding claims, wherein the metallocene polypropylene has at least 0.1 % and at most 1.5 % of 2,1 - insertions.

7. Woven fabric according to any of the preceding claims, wherein the filaments comprise a further component B,

which covers at least 50 % of the surface of said filaments, said component B comprising a metallocene polyethylene.

8. Article comprising the woven fabric of any of claims 1 to 7.

9. Article according to claim 8, wherein the article is selected from the group consisting of bags, sacks, nets, netting, clothing, drapes, woven belts, woven straps and upholstery.

10. Process for the production of the woven fabric of claims 1 to 6, said process comprising the steps of

> (a) providing a polymer blend comprising a metallocene polypropylene,
> (b) feeding the polymer blend of step (a) to an extruder,
> (c) subsequently melt-extruding the polymer blend to obtain a molten polymer stream,
> (d) extruding the molten polymer stream of step (c) from a number of fine capillaries of a spinneret, thus obtaining filaments of molten polymer,
> (e) cooling the filaments obtained in step (d) to form solidified filaments,
> (f) combining a number of the solidified filaments of step (e) to form a yarn, and
> (g) using the yarn obtained in step (f) to form a woven fabric.

11. Process for the production of the woven fabric of claim 7, said process comprising the steps of

> (a1) providing a first polymer blend comprising a metallocene polypropylene,
> (a2) providing a second polymer blend comprising a metallocene polyethylene,
> (b1) providing the first polymer blend of step (a1) to a first extruder,
> (b2) providing the second polymer blend of step (a2) to a second extruder,
> (c1) melt-extruding the first polymer blend of step (a1) through a number of fine capillaries of a spinneret,
> (c2) melt-extruding the second polymer blend of step (a2) through a number of fine openings surrounding said capillaries of step (c1),
> (d) combining the extrudates of steps (c1) and (c2) to form single filaments of molten polymer,
> (e) cooling the filaments obtained in step (d) to form solidified filaments,
> (f) combining a number of solidified filaments of step (e) to form a yarn, and
> (g) using the yarn obtained in step (f) to form a woven fabric.

12. Process according to claim 10 or claim 11, wherein the metallocene polypropylene is further defined as given in any of claims 1 to 6.

13. Process according to claim 10 or claim 11, wherein the woven fabric of step (g) is used in to manufacture an article comprising said woven fabric.

14. Process according to claim 13, wherein the article is selected from the group consisting of bags, sacks, nets, netting, clothing, drapes, woven belts, woven straps and upholstery.

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EUROPEAN SEARCH REPORT

Application Number

EP 10 18 0867

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	JP 2003 138427 A (JAPAN POLYCHEM CORP) 14 May 2003 (2003-05-14) * abstract * * examples * -----	1-6, 8-10, 12-14	INV. D03D15/00 D01F6/06 D01F6/46 D01F8/06
X	WO 95/32091 A1 (EXXON CHEMICAL PATENTS INC [US]) 30 November 1995 (1995-11-30) * page 5, line 29 - line 36 * * page 8, line 33 - page 9, line 7 * * page 13, line 1 - line 24 * * example 5 * -----	1-6, 8-10, 12-14	
X	DATABASE WPI Week 200414 Thomson Scientific, London, GB; AN 2004-136226 XP002627235 -& JP 2003 138428 A (JAPAN POLYCHEM CORP) 14 May 2003 (2003-05-14) * abstract *	1-6, 8-10, 12-14	
Y	* paragraph [0022] * * paragraph [0049] * -----	7,11	**TECHNICAL FIELDS SEARCHED (IPC)** D01F D03D
Y	JP 11 140766 A (OJI PAPER CO) 25 May 1999 (1999-05-25) * abstract * * paragraph [0016] - paragraph [0017] * * paragraph [0079] * -----	7,11	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	9 March 2011	Fiocco, Marco

EPO FORM 1503 03.82 (P04C01)

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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.** EP 10 18 0867

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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09-03-2011

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
JP 2003138427	A	14-05-2003	NONE		
WO 9532091	A1	30-11-1995	CA	2191124 A1	30-11-1995
			CN	1157591 A	20-08-1997
			EP	0760744 A1	12-03-1997
			JP	10502975 T	17-03-1998
			US	5726103 A	10-03-1998
			US	5763080 A	09-06-1998
JP 2003138428	A	14-05-2003	NONE		
JP 11140766	A	25-05-1999	NONE		

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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Non-patent literature cited in the description

- Plastics Additives Handbook. Hanser Publishers, 2001 **[0027]**
- Polypropylene Handbook. Hanser, 2005, 397-403 **[0057]**
- **A. RAZAVI.** *Macromol. Symp.,* vol. 89, 345-367 **[0071]**
- **H.N. CHENG ; J. EWEN.** *Makromol. Chem.,* vol. 190, 1931-1940 **[0072]**