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(54) Title: PROPYLENE-BASED TERPOLYMERS FOR FIBERS

(57) Abstract: A fiber comprising a terpolymer containing propylene, ethylene and an alpha olefin of formula CH2=CHZ wherein Z is an hydrocarbon group having from 2 to 10 carbon atoms, wherein: (i) the content of ethylene derived units ranges from 0.5 wt% to 5.0 wt%; (ii) the content of alpha olefin derived units ranges from 1.0 wt% to 5.0 wt%; (iii) the amount (Wt%) of alpha-olefin (C6), the amount (Wt%) of ethylene (C2) and the melting point (Tm) of the terpolymer fulfil the following relation: Tm>157-6*(C2+0.8C6) (iv) the melt flow rate (MFR) (ISO 1133 230°C, 2.16 kg) ranges from 10 to 100 g/10 min.

Propylene-based terpolymers for fibers

The present invention relates to fibers, including fibrils and cut filaments (staple fibers), made of propylene/ethylene/alpha-olefins terpolymers particularly fit for their production. In particular, it relates to fibers made of propylene/ethylene/1-hexene terpolymers.

The fibers of the present invention are particularly adequate for use in applications where a good balance of tenacity and elongation at break is required. In particular, the fibers of the present invention are specifically suitable for the manufacture of spunbonded non-woven fabrics.

Fibers comprising copolymers of propylene with a low content of 1-hexene are known in the art.

For example, international patent application WO-A1-2005/059210 discloses fibers for thermal bonding applications made of semicrystalline random copolymers of propylene with 1-hexene having a low degree of modification of the polymer. The amount of 1-hexene ranges from 1.5 to less than 3 wt% with respect to the total weight of the copolymer. The said copolymers possess a value of melt flow rate (MFR) ranging from 4 to 35 g/10 min, preferably from 8 to 20 g/10 min. No terpolymers examples have been reported.

International patent application WO-A1-95/32091 discloses fibers comprising a semicrystalline random copolymer of propylene and 1-hexene: In one example a copolymer with a 1-hexene content of 2.9 wt% was used. The copolymer can be spun into a fiber and has a sufficiently low melting or softening point.

International patent application WO-A1-96/27041 discloses fabrics with a very pleasing hand. Said performance is obtained with fibers made from copolymers of propylene and an α-olefin, such as ethylene, 1-butene and 1-hexene. When 1-hexene is chosen, it must be present in an amount between 2 and 5 wt%. The disclosed fibers are suited for spunbonded fabrics. In the examples, the copolymers of propylene either comprise 2.5 wt% or 5 wt% of 1-hexene.

Propylene/ethylene/1-hexene terpolymers containing relatively low amount of 1-hexene are also known in the art. However, their use for the preparation of fibers has not been explored heretofore.

International patent application WO-A1-2006/002778, for example, relates to a pipe system comprising a copolymer of propylene and 1-hexene, optionally containing up to 9% by moles of ethylene units, wherein the 1-hexene content ranges from 0.2 to 5% wt.

US patent No. 6,365,682 relates to propylene based terpolymers useful for the preparation of films. Terpolymers having an ethylene content ranging from 0.9 to 3 wt% and an alpha olefin

content ranging from 1 to 15 wt% are indicated as particularly suitable. Only terpolymers of propylene/ethylene and 1-butene are exemplified.

The applicant has found that fibers having a good balance of mechanical properties, in particular exhibiting a high tenacity value and yet maintain a good elongation at break value, can be obtained when terpolymers containing propylene, ethylene and 1-hexene are used, such terpolymers having a high melting point with a relatively high comonomers content

Thus an object of the present inventions is a fiber comprising a terpolymer containing propylene, ethylene and an alpha olefins of formula CH2=CHZ wherein Z is an hydrocarbon group having from 2 to 10 carbon atoms, such as 1-butene, 1-hexene, 1-octene, preferably 1-hexene, wherein

(i) the content of ethylene derived units ranges from 0.5 wt% to 5.0 wt%, preferably from 1.0 wt% to 3.0 wt%; more preferably from 1.2 wt% to 2.5 wt%

(ii) the content of alpha olefin derived units ranges from 1.0 wt% to 5.0 wt%, preferably from 2.0 wt% to 4.0 wt%; more preferably from 2.5 wt% to 3.5 wt;

(iii) the wt% of alpha-olefin (α), the wt% of ethylene (C2) and the melting point (Tm) of the terpolymer fulfil the following relation (1):

$$Tm > 157-6*(C2+0.8\alpha)$$

(v) the melt flow rate (MFR) (ISO 1133 230°C, 2.16 kg) ranges from 10 to 100 g/10 min; preferably from 15 to 50 g/10 min.

Preferably relation (1) is $Tm>158-6*(C2+0.8\alpha)$; more preferably $Tm>159-6*(C2+0.8\alpha)$.

Generally the crystallization temperature ranges from 70°C to 100°C, preferably from 80°C to 95°C; more preferably from 85°C to 95°C.

Generally the polydispersity index (PI) ranges from 2.0 to 7.0, preferably from 3.0 to 6.5, more preferably from 3.5 to 6.0.

In order to achieve the MFR required by the terpolymer for use in the present invention, it is possible to visbreak a polymer having a lower MFR. Known visbreaking agent can be used such as peroxides. With the visbreaking it is possible to fine tune the MFR of the product. The visbreaking process can be carried out by treating the precursor terpolymer of the present invention with appropriate amounts, preferably from 0.001 to 0.20 wt%, more preferably from 0.04 to 0.10 wt%, of free radical initiators according to processes well-known in the art. Preferably, the visbreaking process is carried out by contacting under high shear conditions the polymeric material with at least one free radical initiator at a temperature equal to or higher that the decomposition temperature of the free radical initiator. Preferred free radical initiators are peroxides having a decomposition temperature ranging from 150° to 250°C,

such as di-tert-butyl peroxide, dicumyl peroxide, the 2,5-dimethyl-2,5-di (tert-butylperoxy)hexyne, and 2,5-dimethyl-2,5-di(tert-butylperoxy)hexane (traded by Akzo under the name Luperox 101 or Trigonox 101).

The terpolymers of the present invention have a stereoregularity of isotactic type of the propylenic sequences this is clear by the low value of xylene extractables at 25°C that is preferably lower than 15%, more preferably lower than 12%.

Without willing to be bound by a theory, it is believed that the fact that even at high comonomers content the terpolymers to be used for the fiber of the present invention show a high melting point is linked to the specifc polymerization process used fot their preparation that is described below: in fact, with that process it is possible to obtain a terpolymer that is multimodalized in composition, i.e. the resulting terpolymer contains various fractions having a low content of comonomers, said fractions being responsible of the high melting point, and other fractions having a quite high comonomer content.

The fiber according to the present invention typically exhibits a value of tenacity higher than 25 cN/tex; preferably higher than 30 cN/tex, more preferably higher than 33 cN/tex, and a value of elongation at break typically higher than 180%, preferably higher than 200%.

Typically, the fibers according to the present invention have a titre ranging from 1 to 8 dtex, preferably 1.5 to 4 dtex, more preferably from 2 to 3 dtex.

The fibres of the present invention can contain formulations of stabilizers suited for obtaining a skin-core structure (skin-core stabilization), or a highly stabilizing formulation. In the latter case, a superior resistance to aging is achieved for durable nonwovens.

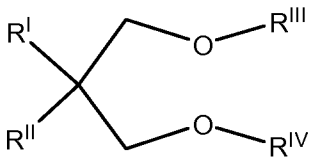
The terpolymer used in the present invention can be prepared by polymerisation in one or more polymerisation steps. Such polymerisation can be carried out in the presence of Ziegler-Natta catalysts. An essential component of said catalysts is a solid catalyst component comprising a titanium compound having at least one titanium-halogen bond, and an electron-donor compound, both supported on a magnesium halide in active form. Another essential component (co-catalyst) is an organoaluminium compound, such as an aluminium alkyl compound. An external donor is optionally added.

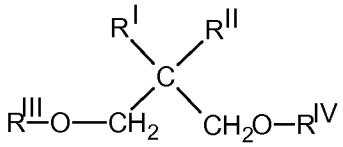
The catalysts generally used in the process of the invention are capable of producing polypropylene with a value of xylene insolubility at ambient temperature greater than 90%, preferably greater than 95%.

Catalysts having the above mentioned characteristics are well known in the patent literature; particularly advantageous are the catalysts described in US patent 4,399,054 and European patent 45977. Other examples can be found in US patent 4,472,524.

The solid catalyst components used in said catalysts comprise, as electron-donors (internal donors), compounds selected from the group consisting of ethers, ketones, lactones, compounds containing N, P and/or S atoms, and esters of mono- and dicarboxylic acids.

Particularly suitable electron-donor compounds are esters of phthalic acid and 1,3-diethers of the following formula:





wherein R^I and R^{II} are the same or different and are C_1-C_{18} alkyl, C_3-C_{18} cycloalkyl or C_7-C_{18} aryl radicals; R^{III} and R^{IV} are the same or different and are C_1-C_4 alkyl radicals; or are the 1,3-diethers in which the carbon atom in position 2 belongs to a cyclic or polycyclic structure made up of 5, 6, or 7 carbon atoms, or of 5-n or 6-n' carbon atoms, and respectively n nitrogen atoms and n' heteroatoms selected from the group consisting of N, O, S and Si, where n is 1 or 2 and n' is 1, 2, or 3, said structure containing two or three unsaturations (cyclopolyenic structure), and optionally being condensed with other cyclic structures, or substituted with one or more substituents selected from the group consisting of linear or branched alkyl radicals; cycloalkyl, aryl, aralkyl, alkaryl radicals and halogens, or being condensed with other cyclic structures and substituted with one or more of the above mentioned substituents that can also be bonded to the condensed cyclic structures; one or more of the above mentioned alkyl, cycloalkyl, aryl, aralkyl, or alkaryl radicals and the condensed cyclic structures optionally containing one or more heteroatom(s) as substitutes for carbon or hydrogen atoms, or both.

Ethers of this type are described in published European patent applications 361493 and 728769.

Representative examples of said diethers are 2-methyl-2-isopropyl-1,3-dimethoxypropane, 2,2-diisobutyl-1,3-dimethoxypropane, 2-isopropyl-2-cyclopentyl-1,3-dimethoxypropane, 2-isopropyl-2-isoamyl-1,3-dimethoxypropane, 9,9-bis (methoxymethyl) fluorene.

Other suitable electron-donor compounds are phthalic acid esters, such as diisobutyl, dioctyl, diphenyl and benzylbutyl phthalate.

The preparation of the above mentioned catalyst component is carried out according to various methods.

For example, a $MgCl_2 \cdot nROH$ adduct (in particular in the form of spheroidal particles) wherein n is generally from 1 to 3 and ROH is ethanol, butanol or isobutanol, is reacted with an excess of $TiCl_4$ containing the electron-donor compound. The reaction temperature is generally from 80 to 120° C. The solid is then isolated and reacted once more with $TiCl_4$, in the presence or absence of the electron-donor compound, after which it is separated and washed with aliquots of a hydrocarbon until all chlorine ions have disappeared.

In the solid catalyst component the titanium compound, expressed as Ti, is generally present in an amount from 0.5 to 10% by weight. The quantity of electron-donor compound which remains fixed on the solid catalyst component generally is 5 to 20% by moles with respect to the magnesium dihalide.

The titanium compounds, which can be used for the preparation of the solid catalyst component, are the halides and the halogen alcoholates of titanium. Titanium tetrachloride is the preferred compound.

The reactions described above result in the formation of a magnesium halide in active form. Other reactions are known in the literature, which cause the formation of magnesium halide in active form starting from magnesium compounds other than halides, such as magnesium carboxylates.

The Al-alkyl compounds used as co-catalysts comprise the Al-trialkyls, such as Al-triethyl, Al-triisobutyl, Al-tri-n-butyl, and linear or cyclic Al-alkyl compounds containing two or more Al atoms bonded to each other by way of O or N atoms, or SO_4 or SO_3 groups.

The Al-alkyl compound is generally used in such a quantity that the Al/Ti ratio be from 1 to 1000.

The electron-donor compounds that can be used as external donors include aromatic acid esters such as alkyl benzoates, and in particular silicon compounds containing at least one Si-OR bond, where R is a hydrocarbon radical.

Examples of silicon compounds are $(tert\text{-}butyl)_2Si(OCH_3)_2$, $(cyclohexyl)(methyl)Si\ (OCH_3)_2$, $(cyclopentyl)_2Si(OCH_3)_2$ and $(phenyl)_2Si(OCH_3)_2$ and $(1,1,2\text{-}trimethylpropyl)Si(OCH_3)_3$.

1,3-diethers having the formulae described above can also be used advantageously. If the internal donor is one of these diethers, the external donors can be omitted.

In particular, even if many other combinations of the previously said catalyst components may allow to obtain propylene terpolymers according to the present invention, the

terpolymers are preferably prepared by using catalysts containing a phthalate as internal donor and $(cyclopentyl)_2Si(OCH_3)_2$ as outside donor, or the said 1,3-diethers as internal donors.

The said propylene-ethylene-hexene-1 polymers can be produced with a polymerization process illustrated in European patent application 1 012 195.

In detail, the said process comprises feeding the monomers to said polymerisation zones in the presence of catalyst under reaction conditions and collecting the polymer product from the said polymerisation zones. In the said process the growing polymer particles flow upward through one (first) of the said polymerisation zones (riser) under fast fluidisation conditions, leave the said riser and enter another (second) polymerisation zone (downcomer) through which they flow downward in a densified form under the action of gravity, leave the said downcomer and are reintroduced into the riser, thus establishing a circulation of polymer between the riser and the downcomer.

In the downcomer high values of density of the solid are reached, which approach the bulk density of the polymer. A positive gain in pressure can thus be obtained along the direction of flow, so that it become to possible to reintroduce the polymer into the riser without the help of special mechanical means. In this way, a "loop" circulation is set up, which is defined by the balance of pressures between the two polymerisation zones and by the head loss introduced into the system.

Generally, the condition of fast fluidization in the riser is established by feeding a gas mixture comprising the relevant monomers to the said riser. It is preferable that the feeding of the gas mixture is effected below the point of reintroduction of the polymer into the said riser by the use, where appropriate, of gas distributor means. The velocity of transport gas into the riser is higher than the transport velocity under the operating conditions, preferably from 2 to 15 m/s.

Generally, the polymer and the gaseous mixture leaving the riser are conveyed to a solid/gas separation zone. The solid/gas separation can be effected by using conventional separation means. From the separation zone, the polymer enters the downcomer. The gaseous mixture leaving the separation zone is compressed, cooled and transferred, if appropriate with the addition of make-up monomers and/or molecular weight regulators, to the riser. The transfer can be effected by means of a recycle line for the gaseous mixture.

The control of the polymer circulating between the two polymerisation zones can be effected by metering the amount of polymer leaving the downcomer using means suitable for controlling the flow of solids, such as mechanical valves.

The operating parameters, such as the temperature, are those that are usual in olefin polymerisation process, for example between 50 to 120° C.

This first stage process can be carried out under operating pressures of between 0.5 and 10 MPa, preferably between 1.5 to 6 MPa.

Advantageously, one or more inert gases are maintained in the polymerisation zones, in such quantities that the sum of the partial pressure of the inert gases is preferably between 5 and 80% of the total pressure of the gases. The inert gas can be nitrogen or propane, for example.

The various catalysts are fed up to the riser at any point of the said riser. However, they can also be fed at any point of the downcomer. The catalyst can be in any physical state, therefore catalysts in either solid or liquid state can be used.

The terpolymer of the present invention may be blended with additives commonly employed in the art, such as antioxidants, light stabilizers, heat stabilizers, nucleating agents, colorants and fillers.

Fibers or filaments comprising the terpolymer of the invention may be prepared using processes and apparatuses well known in the art, i.e. by melt-spinning the terpolymer in conventional devices suitable for producing single or composite fibers or filaments. According to a further embodiment, the composite fibers or filaments may have a "sheath-core structure". By "fibers or filaments having a sheath-core structure" is meant herein fibers or filaments having an axially extending interface and comprising at least two components, i.e. at least an inner core and at least an outer sheath, said at least two components comprising different polymeric materials and being joined along the axially extending interface. In sheath-core fibers or filaments the sheath thickness may be uniform or the sheath thickness may not be uniform around the circumference of a fiber or filament cross-section. Said fibers or filaments having sheath-core structure can be produced using conventional melt-spin equipments having concentric annular dies. The terpolymer of the invention may be conveniently used to for the outer sheath of fibers or filaments having a sheath-core structure. The inner core may comprise any polymeric material commonly used for spunbonding applications, depending on the desired end properties of the composite fibers or filaments. Preferably, the sheath-core fibers or filaments comprise 50-90 wt%, more preferably 65-80 wt%, of polymeric material forming the core-layer and 10-50 wt%, more preferably 20-35 wt%, of the copolymer of propylene and 1-pentene of the invention forming the outer sheath-layer. Particularly advantageous are sheath-core fibers or filaments comprising 70 wt% of polymeric-material forming the core layer and 30 wt% of the terpolymer of the invention forming the outer sheath.

Another object of the present invention is a spunbonded non-woven fabric comprising the fibers of the invention, such fabric .

A further object of the present invention is a process for manufacturing the spunbonded non-woven fabric according to the invention, wherein a terpolymer as described in claim 1 is subjected to spunbonding.

The following examples are given to illustrate the present invention without limiting purpose.

Examples

Characterization methods

- Melting temperature and crystallization temperature: Determined by differential scanning calorimetry (DSC). weighting 6 ±1 mg, is heated to 220 ±1° C at a rate of 20 °C/min and kept at 220 ±1° C for 2 minutes in nitrogen stream and it is thereafter cooled at a rate of 20° C/min to 40 ±2° C, thereby kept at this temperature for 2 min to crystallise the sample. Then, the sample is again fused at a temperature rise rate of 20° C/min up to 220° C ±1. The melting scan is recorded, a thermogram is obtained, and, from this, melting temperatures and crystallization temperatures are read.
- Melt Flow Rate: Determined according to the method ISO 1133 (230° C, 2.16 kg).
- Solubility in xylene (xylene extractables at 25°C): Determined as follows.

  2.5 g of polymer and 250 ml of xylene are introduced in a glass flask equipped with a refrigerator and a magnetical stirrer. The temperature is raised in 30 minutes up to the boiling point of the solvent. The so obtained clear solution is then kept under reflux and stirring for further 30 minutes. The closed flask is then kept in thermostatic water bath at 25° C for 30 minutes. The so formed solid is filtered on quick filtering paper. 100 ml of the filtered liquid is poured in a previously weighed aluminium container, which is heated on a heating plate under nitrogen flow, to remove the solvent by evaporation. The container is then kept on an oven at 80° C under vacuum until constant weight is obtained. The weight percentage of polymer soluble in xylene at room temperature is then calculated.
- 1-hexene and ethylene content: Determined by ^{13}C-NMR spectroscopy in terpolymers:

NMR analysis. ^{13}C NMR spectra are acquired on an AV-600 spectrometer operating at 150.91 MHz in the Fourier transform mode at 120 °C. The peak of the propylene CH was used as internal reference at 28.83. The ^{13}C NMR spectrum is acquired using the following parameters:

Spectral width (SW)	60 ppm
Spectrum centre (O1)	30 ppm
Decoupling sequence	WALTZ 65_64pl
Pulse program (1)	ZGPG
Pulse Length (P1) (2)\	for 90°
Total number of points (TD)	32K

Relaxation Delay (2) 15 s
Number of transients (3) 1500

The total amount of 1-hexene and ethylene as molar percent is calculated from diad using the following relations:

$$[P] = PP + 0.5PH + 0.5PE$$

$$[H] = HH + 0.5PH$$

$$[E] = EE + 0.5PE$$

Assignments of the ^{13}C NMR spectrum of propylene/1-hexene/ethylene copolymers have been calculated according to the following table:

Area	Chemical Shift	Assignments	Sequence
1	46.93 – 46.00	$S_{\alpha\alpha}$	PP
2	44.50 – 43.82	$S_{\alpha\alpha}$	PH
3	41.34 -4.23	$S_{\alpha\alpha}$	HH
4	38.00 - 37.40	$S_{\alpha\gamma}+ S_{\alpha\delta}$	PE
5	35.70 -35.0	$4B_4$	H
6	35.00 - 34.53	$S_{\alpha\gamma}+ S_{\alpha\delta}$	HE
7	33.75 33.20	CH	H
8	33.24	$T_{\delta\delta}$	EPE
9	30.92	$T_{\beta\delta}$	PPE
10	30.76	$S_{\gamma\gamma}$	XEEX
11	30.35	$S_{\gamma\delta}$	XEEE
12	29.95	$S_{\delta\delta}$	EEE
13	29.35	$3B_4$	H
14	28.94 – 28.38	CH	P
15	27.43 – 27.27	$S_{\beta\delta}$	XEE
16	24.67 -24.53	$S_{\beta\beta}$	XEX
17	23.44 -23.35	$2B_4$	H
18	21.80 – 19.90	CH_3	P
19	14.22	CH_3	H

- Polydispersity Index (PI): Determined at a temperature of 200°C by using a parallel plates rheometer model RMS-800 marketed by RHEOMETRICS (USA), operating at an

oscillation frequency which increases from 0.1 rad/sec to 100 rad/sec. From the crossover modulus one can derive the P.I. by way of the equation:

P.I.= 10^5/Gc

in which Gc is the crossover modulus which is defined as the value (expressed in Pa) at which G'=G" wherein G' is the storage modulus and G" is the loss modulus.

- Titre of filaments

From a 10 cm long roving, 50 fibers are randomly chosen and weighed. The total weight of the 50 fibers, expressed in mg, is multiplied by 2, thereby obtaining the titre in dtex.

- Tenacity and Elongation at break of filaments

From a 500 m roving a 100 mm-long segment is cut and single fibers randomly chosen. Each single fiber is fixed to the clamps of a Dynamometer and tensioned to break with a traction speed of 20 mm/min for elongations lower than 100% and 50 mm/min for elongations greater than l00%, the initial distance between the clamps being of 20 mm. The ultimate strength (load at break) and the elongation at break are determined in machine (MD) direction.

The tenacity is calculated by way of the following equation:

Tenacity = Ultimate strength (cN) x 10/Titre (dtex).

Example 1

A copolymer is prepared by polymerising propylene, ethylene and hexene-1 in the presence of a catalyst under continuous conditions in a plant comprising a polymerisation apparatus as described in EP 1 012 195.

The catalyst is sent to the polymerisation apparatus that comprises two interconnected cylindrical reactors, riser and downcomer. Fast fluidisation conditions are established in the riser by recycling gas from the gas-solid separator.

In example 1 the gas composition in the two reactor legs has been differentiated by using the "barrier" feed according to what described in EP 1 012 195. This stream is propylene fed in the larger upper part of the downcomer.

The catalyst employed comprises a catalyst component prepared by analogy with example 5 of EP-A-728 769 but using microspheroidal $MgCl_2 \cdot 1.7C_2H_5OH$ instead of $MgCl_2 \cdot 2.1C_2H_5OH$. Such catalyst component is used with dicyclopentyl dimethoxy silane (DCPMS) as external donor and with triethylaluminium (TEA).

The polymer particles exiting the reactor are subjected to a steam treatment to remove the reactive monomers and volatile substances and then dried. The main operative conditions and characteristics of the produced polymers are indicated in Tables 1-3.

Example 2 (comparative)

A copolymer is prepared by operating as in example 1, except that the "barrier" feed was not used.

Table 1

Examples		1	2*
TEA/solid catalyst component, g/g		5	5
TEA/DCPMS, g/g		4	4
$C_6/(C_3+C_6)$, mol/mol	Riser	0.03	0.034
$C_6/(C_3+C_6)$, mol/mol	Downcomer	0.038	-
$C_2/(C_3+C_2)$, mol/mol	Riser	0.021	0.015
$C_2/(C_3+C_2)$, mol/mol	Downcomer	0.0035	-

C2=ethylene; C3=propylene; C6=1-hexene

* comparative

The polymers obtained in both Examples haven been added with additives and peroxides according to table 2.

Table 2

Examples		1	2*
Irganox 3114	wt%	0.0475	0.0475
Calcium stearate	wt%	0.028	0.028
Luperox 1010	wt%	0.064	0.064

*Comparative

Then the polymer mixture is placed in a twin screw extruder Berstorff (L/D=33) and extruded in the following operating conditions:

- temperature of feeding part: 190-210° C;
- melt temperature: 235-245° C;
- temperature of die part: 210° C;
- flow rate: 15 kg/h;
- rotational speed of the screw: 250 rpm. The properties of the thus obtained polymers are reported on table 3.

Table 3

Example		1	2*
MFR	g/10 min	29.8	32.8
C6 NMR	%	2.6	2.8
C2 NMR	%	1.5	1.5
PI		3.9	3.7
XS	%	8.4	7
IZOD 23°C 24h	KJ/m2	7	5.1
Tm	°C	137.5	134.1
Tc	°C	90.3	91.3

*Comparative

Preparation of the fibers

After extrusion the polymers of examples 1 and 2 are spun in a Leonard 25 spinning pilot line with screw L/D ratio of 25, screw diameter of 25 mm and compression ratio of 1:3. The line is marketed by Costruzioni Meccaniche Leonard-Sumirago (VA). The operative spinning conditions and properties of the filaments are reported in Tables 4 and 5 respectively.

Table 4

Operative conditions		
Hole diameter	mm	0,6
Output per hole	g/min	0.6
Hole number in the die	/	37
Die temperature	°C	250
Melt temperature	°C	258

Table 5

Example		1	2*
Titre, dtex	dTex	2.25	2.25
Tenacity, cN/tex	cN/Tex	35	32.9
Elongation at Break, %	%	210	170
Maximum spinning speed	m/min	4200	3900

The maximum spinning speed gives indication of the spinnability of the propylene polymer composition of the invention. The value corresponds to the highest spinning rate that can be maintained for 30 minutes with no filament break.

From table 5 it is clear that the fibers obtained by using the terpolymer as defined in the present invention show enhanced properties in terms of tenacity, elongation at break and spinning speed.

Claims

1. A fiber comprising a terpolymer containing propylene, ethylene and an alpha olefin of formula CH2=CHZ wherein Z is a hydrocarbon group having from 2 to 10 carbon atoms wherein:

   (i) the content of ethylene derived units ranges from 0.5 wt% to 5.0 wt%;

   (ii) the content of alpha olefin derived units ranges from 1.0 wt% to 5.0 wt%;

   (iii) the amount as weight% of alpha-olefin (α), the amount as weightt% of ethylene (C2) and the melting point (Tm) of the terpolymer fulfil the following relation (1):

   $$Tm>157-6*(C2+0.8\alpha)$$

   (iv) the melt flow rate (MFR) (ISO 1133 230°C, 2.16 kg) ranges from 10 to 100 g/10 min.

2. The fiber according to claim 1 wherein in the terpolymer the alpha olefin is 1-hexene.

3. The fiber according to claims 1 or 2 wherein in the terpolymer the content of ethylene derived units ranges from 1.0 wt% to 3.0 wt%; and the content of alpha olefin derived units ranges from 2.0 wt% to 4.0 wt%.

4. The fiber according to any of claims 1-3 wherein in the terpolymer the relation (1) is:

   $$Tm>158-6*(C2+0.8\alpha)$$

5. The fiber according to any of claims 1-4 wherein the terpolymer have a crystallization temperature ranging from 70°C to 100°C.

6. The fiber according to any of claims 1-5 having a sheath-core structure

7. A spunbonded non-woven fabric comprising the fibers of any of claims 1-6.

8. A process for manufacturing the spunbonded non-woven fabric according to claim 7, wherein a terpolymer as described in any of claims 1-5 is subjected to spunbonding.

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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2012/057229

A. CLASSIFICATION OF SUBJECT MATTER
INV. D01F6/06 D01F8/06
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
D01F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 211 819 A (INADOMI SEIGO [JP] ET AL) 8 July 1980 (1980-07-08) example 3	1-8
X	WO 98/29586 A1 (CHISSO CORP [JP]; KATAOKA YUKINORI [JP]; KOJIMA MITSURU [JP]; SUZUKI M) 9 July 1998 (1998-07-09) examples 1, 2; table 1	1-8
X	WO 96/27041 A1 (KIMBERLY CLARK CO [US]) 6 September 1996 (1996-09-06) cited in the application page 15, line 27 - line 33; claim 1	1-8

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
19 June 2012	27/06/2012

Name and mailing address of the ISA/	Authorized officer
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INTERNATIONAL SEARCH REPORT

Information on patent family members

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