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(54) **A YARN FOR ARTIFICIAL GRASS, A METHOD OF MANUFACTURING SAID YARN AND A FIELD OF ARTIFICIAL GRASS IN WHICH SAID YARN IS INCORPORATED**

GARN FÜR KUNSTRASEN, VERFAHREN ZU SEINER HERSTELLUNG UND AUS DIESEM GARN HERGESTELLTE KUNSTRASENFELD

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(56) References cited:
EP-A- 0 648 868 EP-A1- 0 310 202
EP-A1- 0 417 832 EP-A1- 0 609 892
EP-A2- 0 186 108 EP-A2- 0 332 397
EP-A2- 0 410 415 EP-A2- 0 445 872
WO-A1-91/14029 WO-A1-94/20657
WO-A1-97/08377 DE-A1- 2 100 212
DE-A1- 2 752 838 DE-A1- 3 319 953
DE-A1- 3 624 560 GB-A- 1 014 913
JP-A- 4 272 222 JP-A- 4 281 015
JP-A- 4 327 232 JP-A- 6 073 613
US-A- 3 788 940 US-A- 3 793 822
US-A- 4 297 413 US-A- 5 487 941
US-A- 5 597 650

- DATABASE WPI Section Ch, Week 9517 Derwent Publications Ltd., London, GB; Class A23, AN 95-126442 XP002058435 & JP 07 048778 A (SEKISUI CHEM IND CO LTD), 21 February 1995 cited in the application
- PATENT ABSTRACTS OF JAPAN vol. 097, no. 009, 30 September 1997 & JP 09 119036 A (HAGIWARA KOGYO KK), 6 May 1997 cited in the application

EP 0 996 781 B2

Description

[0001] A yarn for artificial grass, a method of manufacturing said yarn and a field of artificial grass in which said yarn is incorporated.

[0002] The invention relates to a yarn containing polyamide for producing artificial grass. The invention furthermore relates to a method of manufacturing said yarn and to a field of artificial grass in which said yarn is incorporated.

[0003] Such a yarn for a field of artificial grass is known from Japanese patent publication JP 7048778A. The field of artificial grass is obtained by intertwining polyamide fibre and PE fibre in a base layer. More in particular, the method comprises the provision in a base layer, in a pile length of 25 mm, of a yarn by twisting split yarn made of 5000d polyamide and split yarn made of 5000d high density PE.

[0004] Such a yarn is also known from Japanese patent publication JP 09119036A, wherein a yarn for artificial turf pile is formed by melt-spinning a polyamide resin composition comprising 70 - 99 % by weight of a polyamide resin and 1 - 30 % by weight of a polyethylene resin.

[0005] From EP-A-0 648 868 a yarn is furthermore known which is used for making artificial grass, which yarn is manufactured of polypropylene or of a block copolymer of polypropylene and polyethylene.

[0006] It has now become apparent that the properties of yarn for artificial grass, in particular its wear-resistance, flexibility and processibility, can be improved by manufacturing the artificial grass of a specified combination of polymers, and consequently the yarn according to the invention is characterized in that the yarn, in addition to polyamide, also contains a polyolefin compound in which said polyolefin compound is a block copolymer of polypropylene and polyethylene.

[0007] In the yarn according to the present invention, a block copolymer of polypropylene and polyethylene is used. A particularly suitable block copolymer is the polypropylene/polyethylene block copolymer as described in European patent application No. 0 359 321, which block copolymer is marketed by Solvay, Belgium with a melt flow index of about 4. Such a preferred yarn is preferably composed of 20 - 80 % by weight of block copolymer of polypropylene and polyethylene, and 20 - 80 % by weight of polyamide.

[0008] From JP-A-5,171,613 it is known to manufacture artificial grass from various polymers. Said Japanese patent publication mentions a large number of polymers, among which polypropylene and Nylon. It does not describe a yarn which is made from the present combination of polypropylene and/or polyethylene and polyamide, however. Nor does said Japanese patent publication disclose a method of manufacturing the yarn as used in accordance with the invention.

[0009] JP-A-3,279,419 discloses a fibre which consists of Nylon which is mixed with polypropylene. Said fibre has been used for making clothes. Said Japanese patent publication does not describe the use of such a mixture of polymers for manufacturing artificial grass.

[0010] US patent No. 5,597,650 discloses a carpet yarn having special properties as regards flame retardation and resistance to stains. Said yarn consists of a polyolefin matrix, preferably polypropylene, in which smaller polyamide fibrils are embedded. Said US patent does not describe the use of such a yarn for manufacturing artificial grass.

[0011] According to the method which is used in particular for producing yarns which are used for manufacturing artificial grass, the polymer is extruded to form monofilaments, which are subsequently processed into bands, with several bands being twisted to form a yarn, and possibly with several yarns being twined to form a composite yarn. This method is characterized in that monofilaments are extruded from a block copolymer of polypropylene and polyethylene, and that monofilaments are extruded from polyamide, or in that monofilaments are extruded from a mixture of a block copolymer of polypropylene and polyethylene on the one hand and polyamide on the other hand. Furthermore it is preferred to process in particular the monofilaments of the block copolymer of polyethylene and polypropylene into a first yarn containing the block copolymer of polyethylene and polypropylene, and to process the monofilaments of polyamide into a second yarn containing polyamide, after which the two yarns are joined to form a composite yarn. Then the artificial grass is manufactured of said composite yarn. In specified embodiments, however, it is preferred to use a yarn of the block copolymer of polypropylene and polyethylene on the one hand and a yarn of polyamide on the other hand as separate yarns for producing a field of artificial grass. Experiments have shown that fields of artificial grass produced in this manner exhibit better mechanical properties than fields of artificial grass according to the prior art as described above. Such a method of producing monofilaments is described in European patent No. 0 648 868.

[0012] Furthermore it is preferred to use co-extrusion in manufacturing the yarn according to the present invention. According to such a method, the core is built up of a block copolymer of polypropylene and polyethylene, and the cladding is built up of polyamide. Under certain circumstances it is preferred to exchange the aforesaid core and cladding materials, so that a core of polyamide is obtained.

[0013] The present invention is not limited to the use of monofilaments, and in a special embodiment it is preferred to use the yarns of fibrillated yarn of the block copolymer of polyethylene and polypropylene, on the one hand and a yarn of fibrillated polyamide yarn on the other hand. The method of producing fibrillated yarn is described in European patent application No. 0 263 566. Thus, in a special embodiment of the method according to the present invention a foil is made from a polymer which, in addition to polyamide, also contains a polyolefin compound wherein said polyolefin compound

is a block copolymer of polypropylene and polyethylene, which foil is cut into bands, with several bands being twisted to form a yarn, and possibly with several yarns being twined to form a composite yarn. According to such a method it is also possible on the one hand to make a foil from a block copolymer of polypropylene and polyethylene and on the other hand to make a foil from polyamide, after which the bands obtained from said two foils may be processed to form said composite yarn. A combination of mono-filaments and fibrillated yarns, preferably monofilaments of polyamide and fibrillated yarn of the block copolymer of polypropylene and polyethylene, is also suitable for manufacturing the composite yarn.

[0014] The invention will be explained in more detail hereafter by means of the following examples.

Example 1

[0015] Monofilaments were obtained by extrusion of the block copolymer of polyethylene and polypropylene on the one hand and by extrusion of polyamide on the other hand, and after stretching said monofilaments, bands were obtained. A method as indicated in example 1 of EP-A-0 648 868 was thereby used for the block copolymer. The bands were processed to form a yarn, thus producing the block copolymer of polyethylene and polypropylene yarn consisting of four non-twisted bands each having a yarn number of 1100 dtex on the one hand and a polyamide yarn consisting of non-twisted bands each having a yarn number of 666 dtex on the other hand. Said two yarn types were twined to form a composite yarn having a yarn number of 8400 dtex. Said composite yarn was then knitted and fixed so as to obtain a teasing effect, after which the teased composite yarn was used for obtaining a carpet for artificial grass.

[0016] To this end the yarn was tufted with 300 stitches per running metre, and a pile height of 12.5 mm, resulting in a pile insert weight of 1750 g/m².

[0017] The carpet thus obtained was subjected to various tests in order to determine the mechanical properties, such as the tretrad test for determining the fibrillation, the Taber test for determining the weight loss and the Leroux test for determining the sliding properties.

[0018] The data that were obtained are shown in table A.

Table A

	Block copolymer of polypropylene and polyethylene	Polyamide	Composite yarn of polyamide and block copolymer of polypropylene and polyethylene
tretrad	post-fibrillation	no post-fibrillation	no post-fibrillation
Taber (g/m ²) loss			
2000 t	0.38	0.56	0.32
5000 t	0.93	1.49	0.76
sliding Leroux			
dry	0.790	0.760	0.772
wet	0.537	0.440	z 0.390

[0019] The data in this table show that the artificial grass made from the combination of the block copolymer of polyethylene and polypropylene and polyamide did not exhibit any post-fibrillation, so that a much better result is obtained than with artificial grass made from a polypropylene-containing polymer, that the weight loss results as measured by means of the Taber test are much better than with the artificial grass made from the block copolymer of polyethylene and polyethylene and with the artificial grass made from polyamide, that the sliding results as measured by means of the Leroux test are much better in wet conditions, and that the sliding results of artificial grass made from polyamide are slightly better only in dry conditions. Furthermore it has become apparent that burn tests in accordance with BS 4790 show a low value for the artificial grass according to the invention, which value is comparable with that of artificial grass made from polyamide, but which is better than that of artificial grass made from polypropylene-containing polymer.

[0020] Summarizing the above it can be stated, therefore, that the results obtained with the artificial grass according to the invention are better than the results that could be expected with artificial grass of polyamide or with artificial grass of polypropylene-containing polymer. This shows that a synergetic effect is obtained with the combination of starting materials according to the invention.

Example 2

[0021] The artificial grass was manufactured in the same manner as in Example 1. A field of artificial grass scattered in with sand was composed, to which end the yarn was tufted with 140 stitches per running metre and a pile height of 34 mm, as a result of which a pile insert weight of 970 g/m² was obtained. The carpet thus obtained was subjected to tests comparable with the tests of Example 1. It has become apparent thereby that, also in the case of a field of artificial grass scattered in with sand, the mechanical properties of the yarn composed of the block copolymer of polyethylene and polypropylene and polyamide were much better than those of yarns for fields of artificial grass which were made from polypropylene and from polyamide.

Example 3 (not according to the invention)

[0022] Monofilaments were obtained by extrusion of the block copolymer of polyethylene and polypropylene on the one hand and by extrusion of polyamide on the other hand, and after stretching said monofilaments, bands were obtained. A method as indicated in example 1 of EP-A-0 648 868 was thereby used for the block copolymer, so as to obtain a block copolymer having a yarn number of 8800 dtex consisting of 8 bands, each having a yarn number of 1100 dtex. Then a polyamide having a yarn number of 4000 dtex, which consisted of 6 bands, was twined with a polyamide having a yarn number of 4000 dtex, which consisted of 6 bands, to form a yarn having a yarn number of 8000 dtex, which consisted of 12 bands. In order to be subjected to a tufting operation, the block copolymer yarn was preferably threaded on the uneven positions on the creel of the tufting machines, whilst the polyamid yarn was threaded on the even positions. It is also possible, however, to use other position settings. The carpet for artificial grass, which was built up of separate yarns of block copolymer and polyamide, was tufted with 310 stitches per running metre, and a pile height of 12.5 mm, resulting in a pile insert weight of 1750 g/m².

[0023] The carpet thus obtained was subjected to tests comparable with the tests of Example 1. It has become apparent thereby that, also in the case of a field of artificial grass, whether or not scattered in with sand, the mechanical properties of the field of artificial grass made from the block copolymer of polyethylene and polypropylene and polyamide were much better than those of fields of artificial grass made from polypropylene and from polyamide.

Claims

1. A yarn containing polyamide for producing artificial grass, containing in addition to polyamide also a polyolefin compound, **characterized in that** said polyolefin compound is a block copolymer of polypropylene and polyethylene.
2. A yarn according to claim 1, **characterized in that** said yarn contains 20-80% by weight of block copolymer of polypropylene and polyethylene and 20-80% by weight of polyamide.
3. A method of manufacturing a yarn according to claims 1-2 by extruding polymer to form monofilaments, which are subsequently processed into bands, with several bands being twisted to form a yarn, **characterized in that** monofilaments are extruded from a block copolymer of polypropylene and polyethylene, and from polyamide, or **in that** monofilaments are extruded from a mixture of a block copolymer of polypropylene and polyethylene on the one hand and polyamide on the other hand.
4. A method according to claim 3, **characterized in that** a yarn is manufactured from the block copolymer of polypropylene and polyethylene, and that a yarn is manufactured from polyamide, whereupon said composite yarn is made from the two yarns of the block copolymer of polyethylene/polypropylene and polyamide, after which artificial grass fibres are made from said composite yarn.
5. A method of manufacturing a yarn according to claims 1-2 by starting from a foil which is cut into bands, with several bands being twisted to form a yarn, **characterized in that** a foil is made from a polymer which, in addition to polyamide, contains a block copolymer of polypropylene and polyethylene, or **in that** on the one hand a foil is made from a block copolymer of polypropylene and polyethylene and **in that** on the other hand a foil is made from polyamide, after which the bands obtained from said two foils may be processed to form said composite yarn.
6. A method according to claim 5, **characterized in that** a yarn is manufactured from the block copolymer of polypropylene and polyethylene, and that a yarn is manufactured from polyamide, whereupon artificial grass fibres are made from the composite yarn obtained from said two yarns.

7. A method of manufacturing yarns according to claims 1-2, **characterized in that** said yarn is obtained by co-extrusion, wherein the cladding consists of polyamide, and wherein the core consists of a block copolymer of polypropylene and polyethylene.
- 5 8. A field of artificial grass made from artificial grass fibres, **characterized in that** said artificial grass fibres are manufactured from a yarn as defined in claims 1-2.
9. A field of artificial grass according to claim 8, **characterized in that** said artificial grass fibres have been obtained from a composite yarn, composed of the polyamide yarn manufactured in accordance with the method as defined in claims 3-4, and of the yarn of the block copolymer of polypropylene and polyethylene manufactured in accordance with the method as defined in claims 5-6.
- 10 10. A field of artificial grass according to claim 8, **characterized in that** said artificial grass fibres have been obtained from the polyamide yarn manufactured in accordance with the method as defined in claims 3-4, and from the yarn of the block copolymer of polypropylene and polyethylene manufactured in accordance with the method as defined in claims 5-6.
- 15 11. A field of artificial grass according to claims 8-10, **characterized in that** said field is a field of artificial grass which is scattered in with sand.

Patentansprüche

- 25 1. Polyamid enthaltendes Garn zum Herstellen von Kunstrasen, welches zusätzlich zu Polyamid ferner eine Polyolefinverbindung enthält, **dadurch gekennzeichnet, dass** die Polyolefinverbindung ein Blockcopolymer aus Polypropylen und Polyethylen ist.
- 30 2. Garn nach Anspruch 1, **dadurch gekennzeichnet, dass** das Garn 20 - 80 Gew.-% eines Blockcopolymers aus Polypropylen und Polyethylen und 20 - 80 Gew.-% Polyamid enthält.
- 35 3. Verfahren zum Herstellen eines Garns nach den Ansprüchen 1 - 2 durch Extrudieren eines Polymers zum Bilden von Monofilamenten, die nachfolgend zu Bändern verarbeitet werden, wobei mehrere Bänder zum Bilden eines Garns zusammengedreht werden, **dadurch gekennzeichnet, dass** Monofilamente aus einem Blockcopolymer aus Polypropylen und Polyethylen, und aus Polyamid extrudiert werden oder dass Monofilamente aus einem Gemisch aus einem Blockcopolymer aus Polypropylen und Polyethylen auf der einen Seite sowie Polyamid auf der anderen Seite extrudiert werden.
- 40 4. Verfahren nach Anspruch 3, **dadurch gekennzeichnet, dass** ein Garn aus dem Blockcopolymer aus Polypropylen und Polyethylen hergestellt wird und dass ein Garn aus Polyamid hergestellt wird, woraufhin das Verbundgarn aus den zwei Garnen des Blockcopolymers aus Polyethylen/Polypropylen und des Polyamids hergestellt wird, wonach Kunstrasenfasern aus dem Verbundgarn hergestellt werden.
- 45 5. Verfahren zum Herstellen eines Garns nach den Ansprüchen 1 - 2, wobei mit einer Folie gestartet wird, welche in Bänder geschnitten wird und mehrere Bänder zum Bilden eines Garns zusammengedreht werden, **dadurch gekennzeichnet, dass** eine Folie aus einem Polymer hergestellt wird, das zusätzlich zu Polyamid ein Blockcopolymer aus Polypropylen und Polyethylen enthält, oder dass auf der einen Seite eine Folie aus einem Blockcopolymer aus Polypropylen und Polyethylen hergestellt wird und dass auf der anderen Seite eine Folie aus Polyamid hergestellt wird, wonach die aus den beiden Folien erhaltenen Bänder zum Bilden des Verbundgarns verarbeitet werden können.
- 50 6. Verfahren nach Anspruch 5, **dadurch gekennzeichnet, dass** ein Garn aus dem Blockcopolymer aus Polypropylen und Polyethylen hergestellt wird und dass ein Garn aus Polyamid hergestellt wird, woraufhin Kunstrasenfasern aus dem Verbundgarn hergestellt werden, das aus den beiden Garnen erhalten wird.
- 55 7. Verfahren zum Herstellen von Garnen gemäß den Ansprüchen 1 - 2, **dadurch gekennzeichnet, dass** das Garn durch Coextrusion erhalten wird, wobei die Hülle aus Polyamid besteht und wobei der Kern aus einem Blockcopolymer aus Polypropylen und Polyethylen besteht.
8. Aus Kunstrasenfasern hergestelltes Kunstrasenfeld, **dadurch gekennzeichnet, dass** die Kunstrasenfasern aus

einem Garn gemäß den Ansprüchen 1 - 2 hergestellt werden.

9. Kunstrasenfeld nach Anspruch 8, **dadurch gekennzeichnet, dass** die Kunstrasenfasern aus einem Verbundgarn erhalten worden sind, welches aus dem Polyamidgarn, das gemäß dem Verfahren nach den Ansprüchen 3 - 4 hergestellt wird, und aus dem Garn des Blockcopolymers aus Polypropylen und Polyethylen besteht, welches gemäß dem Verfahren nach den Ansprüchen 5 - 6 hergestellt wird.
10. Kunstrasenfeld nach Anspruch 8, **dadurch gekennzeichnet, dass** die Kunstrasenfasern aus dem Polyamidgarn, das gemäß dem Verfahren nach den Ansprüchen 3 - 4 hergestellt wird, und aus dem Garn des Blockcopolymers aus Polypropylen und Polyethylen erhalten worden sind, das gemäß dem Verfahren nach den Ansprüchen 5 - 6 hergestellt wird.
11. Kunstrasenfeld nach den Ansprüchen 8 - 10, **dadurch gekennzeichnet, dass** das Feld ein Kunstrasenfeld ist, in das Sand eingestreut ist.

Revendications

1. Fil contenant un polyamide pour produire un gazon artificiel, contenant aussi, en plus du polyamide, un composé de type polyoléfine **caractérisé en ce que** ledit composé du type polyoléfine est un copolymère séquencé de polypropylène et de polyéthylène.
2. Fil selon la revendication 1 **caractérisé en ce que** ledit fil contient 20-80% en masse de copolymère séquencé de polypropylène et de polyéthylène et 20-80% en masse de polyamide.
3. Procédé de fabrication d'un fil selon les revendications 1 à 2 par extrusion d'un polymère pour former des mono-filaments, qui sont ensuite transformés en bandes, plusieurs bandes étant tordues pour former un fil, **caractérisé en ce que** des mono-filaments sont extrudés à partir d'un copolymère séquencé de polypropylène et de polyéthylène, et à partir de polyamide, ou **en ce que** des mono-filaments sont extrudés à partir d'un mélange d'un copolymère séquencé de polypropylène et de polyéthylène d'une part et de polyamide d'autre part.
4. Procédé selon la revendication 3 **caractérisé en ce qu'un** fil est fabriqué à partir du copolymère séquencé de polypropylène et de polyéthylène, et **en ce qu'un** fil est fabriqué à partir de polyamide, après quoi ledit fil composite est formé à partir de deux fils de copolymère séquencé de polyéthylène/polypropylène et de polyamide, après quoi des fibres de gazon artificiel sont formées à partir dudit fil composite.
5. Procédé de fabrication d'un fil selon les revendications 1 à 2 à partir d'une feuille qui est coupée en bandes, plusieurs bandes étant tordues pour former un fil, **caractérisé en ce qu'une** feuille est formée à partir d'un polymère qui, en plus d'un polyamide, contient un copolymère séquencé de polypropylène et polyéthylène, ou **en ce que**, d'une part, une feuille est formée à partir d'un copolymère séquencé de polypropylène et de polyéthylène et **en ce que**, d'autre part, une feuille est formée à partir de polyamide, après quoi les bandes obtenues à partir desdites deux feuilles peuvent être transformées pour former ledit fil composite.
6. Procédé selon la revendication 5 **caractérisé en ce qu'un** fil est fabriqué à partir du copolymère séquencé de polypropylène et de polyéthylène, **en ce qu'un** fil est fabriqué à partir de polyamide, après quoi des fibres de gazon artificiel sont produites à partir du fil composite obtenu à partir desdits deux fils.
7. Procédé de fabrication de fils selon les revendications 1 à 2 **caractérisé en ce que** ledit fil est obtenu par co-extrusion, où l'enveloppe consiste en polyamide et où le noyau consiste en un copolymère séquencé de polypropylène et de polyéthylène.
8. Champ de gazon artificiel produit à partir de fibres de gazon artificiel, **caractérisé en ce que** lesdites fibres de gazon artificiel sont fabriquées à partir d'un fil défini dans les revendications 1 à 2.
9. Champ de gazon artificiel selon la revendication 8 **caractérisé en ce que** lesdites fibres de gazon artificiel ont été obtenues à partir d'un fil composite composé du fil de polyamide fabriqué selon le procédé défini dans les revendications 3 et 4 et du fil de copolymère séquencé de polypropylène et de polyéthylène fabriqué selon le procédé défini dans les revendications 5 et 6.

10. Champ de gazon artificiel selon la revendication 8 **caractérisé en ce que** lesdites fibres de gazon artificiel ont été obtenues à partir du fil de polyamide fabriqué selon le procédé défini dans les revendications 3 et 4 et à partir du fil de copolymère séquencé de polypropylène et de polyéthylène fabriqué selon le procédé défini dans les revendications 5 et 6.

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11. Champ de gazon artificiel selon les revendications 8 à 10 **caractérisé en ce que** ledit champ est un champ de gazon artificiel dans lequel est dispersé du sable.

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 7048778 A [0003]
- JP 09119036 A [0004]
- EP 0359321 A [0007]
- JP 5171613 A [0008]
- JP 3279419 A [0009]
- US 5597650 A [0010]
- EP 0648868 A [0015] [0022]