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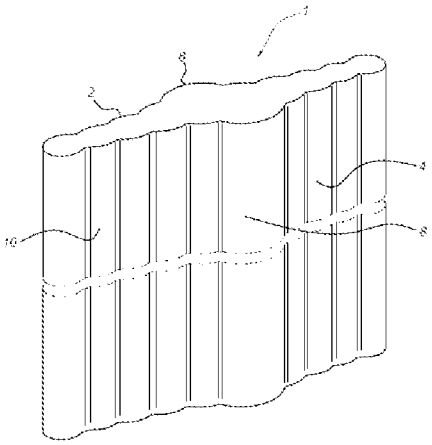
(73) Octrooihouder(s):
Ten Cate Thiolon B.V. te Nijverdal.

(72) Uitvinder(s):
Gerjan van Voorst te Nijverdal.
Frank Pfeiffer te Nijverdal.
Niels Gerhardus Kolkman te Nijverdal.

(74) Gemachtigde:
ir. M.F.J.M. Ketelaars c.s. te Den Haag.

(54) **Split Resistant Fibre**

(57) A fibre for use in artificial turf has an elongate cross-sectional shape defining a first face and a second face that meet at side edges of the fibre. The first and second faces having respective first and second ridges that are offset with respect to each other, such that the cross-sectional shape is 2-fold rotationally symmetric with no reflectional symmetry. The fibre may be an extruded monofilament and shows improved resilience over symmetrical fibres of similar dimensions.



Split Resistant Fibre

Field of the invention

[0001] The present invention relates to a fibre for use as pile in the manufacture of artificial turf and to artificial turf comprising such fibres.

Background art

[0002] Artificial turf has become steadily more accepted as a playing surface for various sports. It is also increasingly used for landscaping purposes. In both cases, its acceptance may be attributed to the steadily improving technology, which make artificial turf appear and perform more like real grass and also ensures that this remains the case during an acceptable lifetime.

[0003] It will be understood that one major difference between natural grass and artificial turf is the fact that the former grows and rejuvenates, while the later does not. Artificial turf, especially when used intensively, must be extremely resilient and resistant to wear and damage. On the other hand, it should also be as pleasant to play on as natural grass. These conflicting requirements are a constant problem for the designer of artificial turf systems and their components.

[0004] Reference to artificial turf systems may include a number of individual components that work together to make a playable or usable surface. These may include a base layer, an impermeable foil, a drainage layer, a shock pad, a backing layer in which the grass pile is anchored, the artificial pile itself and infill. The present invention is specifically directed to fibres forming the upstanding pile of the artificial grass although it will be understood that these fibres interact and interface with other components too.

[0005] It may also be noted that fibres for forming the pile of a carpet-like construction may be present in a number of different forms. Traditional carpets use twined fibres of cotton or synthetic yarn, with individual filaments twined together to form a single pile fibre and a number of fibres bundled together and either woven or tufted into a backing. In the context of artificial grass, fibrillated tape products have been used. These are produced by foil extrusion with the foil being subsequently slit into tape, which is then fibrillated with a specific pattern. The fibrillation improves the natural look and feel of the individual synthetic turf fibres after installation as an artificial turf pitch. A further category of fibre is known as the monofilament fibre. This term is generally intended to designate individually extruded filaments that are extruded from a die head that imparts a desired cross-sectional shape on the fibre. Extrusion in this manner allows a monofilament to be designed for an explicit purpose, whereby the cross-sectional shape is engineered for the intended functionality.

[0006] One example of an artificial turf monofilament is the Evolution™ fibre from Royal Ten Cate, as disclosed in WO 2005/005731. This curved fibre provides significantly improved resilience compared to similar weight fibres of more planar construction. Unfortunately, the improved resilience comes at the expense of durability and extended use trials show that the fibre is susceptible to splitting and cracking.

[0007] Another monofilament fibre is described in US6432505 as having a substantially diamond shaped cross section, which provides increased resistance to cracking and fibrillation while retaining useful flexibility and abrasion characteristics. Turf with a diamond shaped fibre of this form

is available from Royal Ten Cate under the name Slide Max™. Even though this fibre has been shown to be extremely durable, its resilience is significantly lower than that of the Evolution™ and this may further deteriorate with time. Resilience may be reflected in the ball roll performance as measured e.g. according to the FIFA Handbook of Test Methods V2.4. It is also apparent in the ability of the fibre to remain upright after repeated deformation, which affects the appearance of the turf after a period of intensive use.

[0008] Fibre development is a complex process. The direct engineering properties of the fibre, such as stiffness and tensile strength, may be modelled and optimised based on material data and structural formulae. The secondary properties such as those tested according to the above FIFA test methods are more difficult to predict and can only be determined through extensive testing. Other properties such as weaving or tufting performance and manufacturing ability are equally complex and generally can only be established in practice. Fibres may also be mixed together in order to further tune the overall performance of the artificial turf.

[0009] Fibre pull-out is just such an example of a manufacturing related property that is of great significance to the acceptance of the final product. Fibrillated polymeric tape is notoriously slippery compared to twined fibres and tends to have low fibre pull-out values when woven or tufted. Additional provisions may be needed to improve these values, such as firmer weaves or coatings. Monofilaments are generally stiffer to weave than tape but are also not necessarily easily anchored in the weave or backing.

[0010] It would be desirable to provide a fibre that improved upon the properties of existing fibres for use in artificial turf.

Summary of the invention

[0011] According to the present invention, there is provided a fibre for use in artificial turf, the fibre having an elongate cross-sectional shape defining a first face and a second face that meet at side edges of the fibre, the first and second faces having respective first and second ridges that are offset with respect to each other, such that the cross-sectional shape is 2-fold rotationally symmetric with no reflectional symmetry. By 2-fold rotational symmetry is meant that the shape is identical when rotated about its centre by 180°. The absence of reflectional symmetry means that there is no line about which the shape can be reflected onto itself. A (non-rhomboid) parallelogram is an example of such a 2-fold rotationally symmetric shape that does not have reflectional symmetry. The cross-sectional shape of the present fibre may therefore fit within a parallelogram. The extremities of the side edges and the extremities of the first and second ridges may also define a parallelogram.

[0012] The resulting fibre has shown improved resilience with respect to similarly dimensioned symmetrical fibres, as illustrated by extended testing and visual inspection. Without wishing to be bound by theory, it is believed that this is due to the fact that the presently claimed fibre collapses differently to symmetrical fibres. In particular the asymmetry of the fibre causes the point at which the fibre buckles to vary from one cycle to the next, as opposed to symmetrical fibres which appear to have a tendency to repeatedly buckle at the same location.

[0013] The fibre may closely conform to the envelope of a parallelogram. More preferably however, the first and second faces have concave portions. In other words, the surfaces of the fibre may be displaced inwardly with respect to the surface of the corresponding parallelogram. The resulting fibre has relatively less material and a lower second moment of area about the centre line joining the side edges. Although the first and second faces may have convex portions, it is preferable that no part of the first and second faces crosses the centre line.

[0014] It will be noted that each of the first and second faces has a major face, being the portion between the ridge and the most distant side edge and a minor face, being the portion between the ridge and the closer side edge. Both the minor and the major faces may be concave. Alternatively, only the major faces may be concave, while the minor faces may be generally flat or even slightly convex or vice-versa. The shape of the faces is influential in the manner in which the fibres bind together at their attachment to the backing. This can also affect the fibre pull out strength, otherwise referred to as tuft-lock. Flat faces are believed to allow fibres to more easily slide past and over each other and the presently discloses concave surfaces are believed to be the basis for the improved pull-out values experienced with the present fibres.

[0015] The fibre may have smooth surfaces to the first and second faces. In a preferred embodiment, the first and second faces may be provided with corrugations. In this context, the term corrugations is intended to include grooves, ridges, curves, waves and other relief extending in the lengthwise direction of the fibre. These corrugations can help in making the appearance of the fibre less shiny and more grass-like by improving the diffusion of reflected light. It will be understood that the scale of the corrugations will be smaller than that of the first and second ridges on the respective first and second faces. In one embodiment, each face has between five and ten corrugations excluding a single ridge, which defines the maximum distance from the centre line. These corrugations are preferably continuous i.e. smooth curves although scallop-shaped curves may also be contemplated. The side edges are preferably also rounded and may have a radius of curvature of at least 0.05 mm. The first and second ridges are also preferably rounded with a radius of curvature of at least 0.1 mm.

[0016] As indicated above, the fibre cross-section is elongate, meaning that it is longer in the direction between the side edges than it is when measured at any point transverse to this direction. The actual dimension of the fibre may vary according to its intended use. For use in sports, a centre line extending between the side edges may have a length of between 0.5 mm and 2 mm, preferably between 1.0 mm and 1.5 mm, most preferably around 1.25 mm. Reference is given here to a centre line although it should be noted that this need not necessarily be the mid-line defined as the locus of the mid-point between the respective side faces. For the present purpose, the centre line is a straight line, which may deviate from the mid-line due to the asymmetric shape of the fibre. For landscaping purposes, different fibre dimensions may be applicable.

[0017] As a result of the elongate cross-sectional shape, a ratio between a maximum thickness of the fibre measured transverse to a centre line extending between the side edges and a length of the centre line may be between 0.25 and 0.6, preferably between 0.3 and 0.4. This point of maximum thickness will generally correspond to a location at or between the first and second

ridges. The maximum thickness may vary between 0.2 mm and 0.6 mm and will preferably be between 0.3 mm and 0.5 mm. An actual embodiment has a thickness of around 0.38 mm and a centre line length of around 1.2 mm.

[0018] For these fibres a second moment of area may be calculated, which may lie in the range of from 0.0010 mm4 to 0.0080 mm4, generally below 0.0040 mm4 and more generally below 0.0020 mm4. In a preferred embodiment, the second moment of area is around 0.0015 mm4.

[0019] As is customary in fibre technologies, the weight of the fibre may be defined by a dtex value representing the weight in grams of 10 000 metres of the fibre. In the present case, for sports use, the fibre may have a dtex value of between 1500 and 3000, preferably between 1800 and 2500 and in particular, values around 2000. For use in landscaping, lighter fibres may be preferred with dtex values of from 800 to 1500.

[0020] The first and second ridges may be offset by any appropriate amount to achieve the desired bending performance and asymmetry. It will be understood that in the case of a minimal offset, the fibre will perform in a closely similar manner to the above mentioned Slide Max™ diamond shaped fibre. As the ridges approach the side edges of the fibre, the performance may approach that of a flat fibre with bulbous ends. Maximum asymmetry may be achieved at the point at which the ridges are offset from each other by a distance of around half of the centre line length. In this context, offset is intended to refer to the distance between the ridges, measured along the centre line. This means that each of the ridges is offset from the mid-point of the centre line by one quarter of the centre line length. Most preferably, lower asymmetry is desirable and the ridges are preferably offset from each by a distance that is greater than 0.05 x the centre line length but less than 0.4 x the centre line length, preferably in the region between 0.1 and 0.2 x the centre line length.

[0021] The skilled person will understand that such fibres will usually be extruded as individual monofilaments in a conventional extrusion of co-extrusion process. It is nevertheless, not excluded that any other suitable procedure or combination of procedures may be applied, including moulding, coating, multi-fibre extrusion and the like. Preferably, the fibre is drawn subsequent to extrusion at a draw ratio of between 2 and 5, preferably between 3 and 4. Drawing down serves to orientate the polymer and improves the mechanical properties of the final fibre, whereby properties such as modulus and tensile strength are different from those of the initial polymer material as supplied.

[0022] The fibre may be manufactured of any suitable polymeric material, in particular, those that are suitable for fibre extrusion. Suitable polymers include but are not limited to: polyamides (PA-6, PA-6,6); polyesters (PET, PTT, PBT, PLA, PHB); polypropylene (homopolymer, copolymer; regular and metallocene grades); polyethylene (HDPE, LDPE, LLDPE, regular [LLDPE] and metallocene [mLLDPE] grades); polyolefin block copolymers (OBC) and blends or co-extrusions of the above.

[0023] Preferred materials are polypropylene (homopolymer, copolymer; regular and metallocene grades); polyethylene (HDPE, LDPE, LLDPE, regular and metallocene grades), polyolefin block copolymers (OBC) and blends thereof whereby polyethylene (HDPE, LDPE, LLDPE, regular and metallocene grades) and polyolefin block copolymers (OBC) and their blends are the most preferable.

[0024] Co-extruded fibres may also be used, preferably in a core/cladding or inside/outside coextrusion. In one embodiment, the fibre may comprise Inside mLLDPE or mLLDPE + OBC and Outside LLDPE. The skilled person will nevertheless be aware of many alternative combinations of materials that may be applicable to further tailor the fibre properties.

[0025] The invention also relates to an artificial turf comprising upstanding pile fibres as described above or hereinafter, retained in a backing. The fibres may be tufted to the backing or woven together with the backing. Additionally, the pile may be uniform in that all fibres are identical of the fibres may be mixed with further pile fibres having different cross-sectional shapes. This may include other non-symmetrical fibres according to the invention or other fibres not themselves being according to the invention.

[0026] Additionally, the pile fibres may comprise fill fibres, these being shorter than the pile fibres and serving to support the pile fibres in an upright position. In this context, it is meant that the fill fibres are shorter in height in the use position. They may of course be curled or crimped and have an initial length that is larger.

[0027] The artificial turf may further comprise a quantity of infill between the fibres. This may be any suitable infill, including but not limited to rubber, cork, sand and bead infill.

[0028] The invention may be applicable to turf for various uses, although sports such as football, rugby and hockey are most appropriate. This will largely determine the pile height required. The pile fibres may have a pile height of more than 4 cm, preferably more than 5 cm and optionally between 6 cm and 7 cm. The pile may also be anchored into the backing over a distance of more than 10 mm or even more than 15 mm or more than 20 mm. Anchoring the pile may be by multiple W-weave, with the pile fibres passing over a number of weft yarns. A similar effect may be achieved in tufting. The turf may be woven in face to face configuration with pile fibre elements having both of their ends upstanding and an intermediate portion bound into the backing.

Brief description of the drawings

[0029] The present invention will be discussed in more detail below, with reference to the attached drawings, in which:

[0030] Fig. 1 depicts a perspective view of a fibre according to the present invention;

[0031] Fig. 2 depicts a cross-sectional view through the fibre of Fig. 1;

[0032] Fig. 3 depicts artificial turf incorporating the fibres of Fig. 1; and

[0033] Fig. 4 depicts a cross-sectional view of a fibre according to a second embodiment of the invention.

Description of embodiments

[0034] Figure 1 shows a magnified perspective view of a fibre 1 according to the present invention. The fibre 1 is elongate and may be attached to a backing (not shown in this view), to maintain it in an upright position. The fibre 1 has a first face 2 and a second face 4, with a first ridge 6 extending down the first face 2 and a second ridge 8 extending down the second face 4. The faces 2, 4 are also provided with corrugations 10, of which the corrugations 10 extending down the second face 4 can be seen in this view.

[0035] The fibre 1 is an extrusion of metallocene ethylene-hexane copolymer having secant modulus MD (1% secant) of 111 MPa according to ASTM D882 and subjected to a draw ratio of 4.

[0036] Figure 2 shows the fibre 1 of Figure 1 in cross-sectional view. It will be understood that due to the manner of manufacture by extrusion, the fibre is substantially identical at every cross section along the fibre length.

[0037] According to Figure 2, the first and second faces 2, 4 extend between left and right side edges 12, 14. A centre line CL is shown joining the left and right side edges 12, 14. The centre line CL has a mid-point M. According to the invention, the first ridge 6 is offset from the second ridge 8 along the centre line CL away from the mid-point M. In other words, the first ridge 6 is closer to the left side edge 12 and the second ridge 8 is closer to the right side edge 14. The portion of the first face 2 between the first ridge 6 and the right side edge 14 is identified as the major face 20 and the portion of the first face 2 between the first ridge 6 and the left side edge 12 is identified as the minor face 22. Both the major face 20 and the minor face 22 are generally concave, while the first ridge 6 is convex.

[0038] The cross-section of the fibre 1 is such that it has 2-fold rotational symmetry. This means that the first face 2, when rotated through 180° about the mid-point M will coincide directly with the second face 4. Due to the offset between the first and second ridges 6, 8, there is no reflectional symmetry about the centre line CL or even about any other line.

[0039] In the illustrated embodiment, the centre line CL has a length L of 1.2 mm and the offset OS between the first and second ridges 6, 8 is 0.1 mm. A thickness T of the fibre 1 measured transverse to the centre line at the widest point is around 0.38 mm.

[0040] In addition to the first and second ridges 6, 8, the corrugations 10 on the first and second faces 2, 4 of the fibre 1 can also be seen in this view. There are a total of four corrugations 10 on the major face 20 and three corrugations 10 on the minor face 22. Additionally, the left side edge 12 and the right side edge 14 are both rounded. In order to avoid difficulties with splitting, the corrugations 10 are smoothly rounded in a continuous curve with no abrupt changes in contour.

[0041] Figure 3 shows a plurality of fibres 1 tufted into a backing 24 to form artificial turf 26. The turf was used in comparative testing as described below.

Examples

Example 1

[0042] A sample of artificial turf measuring 1 metre x 3,70 metres according to Figure 3 was prepared using bundles of six fibres having a bundle dtex of 12000. The pile height was 60 mm and the backing was double 100% PP Thiobac, black, U.V.- stabilized, weight ca. 222 gr/m² from Royal Ten Cate. The tufts were at 5/8 gauge (15 mm) with a spacing of 13.5 tufts per 10 cm in the length direction. The sample was installed on a concrete base and filled with a first stabilising layer of 5 mm sand infill followed by a 35 mm layer of performance infill comprising Genan fine SBR of particle size 0.7 – 2.0 mm, leaving a free pile height of 20 mm.

Example 2

[0043] A turf sample of Slide MAX XQ 60 from Royal Ten Cate measuring 1 metre x 3.70 metres was installed on a similar basis to Example 1, using identical infill. The turf had the same dtex, tuft spacing and pile height as Example 1.

Example 3

[0044] A turf sample was prepared using Evolution™ fibres from Royal Ten Cate having dtex, tuft spacing and pile height as in Example 1 and measuring 1 metre x 3.70 metres. The sample was installed on a similar basis to Example 1, using identical infill.

[0045] The artificial turf samples of Examples 1 to 3 were subject to repetitive testing using a Lisport XL testing machine. The Lisport™ XL is a new generation of wear simulation machines that realistically replicate wear simulation of sport fields after years of usage. The wear pattern is characterised by the compressive stress of football studs (cleats) and the abrasive wear caused by flat-soled sports shoes. It has been widely adopted by the industry as a means of producing realistic simulated patterns.

[0046] The test samples were tested through a total of 12000 cycles with intermittent checks every 3000 cycles. Cracking, splitting and resilience of the fibres were measured and documented at each check. The protocol for the checks were as follows.

Cracking

- A crack is defined as an opening in the fibre, either at the top of the fibre or within its length.
- Ten fibres were selected at random from the test area.
- A mark was given for each fibre that did not exhibit a crack.

Splitting

- A split is defined as a crack that extends from the top of the fibre to the infill layer.
- Ten fibres were selected at random from the test area.
- A mark was given for each fibre that did not exhibit a split.

Resilience

- the position of the top of 90% of the fibres as a percentage of the initial pile height is measured.
- 10 points given for 100% of the initial pile height.
- 9 points given for 90% etc.

Results

[0047] Based on a quantitative review of the test samples as described above, and after 12000 cycles, the fibres of the Examples scored as follows:

- The fibres according to Example 1 scored values of 8 for cracking, 10 for splitting and 7 for resilience.
- The fibres of Example 2 scored values of 10 for cracking, 10 for splitting and 4 for resilience.
- The fibres of Example 3 scored values of 4 for cracking, 1 for splitting and 1 for resilience.

[0048] The samples were also visually inspected and it was apparent that the turf of Example 1 remained more upright than the other samples. The turf of Example 3 was particularly flattened.

[0049] Figure 4 shows a second embodiment of a fibre 101 according to the invention in which like elements to the first embodiment have similar reference numerals preceded by 100.

[0050] The fibre 101 of the second embodiment is substantially identical to that of the first embodiment but for the curvature of the major face 120 and minor face 122. According to this embodiment, the major face 120 is substantially concave, while the minor face 122 is more or less straight. The resulting fibre 101 has greater asymmetry than the fibre 1 of the first embodiment.

[0051] Thus, the invention has been described by reference to certain embodiments discussed above. It will be recognized that these embodiments are susceptible to various modifications and alternative forms well known to those of skill in the art. In particular, the fibres of Figures 1 and 4 may be provided without corrugations and the positions and sizes of the ridges may be adjusted accordingly. Furthermore, although straight fibres have been described, the fibres may be formed as twisted or helical fibres by adjusting the post extrusion processing accordingly.

[0052] Many modifications in addition to those described above may be made to the structures and techniques described herein without departing from the spirit and scope of the invention. Accordingly, although specific embodiments have been described, these are examples only and are not limiting upon the scope of the invention.

Conclusies

1. Vezel voor gebruik in kunstgras, waarbij de vezel een langwerpige dwarsdoorsnedevorm heeft die een eerste vlak en een tweede vlak definieert welke elkaar ontmoeten aan zijranden van de vezel, waarbij het eerste vlak en het tweede vlak een respectieve eerste en tweede richel hebben die een offset ten opzichte van elkaar hebben, zodanig, dat de dwarsdoorsnedevorm tweevoudig rotatiesymmetrisch is zonder spiegelsymmetrie.

2. Vezel volgens conclusie 1, waarbij het eerste en het tweede vlak concave gedeelten hebben.

3. Vezel volgens conclusie 1 of 2, waarbij het eerste en het tweede vlak golvingen hebben.

4. Vezel volgens willekeurig welke van de voorgaande conclusies, waarbij een centrale lijn die zich uitstrekt tussen de zijranden een lengte heeft in het gebied van 0,5-2 mm, bij voorkeur 1,0-1,5 mm, liefst ongeveer 1,25 mm.

5. Vezel volgens willekeurig welke van de voorgaande conclusies, waarbij een verhouding tussen een maximumdikte van de vezel, transversaal gemeten ten opzichte van een centrale lijn die zich uitstrekt tussen de zijranden, en een lengte van de centrale lijn, gelegen is in het gebied van 0,25-0,6, bij voorkeur 0,3-0,4.

6. Vezel volgens willekeurig welke van de voorgaande conclusies, waarbij de vezel een dtex waarde heeft in het gebied van 1500-3000, bij voorkeur 2000-2500.

7. Vezel volgens willekeurig welke van de voorgaande conclusies, waarbij de zijranden zijn afgerond en een krommingstraal hebben van ten minste 0,05 mm.

8. Vezel volgens willekeurig welke van de voorgaande conclusies, waarbij de eerste en de tweede richel zijn afgerond en een krommingstraal hebben van ten minste 0,1 mm.

9. Vezel volgens willekeurig welke van de voorgaande conclusies, waarbij de eerste en de tweede richel ten opzichte van elkaar een offset hebben langs een centrale lijn die zich uitstrekt tussen de zijranden, die groter is dan 0,05 x de lengte van de centrale lijn maar kleiner dan 0,4 x de lengte van de centrale lijn, bij voorkeur in het gebied tussen 0,1-0,2 x de lengte van de centrale lijn.

10. Vezel volgens willekeurig welke van de voorgaande conclusies, waarbij de vezel een geëxtrudeerd monofilament is, bij voorkeur een geëxtrudeerd en getrokken monofilament.

11. Vezel volgens willekeurig welke van de voorgaande conclusies, waarbij de vezel bestaat uit een polymeer dat is geselecteerd uit de groep die bestaat uit: polyamiden (PA-6, PA-6,6); polyesters (PET, PTT, PBT, PLA, PHB); polypropyleen (homopolymeer, copolymeer; reguliere een metallocene kwaliteiten); polyethyleen (HDPE, LDPE, LLDPE, reguliere [LLDPE] en metallocene [mLLDPE] kwaliteiten); polyolefine blok-copolymeren (OBC) en mengsels en coëxtrusies daarvan.

12. Kunstgras, omvattend rechtopstaande poolvezels volgens willekeurig welke van de voorgaande conclusies, vastgehouden in een ruglaag.

13. Kunstgras volgens conclusie 12, waarbij de poolvezels zijn getuft aan de ruglaag.

14. Kunstgras volgens conclusie 12, waarbij de poolvezels zijn verweven met de ruglaag.

15. Kunstgras volgens willekeurig welke van conclusies 12-14, waarbij de poolvezels zijn gemengd met verdere poolvezels die andere dwarsdoorsnedevormen hebben.

16. Kunstgras volgens conclusie 15, waarbij de verdere poolvezels vullingsvezels omvatten die korter zijn dan de poolvezels en dienen om de poolvezels te ondersteunen in een rechtopstaande positie.

17. Kunstgras volgens willekeurig welke van conclusies 12-16, verder omvattend een hoeveelheid instrooivulling tussen de vezels.

18. Kunstgras volgens willekeurig welke van conclusies 12-17, waarbij de poolvezels een poolhoogte hebben van meer dan 4 cm, bij voorkeur meer dan 5 cm en optioneel in het gebied van 6-7 cm.

19. Kunstgras volgens willekeurig welke van conclusies 12-18, waarbij de poolvezels zijn verankerd in de ruglaag over een vezellengte van meer dan 10 mm, bij voorkeur ten minste 15 mm en bij voorkeur ten minste 20 mm.

20. Sportveld omvattend kunstgras volgens willekeurig welke van conclusies 12-19.

Fig. 1

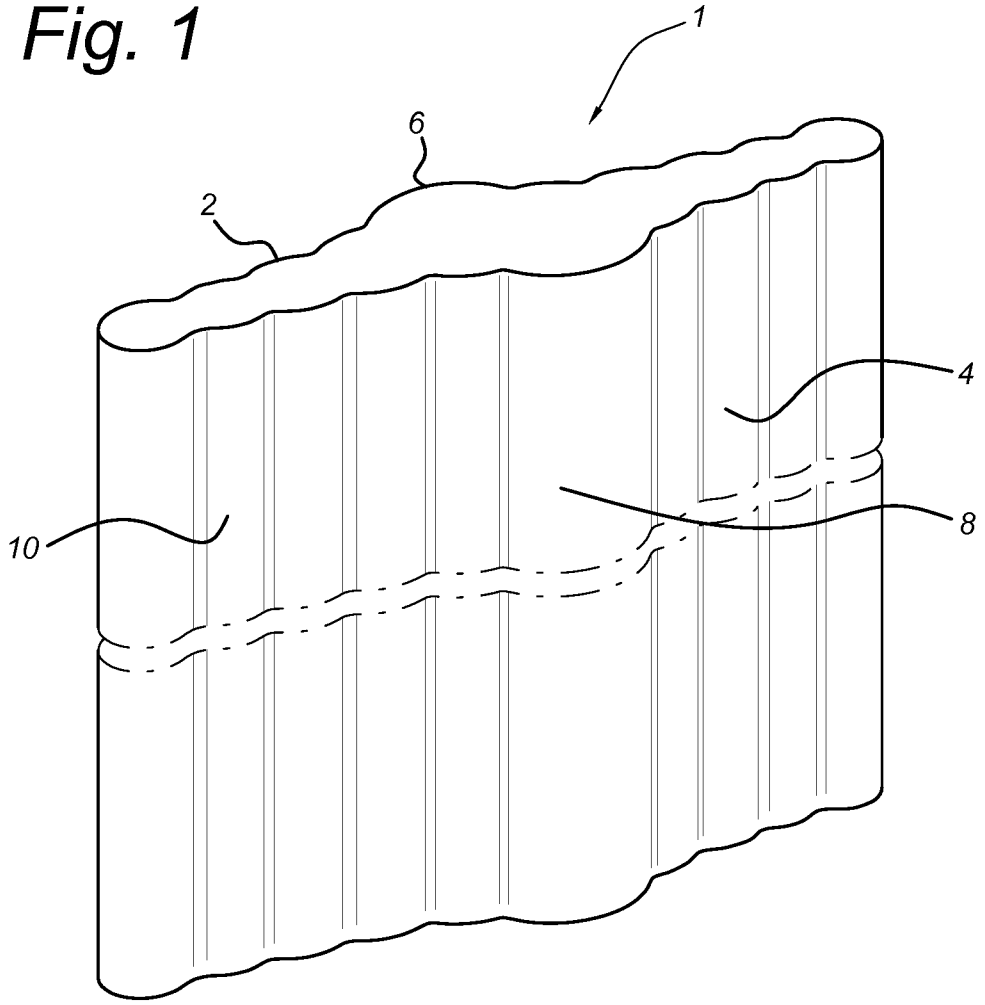


Fig. 2

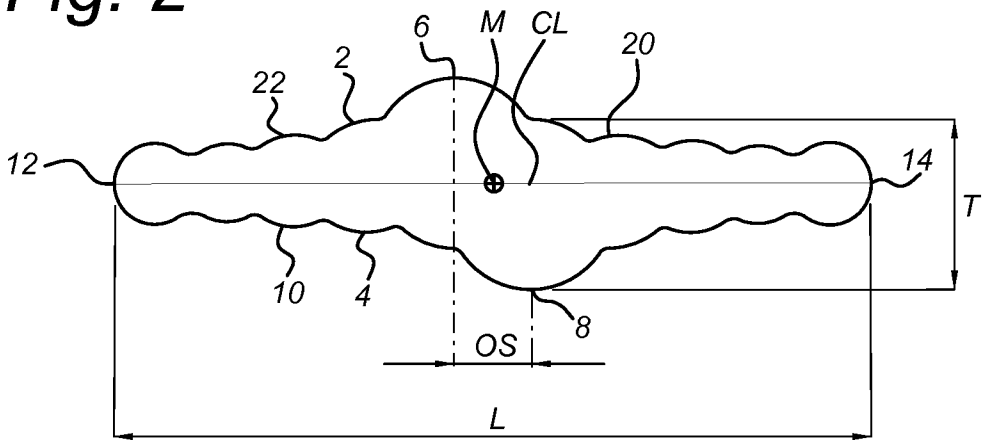


Fig. 3

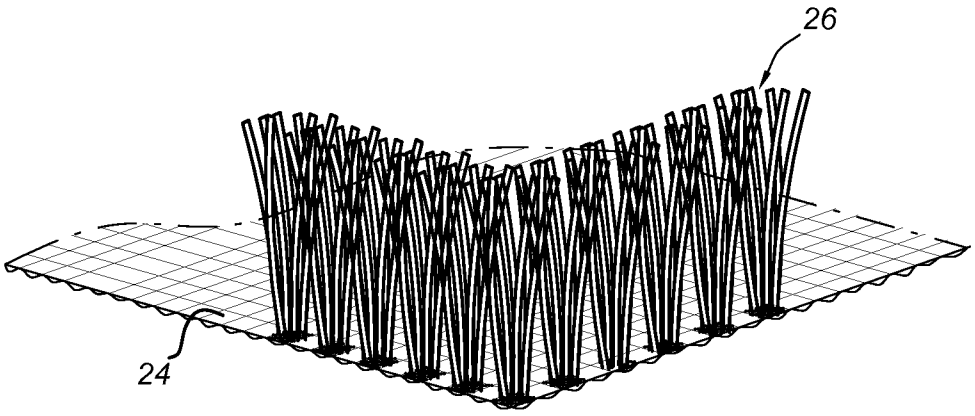
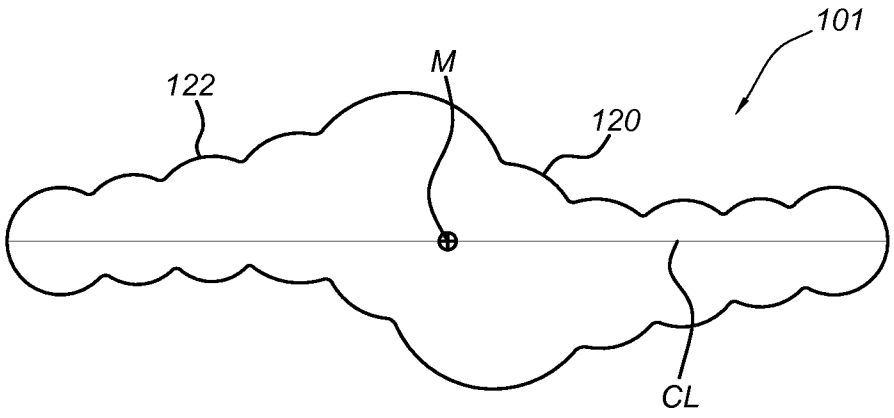


Fig. 4



Abstract

A fibre for use in artificial turf has an elongate cross-sectional shape defining a first face and a second face that meet at side edges of the fibre. The first and second faces having respective first and second ridges that are offset with respect to each other, such that the cross-sectional shape is 2-fold rotationally symmetric with no reflectional symmetry. The fibre may be an extruded monofilament and shows improved resilience over symmetrical fibres of similar dimensions.

[Fig 1]

SAMENWERKINGSVERDRAG (PCT)

RAPPORT BETREFFENDE NIEUWHEIDSONDERZOEK VAN INTERNATIONAAL TYPE

IDENTIFICATIE VAN DE NATIONALE AANVRAGE	KENMERK VAN DE AANVRAGER OF VAN DE GEMACHTIGDE
	P6064986NL
Nederlands aanvraag nr. **2017901**	Indieningsdatum **30-11-2016**
	Ingeroepen voorrangsdatum
Aanvrager (Naam) **Ten Cate Thiolon B.V.**	
Datum van het verzoek voor een onderzoek van internationaal type **04-03-2017**	Door de Instantie voor Internationaal Onderzoek aan het verzoek voor een onderzoek van internationaal type toegekend nr. **SN68496**

I. CLASSIFICATIE VAN HET ONDERWERP (bij toepassing van verschillende classificaties, alle classificatiesymbolen opgeven)

Volgens de internationale classificatie (IPC)

D02G3/44;E01C13/08;D01D5/253

II. ONDERZOCHTE GEBIEDEN VAN DE TECHNIEK

Onderzochte minimumdocumentatie

Classificatiesysteem	Classificatiesymbolen
IPC	**D02G;E01C;D01D**

Onderzochte andere documentatie dan de minimum documentatie, voor zover dergelijke documenten in de onderzochte gebieden zijn opgenomen

III. ☐	**GEEN ONDERZOEK MOGELIJK VOOR BEPAALDE CONCLUSIES**	(opmerkingen op aanvullingsblad)
IV. ☐	**GEBREK AAN EENHEID VAN UITVINDING**	(opmerkingen op aanvullingsblad)

ONDERZOEKSRAPPORT BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE

Nummer van het verzoek om een onderzoek naar de stand van de techniek
NL 2017901

A. CLASSIFICATIE VAN HET ONDERWERP
INV. D02G3/44 E01C13/08 D01D5/253
ADD.

Volgens de Internationale Classificatie van octrooien (IPC) of zowel volgens de nationale classificatie als volgens de IPC.

B. ONDERZOCHTE GEBIEDEN VAN DE TECHNIEK

Onderzochte minimum documentatie (classificatie gevolgd door classificatiesymbolen)
D02G E01C D01D

Onderzochte andere documentatie dan de minimum documentatie, voor dergelijke documenten, voor zover dergelijke documenten in de onderzochte gebieden zijn opgenomen

Tijdens het onderzoek geraadpleegde elektronische gegevensbestanden (naam van de gegevensbestanden en, waar uitvoerbaar, gebruikte trefwoorden)
EPO-Internal, WPI Data

C. VAN BELANG GEACHTE DOCUMENTEN

Categorie *	Geciteerde documenten, eventueel met aanduiding van speciaal van belang zijnde passages	Van belang voor conclusie nr.
X	WO 2011/027235 A1 (MONDO SPA [IT]; TESTA EMANUELE [IT]) 10 maart 2011 (2011-03-10) * bladzijde 2, regel 29 - bladzijde 3, regel 15 * * bladzijde 6, regel 1 - regel 9; figuren 1-2 * -----	1,4, 10-13, 18,20
X	CN 203 462 184 U (GUANGZHOU ALL VICTORY GRASS CO LTD) 5 maart 2014 (2014-03-05) * alinea [0004] * * alinea [0021]; figuur 2 * -----	1,10-12, 20
X	KR 101 357 683 B1 (DAE GUN C & L CO LTD [KR]) 4 februari 2014 (2014-02-04) * alinea [0005] - alinea [0007] * * alinea [0011]; figuur 3 * * alinea [0020] - alinea [0024] * ----- -/--	1,3, 10-13,20

[X] Verdere documenten worden vermeld in het vervolg van vak C.

[X] Leden van dezelfde octrooifamilie zijn vermeld in een bijlage

* Speciale categorieën van aangehaalde documenten

"A" niet tot de categorie X of Y behorende literatuur die de stand van de techniek beschrijft

"D" in de octrooiaanvrage vermeld

"E" eerdere octrooi(aanvrage), gepubliceerd op of na de indieningsdatum, waarin dezelfde uitvinding wordt beschreven

"L" om andere redenen vermelde literatuur

"O" niet-schriftelijke stand van de techniek

"P" tussen de voorrangsdatum en de indieningsdatum gepubliceerde literatuur

"T" na de indieningsdatum of de voorrangsdatum gepubliceerde literatuur die niet bezwarend is voor de octrooiaanvrage, maar wordt vermeld ter verheldering van de theorie of het principe dat ten grondslag ligt aan de uitvinding

"X" de conclusie wordt als niet nieuw of niet inventief beschouwd ten opzichte van deze literatuur

"Y" de conclusie wordt als niet inventief beschouwd ten opzichte van de combinatie van deze literatuur met andere geciteerde literatuur van dezelfde categorie, waarbij de combinatie voor de vakman voor de hand liggend wordt geacht

"&" lid van dezelfde octrooifamilie of overeenkomstige octrooipublicatie

Datum waarop het onderzoek naar de stand van de techniek van internationaal type werd voltooid	Verzenddatum van het rapport van het onderzoek naar de stand van de techniek van internationaal type
4 augustus 2017	

Naam en adres van de instantie	De bevoegde ambtenaar
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Pollet, Didier

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ONDERZOEKSRAPPORT BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE

Nummer van het verzoek om een onderzoek naar de stand van de techniek
NL 2017901

C.(Vervolg). VAN BELANG GEACHTE DOCUMENTEN

Categorie *	Geciteerde documenten, eventueel met aanduiding van speciaal van belang zijnde passages	Van belang voor conclusie nr.
X	EP 2 039 831 A1 (DOMO ZELE NV [BE]) 25 maart 2009 (2009-03-25) * alinea [0041] - alinea [0068]; figuren 1,5,10 * -----	1,4,6, 10-13, 15,17, 18,20
X	DE 10 2009 052848 A1 (OERLIKON TEXTILE GMBH & CO KG [DE]) 12 mei 2011 (2011-05-12) * alinea [0030] * * alinea [0035] - alinea [0038]; figuur 4.2 * -----	1,10-13, 20
A	US 2013/004683 A1 (AUGUSTE JEAN-CLAUDE [US] ET AL) 3 januari 2013 (2013-01-03) * alinea [0001] * * alinea [0010] - alinea [0012] * * alinea [0021] * * alinea [0030] * * alinea [0045] - alinea [0047] * * alinea [0050] - alinea [0051]; figuur 2 * -----	1-20

Formulier PCT/ISA/201 (vervolg tweede blad) (januari 2004)

ONDERZOEKSRAPPORT BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE

Informatie over leden van dezelfde octrooifamilie

Nummer van het verzoek om een onderzoek naar de stand van de techniek: NL 2017901

In het rapport genoemd octrooigeschrift	Datum van publicatie	Overeenkomend(e) geschrift(en)	Datum van publicatie
WO 2011027235 A1	10-03-2011	CA 2771970 A1	10-03-2011
		CN 102625865 A	01-08-2012
		EP 2473655 A1	11-07-2012
		ES 2336760 A1	15-04-2010
		ES 2437129 T3	09-01-2014
		JP 2013503984 A	04-02-2013
		KR 20120085750 A	01-08-2012
		US 2012270045 A1	25-10-2012
		WO 2011027235 A1	10-03-2011
CN 203462184 U	05-03-2014	GEEN	
KR 101357683 B1	04-02-2014	GEEN	
EP 2039831 A1	25-03-2009	GEEN	
DE 102009052848 A1	12-05-2011	GEEN	
US 2013004683 A1	03-01-2013	GEEN	

WRITTEN OPINION

File No.	Filing date *(day/month/year)*	Priority date *(day/month/year)*	Application No.
SN68496	30.11.2016		NL2017901

International Patent Classification (IPC)
INV. D02G3/44 E01C13/08 D01D5/253

Applicant
Ten Cate Thiolon B.V.

This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☒ Box No. VII Certain defects in the application
- ☒ Box No. VIII Certain observations on the application

	Examiner
	Pollet, Didier

Application number

WRITTEN OPINION

NL2017901

Box No. I Basis of this opinion

1. This opinion has been established on the basis of the latest set of claims filed before the start of the search.
2. With regard to any **nucleotide and/or amino acid sequence** disclosed in the application and necessary to the claimed invention, this opinion has been established on the basis of:

   a. type of material:

   ☐ a sequence listing

   ☐ table(s) related to the sequence listing

   b. format of material:

   ☐ on paper

   ☐ in electronic form

   c. time of filing/furnishing:

   ☐ contained in the application as filed.

   ☐ filed together with the application in electronic form.

   ☐ furnished subsequently for the purposes of search.

3. ☐ In addition, in the case that more than one version or copy of a sequence listing and/or table relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.
4. Additional comments:

Box No. V Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty	Yes:	Claims	2, 5, 7-9, 14, 16, 19
	No:	Claims	1, 3, 4, 6, 10-13, 15, 17, 18, 20
Inventive step	Yes:	Claims	
	No:	Claims	1-20
Industrial applicability	Yes:	Claims	1-20
	No:	Claims	

2. Citations and explanations

see separate sheet

WRITTEN OPINION

Box No. VII Certain defects in the application

see separate sheet

Box No. VIII Certain observations on the application

see separate sheet

Reference is made to the following documents:

D1	WO-A-2011/027235
D2	CN-U-203 462 184
D3	KR-B-101 357 683
D4	EP-A-2 039 831
D5	DE-A-10 2009 052848
D6	US-A-2013/004683

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

Lack of novelty

The present application does not meet the criteria of patentability, because the subject-matter of claims 1, 3-4, 6, 10-13, 15, 17-18 and 20 is not new.

re claims 1, 12 and 20:

Document D1 discloses (see fig. 1 and p. 6, l. 1-9) a *vezel (1) voor gebruik in kunstgras, waarbij de vezel een langwerpige dwarsdoorsnedevorm heeft die een eerste vlak en een tweede vlak definieert welke elkaar ontmoeten aan zijranden van de vezel, waarbij het eerste vlak en het tweede vlak een respectieve eerste en tweede richel (2, 3) hebben die een offset ten opzichte van elkaar hebben, zodanig, dat de dwarsdoorsnedevorm tweevoudig rotatiesymmetrisch is zonder spiegelsymmetrie.*

Note that also documents D2 (see fig. 2 and [0021]: *vezel* 1, *richel* 13), D3 (see fig. 3 and [0011]-[0012]: *vezel* 100, *richel* 201, 202, 300), D4 (see fig. 10 and [0054]: *vezel* 17, *richel* a) and D5 (see fig. 4.2 and [0036]-[0038]) at least disclose the subject-matter of claims 1, 12 and 20.

re claim 3:

Het eerste en het tweede vlak (101, 102) in de vezel (100) volgens D3 (see figs. 3-4) hebben golvingen (201, 202, 300, 301).

re claim 4:

Een centrale lijn die zich uitstrekt tussen de zijranden in de vezel volgens D1 (p. 3, l. 3-4) heeft een lengte in het gebied van 0,5-2 mm, bij voorkeur 1,0-1,5 mm, liefst ongeveer 1,25 mm. See also D4, p. 5, l. 11-13.

re claim 6:

De vezel volgens D4 (p. 7, l. 5-6) heeft een dtex waarde in het gebied van 1500-3000, bij voorkeur 2000-2500.

re claims 10-11:

De vezel volgens D1 (p. 2, l 29-33) is een geëxtrudeerd monofilament, bij voorkeur een geëxtrudeerd en getrokken monofilament en bestaat uit een polymeer dat is geselecteerd uit de groep die bestaat uit: polyamiden; polyesters; polypropyleen; polyethyleen; polyolefine blok-copolymeren en mengsels en coëxtrusies daarvan. See also D2 ([0024]), D3 ([0020]), D4 ([0065]-[0066]) and D5 ([0035]).

re claim 13:

De poolvezels in het kunstgras volgens D4 (see [0043]) zijn getuft aan de ruglaag. See also D1 to D3 and D5.

re claim 15:

De poolvezels (17) in het kunstgras volgens D4 (see fig. 5 and [0055]-[0057]) zijn gemengd met verdere poolvezels (14) die andere dwarsdoorsnedevormen hebben.

re claim 17:

Het kunstgras volgens D4 (see [0075]-[0094]) omvat verder een hoeveelheid instrooivulling (3) tussen de vezels.

re claim 18:

De poolvezels in het kunstgras volgens D4 (see [0068]) hebben een poolhoogte van meer dan 4 cm, bij voorkeur meer dan 5 cm en optioneel in het gebied van 6-7 cm. See also D1 (p. 3, l. 5-6).

Lack of inventive step

Dependent claims 2, 5, 7-9, 14, 16 and 19 do not appear to contain any features which, in combination with the features of any claim to which they refer, meet the criteria of patentability. The features herein disclosed appear to be merely some of several constructional possibilities from which the skilled person would select, in accordance with circumstances, without the exercise of inventive skill. Hints thereto could easily be taken from the above mentioned documents.

Industrial applicability

Since it appears that the claimed invention can be made or used in a technological sense in industry, the claimed invention appears to have industrial applicability.

Re Item VII

Certain defects in the application

Independent claim 1 is not in the two-part form, which in the present case would be appropriate, with those features known in combination from the prior art being placed in the preamble and the remaining features being included in the characterising part.

The features of the claims are not provided with reference signs placed in parentheses.

The relevant background art disclosed in D1 to D6 is not mentioned in the description, nor are these documents identified therein.

Re Item VIII

Certain observations on the application

Claims 1, 10-11 and 16 are not clear.

The result to be achieved (i.e. *zodanig, dat de dwarsdoorsnedevorm tweevoudig rotatiesymmetrisch is zonder spiegelsymmetrie*) defined in claim 1 is vague and unclear and leaves the reader in doubt as to the meaning of the technical feature to which it refers (see [0011]), thereby rendering the definition of the subject-matter of said claim unclear.

Claim 10 defines *preferably an extruded and drawn monofilament*. Yet, it is unclear whether one can distinguish from the product the fact that a monofilament has been drawn.

The bracketed expressions in claim 11 (i.e. (PA-6, PA-6,6); (PET, PTT, PBT, PLA, PHB); (homopolymeer, copolymeer; reguliere een metallocene kwaliteiten); (HDPE, LDPE, LLDPE, reguliere [LLDPE] en metallocene [mLLDPE] kwaliteiten) and (OBC)) render the claim unclear (i.e. are they options or examples and what is meant by regular and metallocene grades?).

The relative term *korter* used in claim 16 is in view of paragraph [0016] unclear (i.e. the fibres are shorter *in height in the use position*).

The vague and imprecise statement in paragraph [0052] of the description implies that the subject-matter for which protection is sought may be different to that defined by the claims, thereby resulting in lack of clarity when used to interpret them.