

SPORTS SURFACE, ITS USE AND ITS METHOD OF MANUFACTURING

Technical Field

[0001] The invention relates to a fibre-based sport surface and a method of manufacturing a fibre-based sports surface. The sports surface comprises a backing layer and a pile layer and is suited for a large variety of sports and recreational activities, including field hockey, lawn bowls, cricket, golf, tennis and paddle. The sports surface shows excellent performance without irrigation and is therefore particularly suited for use in its dry condition, i.e., without the addition of water.

10 Background Art

[0002] Sports surfaces need to fulfil certain performance criteria to enable comfortable play and/or to comply with norms and restrictions that have been set by professional sports associations. For example, restrictions may be provided to ensure a minimum or maximum ball-roll distance, specify ball bounce characteristics, or to enable a safe player sliding performance. Natural turf is one of the preferred surfaces for many sports but is frequently found too costly to maintain for everyday use. For this reason, artificial turf has become increasingly popular and has developed through multiple generations to achieve sports performance that is equal to or even exceeds the natural version. In general, artificial turf comprises a backing layer and a pile layer, which are connected together by tufting or weaving or the like. The pile layer forms the playing surface.

[0003] The pile layer of the sports surface determines the performance of the sports surface. It may also be provided with infill materials to achieve the required resiliency and other sports performance characteristics. Features such as the pile height, yarn type, fibre density and stiffness all contribute to the ball's behaviour on the playing surface. For example, if the friction between a ball and the playing surface is very large, then the ball may not roll the required distance. In general, the development of pile has sought to mimic its natural equivalent by providing different fibre shapes and materials. WO 2006/091067 A1 shows an example of an artificial grass turf system specifically intended for use as a sports field, in particular for soccer.

[0004] Fibre-based sports surfaces are widely used to play ball sports like soccer and hockey, but can have as a disadvantage that the friction at the playing surface is too large. This can negatively affect the sports performance and can lead to injuries of the players when sliding. To mitigate these negative effects, the sports surface can be wetted in order to lower the friction at the playing surface. This is especially applied on hockey fields and this solution is commonly referred to as a "water based field".

[0005] Although the described water based fields provide excellent sports performance, the required large volumes of water for wetting the field are not always readily available. Moreover, it is not environmentally friendly to use large amounts of water, especially in periods of draught. Preparing a water based field for a match can require as much as 20 000 litres of water per period of play. While such water based fields have become the standard for sports such as hockey, their

use has become untenable, since they put the sport out of reach for certain groups of players and nations with scarce water.

[0006] The present invention attempts to further improve on such sports surfaces by providing a field with a comparable or improved level of functionality while reducing the required amount of water to wet the field and/or entirely omitting the use of water.

Summary of Invention

[0007] Therefore, according to a first aspect of the invention, there is provided a sports surface comprising a backing layer and a pile layer, wherein the pile layer comprises pile fibres, connected to the backing layer to form loops and the loops are closely packed together to form a substantially continuous playing surface. The pile fibres can be formed by monofilaments, fibrillated tapes, slit tapes or the like. Preferably, the pile fibres are formed by monofilaments i.e. fibres that have been extruded as individual filaments.

[0008] Here the term "sports surface" is used to refer to a specialized surface for carrying out sports or other recreational activities, for example to play field hockey, lawn bowls, cricket, golf, tennis, paddle or soccer. It will be understood that in embodiments the sports surface can be adjusted to comply with norms set by professional sports associations regarding certain performance features such as ball roll distance or ball rebound height. The sports surface according to the present claims marks a significant departure from conventional thinking in that it no longer seeks to approximate natural turf but instead delivers a sports performance that is inherently different from natural turf and existing artificial turf.

[0009] The pile layer comprises a plurality of loops and the playing surface is formed by an upper part of the plurality of loops. The term "loop crest" is used to refer to the upper and outer part of the plurality of loops that forms the playing surface. Typically, each loop has a loop base defined by the points where the pile fibre extends from a top surface of the backing layer. From the loop base, two loop sides extend between the backing layer and the playing surface. The playing surface is formed by the loop crest that connects the two loop sides. It will be understood that the loop is formed by a continuous fibre and that the definition of what a loop side and a loop crest is, may depend on the momentary shape of the loop. The loop shape is for instance dependent on the pressure currently and/or previously applied to the playing surface, but may also depend on other factors such as the degree of packing of adjacent loops.

[0010] Traditional sports surfaces typically use cut-fibres in the pile layer. In comparison to such traditional cut-fibre sports fields, the resistance at the playing surface is reduced. The loops provide a better support for the same pile fibre volume and consequently the ball does not sink into the field as much. This may result in a smaller contact area between the pile fibres and the ball, which can reduce the friction between the ball or player's skin on the one hand, and the playing surface on the other hand. Less friction results in less deceleration of the ball and a lower risk of skin abrasive wounds when a player makes a sliding tackle. When a player slips or slides on a playing surface

with high frictional resistance, then locally high temperatures may develop that can lead to friction burns and skin abrasion.

[0011] In addition to a smaller contact area, the contact area in the playing surface according to the invention also has a lower roughness. A cut-fibre playing surface may have sharp edges around
5 the cut cross-sections of the pile fibres, whereas the sides of the loop crests that form the playing field are typically much smoother. This additional smoothness contributes to a further reduction of the friction between the ball or player's skin on the one hand, and the playing surface on the other hand.

[0012] Consequent to the lower friction, it is typically not needed to provide additional water on
10 the sports surface to further reduce the friction. From an environmental perspective, this is a significant advantage. Traditional water based fields used for field hockey, for example, require approximately 20,000 litres of water per hour of play for a single hockey field.

[0013] The loops provide a significant amount of support and because the loops can deform, the resilience of the layer is improved. This results in increased player comfort in comparison to cut pile
15 fibres and lower ball bounces as more energy is absorbed in the pile layer.

[0014] The loops further increase the rotational resistance of the playing surface, leading to an improved grip of the ball and player foot. This prevents a player from accidentally slipping and falling or becoming injured.

[0015] Further advantageous to the sports surface according to the invention is the increased
20 longevity of the surface. Due to the relatively good flexibility of the loops, pile fibre wear is reduced. Moreover, pile fibre pull out is reduced because it requires more force to pull out a loop than a single cut pile fibre. In addition, the closed loops make it more difficult to damage the pile fibres by splitting them because there are no pile fibre ends extending to the surface that can be damaged. This in turn allows the fibre material to be adapted, since split resistance is no longer paramount. It is thus
25 easier to tailor the fibre material to improved comfort or lower friction e.g. by using softer materials or coatings.

[0016] Finally, in most professional sports, consistency across the surface is paramount to the game. The loops are closely packed together to form a substantially continuous playing surface. The dense packing improves the consistency of the field. Due to the good longevity of the field, the
30 consistency remains guaranteed over a longer period of time.

[0017] A close packing of the loops may help achieve the required support and resilience of the sports surface. In an embodiment, the pile layer has a pile density ratio of at least 100 g/m² per mm, preferably at least 150 g/m² per mm. Here the pile density ratio is defined as the mass of the pile layer [g/m²] per unit of height [mm] of the pile layer. The mass of the pile layer may be determined
35 according to ISO 8543 and the pile height may be measured according to ISO 2549. Hence the unit of the pile density ratio is grams per square meter per millimetre.

[0018] Alternatively, the close packing of the loops can be defined by the number of loops per square meter or the number of loops or filaments per square meter. In an embodiment, at least

40,000 loop bundles are provided per square meter, preferably at least 60,000 loop bundles per square meter. The number of loop bundles may be measured according to the standard ISO 1763.

[0019] In an embodiment, at least 400,000 individual loops are provided per square meter, preferably at least 600,000 loops per square meter. Here each loop is formed by an individual
5 filament or fibre. A count of 600,000 loops is thus comparable to 1,200,000 filaments in a cut-fibre pile layer. The number of filaments may be measured according to the standard ISO 1763.

[0020] In an embodiment, the pile layer has a pile height between 5 mm and 20 mm, preferably between 8 mm and 10 mm. The pile height may be measured according to ISO 2549. For a larger
10 pile height, the sports surface becomes more prone to damages as the likelihood that part of a player's shoe gets entangled in a loop increases. Larger loops therefore have a higher risk of being pulled out.

[0021] In an embodiment, the loops have an aspect ratio (H/W) of less than 3. The loop base is generally determined by the manner in which the loop is formed. For a tufted pile layer, the loop base will be largely determined by the needle size and the bundle diameter that is tufted. A loop, if
15 unconstrained will tend to have a curvature determined by the structural properties of the fibre i.e. the second moment of area. If the loops are packed closely together, the adjacent loops may support against each other, leading to narrower loops. In general, a maximum loop width is obtained within the pile layer at a position spaced from the top surface of the backing layer. It is however not excluded that other constructions may form loops having a greater width at their base at the position
20 where the pile exits the backing layer.

[0022] In an embodiment, an aspect ratio may be at least 2.2, preferably at least 2.4. For a tufted pile layer the loop base is provided by a single opening in the backing layer. In embodiments, the loop base may be wider.

[0023] In an embodiment, the pile layer has a mass of at least 800 g/m². The mass may be
25 determined according to the standard ISO 8543.

[0024] In an embodiment, the backing layer has an upper surface and a lower surface, the pile fibres passing through the backing layer and extending along the lower surface of the backing layer, wherein the pile fibres at the lower surface of the backing layer have been heated to weaken or destructure the material. It will be understood that the pile fibres are generally drawn down during
30 extrusion in order to orientate the polymer material. Heating the material to the softening temperature can cause the orientation to be lost and the fibre strength to be reduced. When a large pulling force is exerted on one of the loops in the pile layer, the loop may be pulled out, while breaking the yarn at the weakened lower side of the backing. Consequently, the effects of laddering, i.e., loss of consecutive loops from the same column or row if one loop is pulled out, and fraying,
35 i.e., loss and damage of pile fibres from the cut edge, may be reduced or fully prevented.

[0025] It is believed that attempts have been made in the past to use loop pile constructions for sports surfaces but these have failed due to the tendency of loops to become snagged and cause unacceptable laddering. Cutting of the loops to provide cut-pile sports surfaces was seen as the only solution to this problem. In an embodiment, the present disclosure teaches a way of

overcoming the problem of laddering by providing a point of weakness in the pile fibres that avoids laddering.

[0026] In an embodiment, the pile fibres at the lower surface of the backing layer are at least partially melted. The pile fibres may be partially melted or fused entirely. The term "fusing" is used to refer to the situation where two components or fibres are fully melted together i.e. to form an integral component. Melting may merely cause one component to mould around the other component without actual bonding or fusing taking place. In this case, once cooled, there may be merely a mechanical bonding of the two components e.g. the pile fibres and the woven backing layer. Melting the pile fibres together may lead to bundles of fibres at the lower surface of the backing layers which have a higher pull out strength. The melted bundles of filaments are more difficult to pull out than a single filament but can nevertheless not easily ladder.

[0027] In an embodiment, the sports surface further comprises a locking layer provided at a lower surface of the backing layer for locking the pile fibres to the backing layer and/or mitigate laddering. The locking layer prevents pull-out of the pile fibres from the backing layer and may further reduce the effects of laddering due to the enhanced pull out strength.

[0028] In an embodiment, the locking layer comprises one of the following: a hot melt adhesive, a powder melt adhesive, a coating layer or a laminated film. The coating layer may for example be a latex or polyurethane coating. In embodiments, a combination may be applied; for example application of both a powder melt adhesive and a laminated film.

[0029] Additional layers may be provided below the backing layer, both for locking and other purposes. Woven layers or needled felt layers may be provided to add strength and durability or to enhance shock absorption. The sports surface may thus be produced with an integral shock pad.

[0030] In an embodiment, the pile layer further comprises a plurality of cut loops. Such cut loops preferably have a similar pile height or a lower pile height than the loops, such that the playing surface is at least partially formed by the looped pile fibres. In embodiments, all loops are uncut. A combination of both cut loops and uncut loops can be used to optimize the sports performance characteristics of the sports field. In addition, cut loops can be provided to mitigate the effects of "fraying", and "laddering" as cutting the loops reduces the length of consecutive loops so that less loops are pulled out. Alternatively, the effects of laddering and fraying may be mitigated by cutting the pile fibres at a lower surface of the backing layer.

[0031] In an embodiment, at least 70 wt. % of the pile layer consists of uncut loops, preferably wherein at least 90 wt. % of the pile layer consists of uncut loops. The term 'uncut' loops in this context is understood to refer to them not being cut within the pile layer, i.e., above the top surface of the backing layer.

[0032] In an embodiment, the pile fibres comprise a polymeric material, preferably a polyethylene material. The polymeric material may be extruded and oriented by drawing. Polyethylene, in particular low density polyethylene is a preferred material due to its good resilience and is therefore most suited to achieve the required sports performance. Alternatively, for example polypropylene or polyamide material can be used to form the pile layer. As noted above, due to the use of loops

and the absence of cut ends that may be prone to fraying and splitting, softer materials may be used that have been conventionally used in artificial turf.

[0033] In an embodiment, the pile fibres forming the loops are arranged in bundles. Preferably, each bundle comprises 3 to 30, preferably from 6 to 12 monofilaments, fibrillated tapes, or bundles of slit tapes. Application of the pile in bundles is efficient from a production standpoint and the skilled person will understand the trade-offs between bundle size and processability. In embodiments, the bundles of pile fibres have a linear density between 2000 dtex and 20000 dtex, preferably between 6000 dtex and 10000 dtex.

[0034] According to an aspect of the invention, the fibres within the bundle have a linear density between 500 dtex and 2000 dtex, preferably between 800 dtex and 1200 dtex. It will be understood that this is not comparable with carpet materials e.g. for indoor use, which may also be formed with a loop pile but have dtex values far below 100 dtex.

[0035] In an embodiment, the pile layer further comprises texturized yarns. The texturized yarns may be formed as looped pile fibres or can be cut pile fibres. The texturized yarns may have the same pile height or be shorter and provided to form a resilient thatch layer.

[0036] In an embodiment, the pile fibres are tufted into the backing layer. The skilled person will be familiar with the procedure for tufting such loops. The tufts may be straight or may be arranged in a zig-zag fashion. It has been found that a slight zig-zag is useful in avoiding an overly linear pattern of the loops, which could lead to directionality in the playing surface. Alternatively, the pile fibres may be integrated in the backing layer in a different way such as by knitting, weaving, or needling.

[0037] In an embodiment, the loops have a pull-out strength of at least 35 N, preferably at least 50 N. The pull-out strength may be determined by the minimum withdrawal force as defined according to ISO norm 4919 for loops. Where the loop comprises a plurality of fibres in a bundle, this is the pull-out strength of the bundle. Such a strength is typically required by sports associations as a minimum. The sports field according to the invention can be configured to comply with norms set by sports associations.

[0038] In an embodiment, the pile fibres have a cross section with an aspect ratio (w/t) of not greater than 5, preferably not greater than 4. The person skilled in the art will understand that this is relatively thick for conventional artificial grass blades. In the present case however, the fibre is no longer functioning as an upstanding blade, intending to mimic grass. The shape instead provides the pile fibre with structural strength in the form of a bowed arch.

[0039] In an embodiment, the pile fibres may have a substantially circular, elliptical, oval, lenticular, diamond or rectangular cross-sectional shape.

[0040] In another embodiment, the pile fibres may have a plurality of elongated ribs extending along the elongated direction of the pile fibres. Disadvantageous to a smooth circumferential surface of the pile fibres is a potential glaring when the light is bright. Roughening the surface of the pile fibres by providing elongated ribs along the pile fibres can mitigate glare and provide a more natural appearance.

[0041] In an embodiment, the sports surface is suited for ball sports, in particular for field hockey, lawn bowls, cricket, golf, tennis or paddle. It will be understood that the pile layer may be adjusted to comply with the norms and requirements for a specific sports application. It will further be understood that the sports surface may also be used for other recreational activities without a ball.

5 [0042] In an embodiment, the sports surface is suited for use without irrigating the surface. As explained above, conventional fields are often used in combination with water to enhance sports performance. The water reduces the resistance of the playing surface thereby improving sports performance. For the sports surface according to the invention, it has surprisingly been found that no water is required for good sports performance as the resistance is naturally lower.

10 [0043] In an embodiment, the backing layer comprises polymeric material. For example, the backing layer may be made of polypropylene, which exhibits excellent stability to outdoor conditions, shows high creep resistance and has excellent longevity. Stability of the backing layer is important because temperatures on a pitch may vary between below freezing and up to 85 degrees Celsius if exposed to direct sun without suitable cooling provisions. Sufficient creep
15 resistance is especially important for sports surfaces applied on sports fields with even a minor slope for drainage, where static forces can otherwise lead to deformation over time of the sports surface. Alternatively, the backing layer may be made of another polymeric material such as polyethylene and preferably a high density polyethylene. A high density polyethylene material may also be used to manufacture a backing that exhibits excellent stability to outdoor conditions, shows
20 high creep resistance and has excellent longevity. Moreover, providing both the backing layer and the pile fibres of a polyethylene material enhances the ability to recycle the product at end of life.

[0044] Preferably, the backing layer is made of a polymeric material having a higher melting temperature than the pile fibres. In an embodiment, the backing layer comprises a polymeric material having a first melting temperature and the pile fibres comprise a polymeric material having
25 a second melting temperature, wherein the difference between the first and second melting temperature is at least 2 degrees Celsius, preferably at least 3 degrees Celsius and may be more than 5 degrees Celsius. The different melting temperature enables the pile fibres to be secured in the backing layer through melting of the pile fibres without affecting the filaments of the backing layer.

30 [0045] In an embodiment, the sports surface has been heat-stabilized. For heat stabilization the sports surface is heated above the maximum temperature that can be expected during play. Heat stabilization may improve the dimensional stability of the sports surface. The backing layer may be a woven fabric and the heat-stabilization relaxes the strain developed in the filaments of the backing layer during the weaving process. It will be understood that weaving generally takes place at
35 ambient temperatures at which the filaments have a given modulus. The weaving action creates bends and twists in the filaments, which remain once the process is completed. If the temperature of the backing layer is elevated, the induced strain can recover by relaxation and straightening of bends in the filaments. As a side-effect of the heat-stabilization, the height of the pile layer may be reduced by approximately 20%.

[0046] The heat-stabilization may be performed using a variety of different methods. In an embodiment, heat-stabilization takes place by feeding the substrate along a body having a heated surface, a first surface of the backing layer being arranged to contact the heated surface. The heated surface may be a roller or calendar as is generally known in the art. In another embodiment, the heat-stabilization is performed by guiding the backing layer through an oven or ovens without direct contact with a heated surface. For example, a tenter frame may be used to guide the backing layer through the oven.

[0047] According to a second aspect of the invention and in accordance with the advantages and effects described herein above, use of a sports surface according to the invention for a ball sport is disclosed, preferably for field hockey, lawn bowls, cricket, golf, tennis or paddle.

[0048] In an embodiment, the sports surface is used without purposely watering the surface in advance, to improve play. Here "purposely watering the surface in advance, to improve play" refers to the common practice to water hockey fields to enhance their performance. It will be understood that water may naturally be added to outdoor fields when it rains, or possibly when a field is cleaned or for cooling purposes. The sports surface according to the invention can be used without watering and still meet the desired performance criteria.

[0049] According to a further aspect of the invention and in accordance with the advantages and effects described herein above there is provided a method of manufacturing a sports surface, the method comprising providing a backing layer, the backing layer have an upper surface and a lower surface; integrating a plurality of pile fibres into the backing layer to be upstanding as loops from the upper surface, the loops being connected to each other at the lower surface of the backing layer; and forming a substantially continuous playing surface by providing a close packing of loops.

[0050] In an embodiment, the method further comprises weakening the pile fibres at the lower surface of the backing layer to prevent laddering.

[0051] In an embodiment, the method further comprises at least partially melting the pile fibres at the lower surface of the backing layer to disrupt or reduce the molecular orientation of the fibre material to prevent laddering and/or prevent fibre pull-out.

[0052] In an embodiment, the method further comprises heat-stabilizing the sports surface.

30 **Brief Description of Drawings**

[0053] Embodiments will now be described, by way of example only, with reference to the accompanying schematic drawings in which corresponding reference symbols indicate corresponding parts. In the drawings, like numerals designate like elements. Multiple instances of an element may each include separate letters appended to the reference number. For example, two instances of a particular element "20" may be labelled as "20a" and "20b". The reference number may be used without an appended letter (e.g. "20") to generally refer to an unspecified instance or to all instances of that element, while the reference number will include an appended letter (e.g. "20a") to refer to a specific instance of the element.

[0054] Figure 1A schematically shows a cross-sectional side view of a sports surface according to a first embodiment.

[0055] Figure 1B shows a detail of a looped pile fibre in the sports surface according to Fig. 1A.

[0056] Figure 2 shows a cross-sectional view of a filament in a pile fibre according to a first
5 embodiment.

[0057] Figure 3 shows a first embodiment of an apparatus that can be used to heat-stabilize the sports surface and/or to provide the pile fibres with an anti-laddering treatment.

[0058] Figure 4A schematically shows a cross-sectional side view of a hockey ball arranged on the sports surface according to an embodiment of the invention.

10 [0059] Figure 4B schematically shows a cross-sectional side view of a hockey ball arranged on a prior art water field with cut pile fibres.

[0060] The figures are meant for illustrative purposes only, and do not serve as restriction of the scope or the protection as laid down by the claims.

15 **Description of Embodiments**

[0061] The following is a description of certain embodiments of the invention, given by way of example only and with reference to the figures.

[0062] Figure 1A schematically shows a cross-sectional side view of a first embodiment of a sports surface 10 comprising a backing layer 1 having a lower surface 11 and a top surface 12, a
20 pile layer 2 with loop bundles 20, a locking layer 3 and a playing surface 15. The loop bundles 20 are formed by bundles of pile fibres 27 formed as monofilaments. Each monofilament forms an individual loop 21, having loop sides 22, a loop crest 23 and a loop base 24.

[0063] The backing layer 1 is a woven fabric having warp tapes and weft tapes through which the loops 21 have been tufted. The backing layer 1 is made of polypropylene and has a fabric weight
25 of approximately 250 g/m². The backing layer 1 comprises two sub layers 13 and 14 that are stitched together to form the primary backing layer 1. Nevertheless, it will be understood that also a single layer backing layer, or a backing layer made of another material may be used in other embodiments. The polypropylene backing layer 1 has a melting point of approximately 160 degrees Celsius.

[0064] The pile layer 2 comprises a plurality of closely packed loop bundles 20, each formed by
30 ten loops 21 extending from the top surface 12 of the backing layer 1 to the playing surface 15. Each loop 21 has two loop sides 22a, 22b, and a loop crest 23, wherein the loop sides 22 are connected to each other by the loop crest 23. The loop crests 23 of all loops 21 together form the playing surface 15 of the sports surface 10. The playing surface 15 may support a ball or a player during play.

35 [0065] At the lower surface 11 of the backing layer 1, the fibres 27 are continuous between consecutive loop bundles 20. The portions of fibre 27 that extends along the lower surface 11 of the backing layer 1 is locked to the backing layer 1 by the locking layer 3. The locking layer 3 comprises a latex coating with a weight of approximately 1000 g/m².

[0066] Figure 1B shows a detail of a single loop 21 within a loop bundle 20. The loop sides 22 each extend approximately over a pile height H from the top surface 11 of the backing layer 1. The loop base 24 is here defined as the point where the loop 21 intersects the top surface 12 of the backing layer 1. The loop 21 is widest at a distance of approximately 2/3 of the pile height from the loop base 24. The loop 21 has an aspect ratio (H/W) of approximately 2.5.

PILE LAYER - EXAMPLE 1

[0067] According to a first embodiment of the pile layer 2, the loops 21 have a height of approximately 8 mm, measured as the distance between the top surface 11 of the pile layer 2 and the average height of the loop crests 23. The loops 21 are provided at a stitch rate of approximately 375 stiches per meter across a length direction of the sports surface 10 and a gauge of approximately 4 mm along the width direction of the sports surface. In this way, approximately 100,000 bundles of loops are provided per square meter of sports surface 10.

[0068] Each bundle has a linear density of 8000 dtex, consisting of 10 monofilaments of 800 dtex each. Consequently, the sports surface 10 comprises approximately 2 million filaments per square meter, wherein each loop side 22 is counted as a separate filament. Hence the loops 21 are packed closely together to form the playing surface 15. The pile layer 2 has a total pile mass of approximately 2000 g/m².

[0069] The pile height is approximately 8mm, leading to a pile density ratio of 250 g/m² per mm of height. The aspect ratio (H/W) is approximately 2.5.

PILE LAYER - EXAMPLES 2 - 5

[0070] Table 1 shows the characteristics of four further examples for the pile layer 2. Features in the pile layer 2 that have already been described above with reference to the first example may also be present in examples 2-5 and will not all be discussed here again. For example, the loop shape and loop aspect ratio (H/W) are approximately the same as in Example 1.

Table 1

Property	Method	Unit	Example 2	Example 3	Example 4	Example 5
Pile height	ISO 2549	mm	8 mm	8 mm	8 mm	8 mm
Stitch rate	ISO 1763	/m	450	450	250	250
Gauge	ISO 1763	/m	252	252	252	252
Filaments per m ²	ISO 1763	#	2,3 million	2,3 million	1,3 million	1,3 million
Pile mass	ISO 8543	g/m ²	2200	2200	1220	1220

PILE LAYER - EXAMPLE 6

[0071] According to a second embodiment of the pile layer 2, the loops 21 have a height of 9mm. The loops 21 are provided at a stitch rate of approximately 450 stiches per meter across a length

direction of the sports surface and a gauge of approximately 4 mm along the width direction of the sports surface. In this way, approximately 115,000 bundles of loops are provided per square meter of sports surface 10.

- [0072] The bundles are formed by two different types of filaments. Each bundle has a linear
5 density of 8000 dtex, comprising 4 fibres of a first straight filament of 1000 dtex and 5 fibres of a
texturized filament of 800 dtex. The pile layer 2 has a total pile mass of approximately 2400 g/m²,
leading to a pile density ratio of approximately 260 g/m² per mm of height.

MATERIAL OF THE PILE FIBRE FILAMENTS

- 10 [0073] The pile fibres of each of examples 1-6 are made of a polyethylene (PE) material as this
can provide the desired sports performance. The filaments may further comprise one or more
additives preferably selected from the group comprising antioxidants, UV stabilizers, pigments,
processing aids, acid scavengers, lubricants, antistatic agents, fillers, nucleating agents, and
clarifying agents.

- 15 [0074] In each of the examples, approximately 90.5 wt.% of the filaments is made of PE and the
remaining 9.5 wt.% is provided by additives. For example, 6 wt.% of pigments, 3 wt.% of calcium
carbonate and 0.5 wt.% of processing aids. It will be understood, however, that different
compositions may be used in other embodiments.

- [0075] According to a first embodiment of the PE composition, used in examples 2 and 4 of the
20 pile layer, the filaments of the pile fibres are made of a low density polyethylene material formed
from monomers having four carbon atoms, i.e., butene based PE, here referred to as a C4 grade
PE. The C4 grade PE has a melt flow index (MFI) of approximately 2 and a density of 918 kg/m³.
The straight pile fibres of Example 6 are also of C4 grade PE.

- [0076] According to a second embodiment of the PE composition, used in examples 3 and 5 of
25 the pile layer, the filaments of the pile fibres are made of a low density polyethylene material formed
from monomers having six carbon atoms, i.e., a hexene based PE, here referred to as a C6 grade
PE. The C6 grade PE has a higher toughness and higher flexibility than the C4 grade PE. The C6
grade PE has a melt flow index (MFI) of approximately 3.5 and a density of 918 kg/m³. The
texturized filaments of Example 6 are also of this polymer grade.

- 30 [0077] According to a third embodiment of the PE composition, used in example 1, the filaments
of the pile fibres are made of a C4 grade PE and C6 grade PE blend. Approximately 85 wt.% of the
PE blend consists of a C4 grade of PE and 15 wt.% of the PE blend consists of a C6 grade of PE.

- [0078] Typically, in a conventional sports surface with cut pile fibres a higher grade PE is used
to increase the toughness. The pile fibres are prone to damage if the material is soft, such as a
35 C4 grade PE, mainly due to the grass blades splitting from their top surface. By providing closed
loops in the pile layer of the sports surface according to the invention, splitting of the pile fibres is
prevented and softer C4 grade PE can be used without adverse consequences. Having a greater
proportion of C4 grade PE in the fibre material leads to a much softer fibre that is more comfortable
for players in use.

CROSS SECTIONAL SHAPE OF THE FILAMENTS

[0079] The filaments may be provided in many different shapes such as substantially circular, oval, lenticular, diamond shaped, rectangular, or shaped as a capital letter "C" or "D". The closed loop protects the pile fibre from splitting as no separate blade ends are provided and therefore the cross-sectional shape has less need for a special shape to prevent splitting of the pile fibres.

[0080] Figure 2 depicts the cross-sectional shape of a fibre 27 as used in the pile layer 2 according to Example 1. The cross section has a lenticular shape with a maximum width w of approximately 0.75 mm and a maximum thickness t of approximately 200 μm . Hence the aspect ratio (w/t) is approximately 3.75. The thicker filaments forming the loops provide a good ratio between the contact area versus the cross-sectional area of the pile fibre and ensure that the loop is structurally more resilient due to the higher second moment of area of the fibre.

[0081] The surface of the fibre 27 is relatively smooth, which reduces the friction at the contact surface. This has several advantageous effects and in particular reduces the risk of skin abrasions when a player falls or slides along the playing surface 15.

[0082] The surface of the fibre 27 is provided with a plurality of elongated ribs 25 that extend along the elongated direction of the fibre 27. The ribs 25 along the surface reduce the glare from the surface in bright areas. It will be understood that the ribs 25 may be omitted if the reduction of glare is not required, for example for indoor use. Examples 2-6 have filaments or fibres with a similar lenticular shape, yet no ribs 25 have been provided.

HEAT STABILIZATION AND HEAT TREATMENT

[0083] The sports surface 10 according to each of examples 1 to 6 has been heat stabilized before use by guiding the sports surface 10 through an oven using a tenter frame during application of the latex coating. This process is well known to the skilled person for drying of the latex material and also leads to a reduction in the pile height from the initially tufted condition.

[0084] In addition to heat stabilization of the overall sports surface, the fibres 27 at the lower surface 11 of the backing layer 1 may undergo an additional heat treatment step to prevent laddering.

[0085] Fig. 3 shows an exemplary embodiment of an apparatus 30 that can be used to carry out the heat treatment. The sports surface 10 is provided to a feed roller 31 and guided through the apparatus 30 using a plurality of guiding rollers 32. The sports surface 10 is carried through the machine at a speed between 1 and 30 m/min and guided along the heated surface 35 of a roller 34. In the case of the polypropylene backing layer described in relation to Example 1, the melting temperature of the PP backing layer 1 is at least 25 C above the temperature at which the pile fibres 27 are softened. By heating to the point at which the pile fibres 27 at the lower surface 11 of the backing layer 1 are melted, the fibres 27 become weakened at this point and will break prior to laddering when subjected to a sufficient force. The weakening of the pile fibres 27 may be sufficient that the breaking strength of the fibre is lower than the pull out force of an individual fibre.

[0086] The heat treatment may be combined with the heat stabilization or carried out separately. The heat treatment may further be combined with the application of a locking layer. For example, a hot melt adhesive or powder melt may be applied to further increase the pull-out strength. A device 33, for instance a sprinkling device, may be arranged in the apparatus 30. The device 33 may
5 sprinkle hot melt adhesive powder on the lower surface 11 of the backing layer 1 before the sports surface 10 is carried along the heated roller 34.

SPORTS PERFORMANCE

[0087] The sports surface 10 has enhanced sports performance properties in comparison to a
10 prior art sports surface 80 used on water based fields. Figures 4A and 4B schematically depict a hockey ball 7 arranged on top of the playing surface 15 of the sports surface 10 according to the invention, and of a prior art sports surface 80, respectively. The drawings are highly schematic and it will be understood by the skilled person that in reality a hockey ball is significantly larger than a few loops or cut pile fibres.

15 [0088] At each of the sports surfaces 10, 80, frictional resistance occurs between the ball 7 and the surface from rolling and when skidding. Both actions are interrelated and the transition from skidding to rolling is a key property in many games. The 'rolling resistance' is considerably less than the resistance to skidding, but depending on the velocity and spin applied to the ball the transition between the two can differ. In this context, skidding is used to refer to the movement of a ball, which
20 moves along the surface without rotation. Reverse rotation may also be present.

[0089] Roll resistance is defined as the force acting at the point of contact between the ball and surface whose direction is opposite to that of the motion and thus causes deceleration of the ball as it moves across the surface. Friction between the ball and the surface is responsible for variations in speed, direction and rate of rotation. The type of surface can dramatically influence friction.
25 Differences in pile height, yarn type, fibre density and stiffness (amongst others) all contribute to the ball's behaviour. If the friction between a ball and the surface is too large, then the ball will not roll the required distance.

[0090] A ball will continue to skid across the surface until its linear velocity parallel to the playing surface 15 has been reduced and the angular velocity of the ball 7 has increased to the point where
30 rolling occurs. For smooth rolling there can be no skidding between the ball and surface, therefore, a balance between the forward velocity and rate of rotation at the point of contact with the surface is required for pure rolling. The transition between the Rolling friction (RF) and Skidding friction (SF) is impacted by a range of variables of the sports surface 15, specifically by the pile layer 2.

[0091] Advantageous to the use of the loops 21 in the pile layer 2 is that they naturally have a
35 lower skidding friction than the conventional cut pile sports surface 80. The ball 7 is supported by the loop crests 23 and the loop crests 23 are formed by the sides of the filament forming the loop 21. Therefore the contact area between the ball 7 and the playing surface 15 is relatively smooth.

[0092] In contrast, the cut pile fibres 81 in the pile layer of the prior art surface 80 have sharp edges, providing a contact area which is not smooth. In addition, the hockey ball 7 does not sink as

deep within the pile layer 2 as the loops provide more support than the cut pile fibres for the same pile fibre volume. Consequently, the contact area of the ball 7 with the pile fibres is reduced. Hence the roll and skidding resistance provided at the playing surface 15 is significantly larger in the prior art system for the same pile fibre volume.

5 [0093] In prior art systems, for example for field hockey surfaces, water is applied to reduce the friction at the playing surface, especially skidding friction. By providing the loops 21, the skidding friction is already naturally lower, providing good sports performance also when no water is applied. The ball roll distance is approximately a factor two larger in the sports surface according to the invention in comparison to a dry sports surface of the fields currently used as water based fields.

10 [0094] Table 2 provides an overview of the performance characteristics of the sports surface according to examples 1-6 in comparison to a reference water based sports surface with cut pile fibres. For the reference surface, the pile height is 13 mm, provided at a stitch rate of 360 stitches per m, a gauge of 210 per m, and approximately 75,000 tufts per surface. Each tuft comprising 8000 dtex bundle with 10 texturized filaments of 800 dtex each.

15

Table 2

Property	Method	Unit	Reference	Example					
				1	2	3	4	5	6
Ball roll distance (dry)	EN 12235 (1.0 m)	mm	14	29	>25	>26	22	>23	22
Rot. resistance (dry)	EN 15301-1	Nm	35-38	38-40	41-44	46-48	33-35	39-42	41-43
Rot. resistance (wet)	EN 15301-1	Nm	37	38	43	44	34	40	41
Ball rebound (dry) *	EN 12235	mm	500	440	440	390	540	480	420

[0095] Besides the rolling and skidding resistance, ball bounce characteristics are important for sports performance of a field. The loops 21 absorb more energy than cut-pile fibres, thereby resulting in a lower ball rebound. It will be understood that dependent on the sports application this is preferable. For example for field hockey, a lower ball bounce is advantageous. For a similar pile fibre volume, the ball rebound height is up to 15% lower for the dry sports surface according to the invention in comparison to the prior art system with cut pile fibres. It is to be noted that the ball rebound value is based on a solid concrete undersurface for comparison purposes only. In actual use, the sports surface 10 would be installed on a shock pad or provided with additional cushioning to achieve the required specifications.

[0096] Further important for sports performance is the rotational resistance experienced by the ball 7. The rotational resistance has an effect on the grip and is approximately 5 % higher on the dry sports surface according to the invention in comparison to a wetted prior art system with cut pile fibres.

[0097] Finally, in ball sports consistency across the surface is paramount to the game. The playing surface 15 comprising loop crests 23 is very consistent due to the high density of the loops.

Moreover since the pull-out strength very good, the consistence of the sports surface remains good for a long time. Each of examples 1-5 has a pull-out strength of at least 50 N. Example 6 has a pull-out strength of approximately 45 N.

[0098] Additionally, as a consequence of the present loop based system, extra fibre mass can
5 be used without risking the fibre integrity of the system. In prior art cut-pile systems, the bundle size was limited by the ability to successfully lock in all of the fibres within a bundle. A common failure mode was the loss of individual filaments which compromised the strength of the bundle. Were a less well held fibre to be pulled out from the middle of a bundle, the remaining fibres would become loose and soon also pull out. In the case of a loop-based system, even if a single fibre is partially
10 pulled, it is not removed and does not therefore affect the remaining fibres in the bundle.

[0099] Although the sports surface 10 according to the above described examples has been designed for field hockey, the skilled person will understand that the field may also be suited for use in a variety of different ball sports, for example lawn bowls, cricket, golf, tennis or paddle, or for other recreational purposes.

15 [00100] The present invention may be embodied in other specific forms without departing from its spirit or essential characteristics. The described embodiments are to be considered in all respects only as illustrative and not restrictive. The scope of the invention is, therefore, indicated by the appended claims rather than by the foregoing description. It will be apparent to the person skilled in the art that alternative and equivalent embodiments of the invention can be conceived and
20 reduced to practice. All changes which come within the meaning and range of equivalency of the claims are to be embraced within their scope.

Claims

1. A sports surface comprising a backing layer and a pile layer, wherein the pile layer comprises pile fibres, connected to the backing layer to form loops and the loops are closely packed together to form a substantially continuous playing surface.
2. The sports surface according to claim 1, wherein the pile layer has a pile density ratio of at least 100 g/m² per mm, preferably at least 150 g/m² per mm.
3. The sports surface according to claim 1 or claim 2, wherein at least 40,000 loops are provided per square meter, preferably at least 60,000 loops per square meter.
4. The sports surface according to any one of the preceding claims, wherein the pile layer has a pile height between 5 mm and 20 mm, preferably between 8 mm and 10 mm.
5. The sports surface according to any one of the preceding claim wherein the loops have an aspect ratio (H/W) of less than 3.
6. The sports surface according to any of the preceding claims, wherein the loops have an aspect ratio (H/W) of at least 2.2, preferably at least 2.4.
7. The sports surface according to any one of the preceding claims, wherein the pile layer has a mass of at least 800 g/m².
8. The sports surface according to any one of the preceding claims, wherein the pile fibres are arranged to prevent laddering.
9. The sports surface according to any one of the preceding claims, wherein the backing layer has an upper surface and a lower surface, the pile fibres passing through the backing layer and wherein the pile fibres at the lower surface of the backing layer are weakened.
10. The sports surface according to claim 9, wherein the pile fibres at the lower surface of the backing layer are at least partially melted.
11. The sports surface according to any one of the preceding claims, further comprising a locking layer provided at a lower surface of the backing layer for locking the pile fibres to the backing layer and/or mitigate laddering.

12. The sports surface according to claim 11, wherein the locking layer comprises one of the following: a hot melt adhesive, a powder melt adhesive, a coating layer, or a laminated film.
- 5 13. The sports surface according to any one of the preceding claim, wherein the pile layer further comprises a plurality of cut loops.
- 10 14. The sports surface according to any one of the preceding claim wherein at least 70 wt. % of the pile layer consists of uncut loops, preferably wherein at least 90 wt. % of the pile layer consists of uncut loops.
- 15 15. The sports surface according to any one of the preceding claims, wherein the pile fibres are made of a polymeric material, preferably a polyethylene material.
- 16 16. The sports surface according to any one of the preceding claim, wherein the pile fibres are arranged in bundles.
- 20 17. The sports surface according to claim 16, wherein each bundle has a linear density between 2000 dtex and 20000 dtex, preferably between 6000 dtex and 10000 dtex.
- 25 18. The sports surface according to any one of the preceding claim wherein the pile fibres have a linear density of between 500 dtex and 2000 dtex.
19. The sports surface according to one of the preceding claims, wherein the pile layer further comprises texturized yarns.
20. The sports surface according to any one of the preceding claims wherein the pile fibres are tufted into the backing layer.
- 30 21. The sports surface according to any one of the preceding claims, wherein the loops have a pull-out strength of at least 35 N, preferably at least 50 N.
22. The sports surface according to any one of the preceding claim wherein the pile fibres have a cross section with an aspect ratio (w/t) of not greater than 5, preferably not greater than 4.
- 35 23. The sports surface according to any of the preceding claims wherein the pile fibres have a width between 50 and 450 μm , preferably between 150 and 300 μm .

24. The sports surface according to any one of the preceding claim wherein the pile fibres have a substantially circular, elliptical, oval, lenticular, diamond, or rectangular cross-sectional shape.
- 5 25. The sports surface according to any one of the preceding claims wherein the pile fibres have a plurality of elongated ribs extending along the elongated direction of the pile fibres.
- 10 26. The sports surface according to any one of the preceding claims, wherein the sports surface is suited for ball sports, in particular for field hockey, lawn bowls, cricket, golf, tennis or paddle.
- 15 27. The sports surface according to any of the preceding claims, wherein the sports surface is suited for use without irrigating the surface.
28. The sports surface according to any one of the preceding claims, wherein the backing layer is made of a polymeric material, preferably polypropylene or high density polyethylene.
- 20 29. The sports surface according to any one of the preceding claims, wherein the sports surface has been heat-stabilized.
30. Use of a sports surface according to any of claims 1-29 for a ball sports, preferably for the use of field hockey, lawn bowls, cricket, golf, tennis or paddle.
- 25 31. Use of the sports surface according to claim 28, wherein the sports surface is used without purposely watering the surface to improve play in advance.
- 30 32. A method of manufacturing a sports surface, the method comprising
- providing a backing layer, the backing layer have an upper surface and a lower surface;
 - integrating a plurality of pile fibres into the backing layer to be upstanding as loops from the upper surface and, the loops being connected to each other at the lower surface of the backing layer,
 - 35 - forming a substantially continuous playing surface by providing a close packing of loops.
33. The method according to claim 32, wherein the method further comprises weakening the pile fibres at the lower surface of the backing layer to prevent laddering.

34. The method according to claim 32 or 33, wherein the method further comprises at least partially melting the pile fibres at the lower surface of the backing layer to prevent laddering and/or prevent fibre pull-out.
- 5 35. The method according to any of claims 32 to 35, wherein the method further comprises heat-stabilizing the sports surface.