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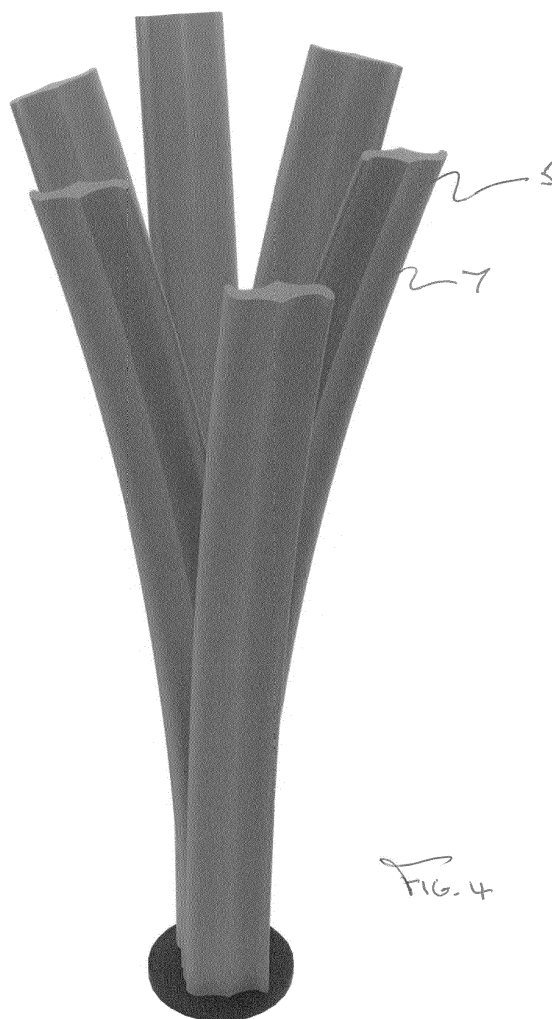
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(54) **IMPROVEMENTS IN OR RELATING TO ARTIFICIAL SURFACES**

(57) An artificial surface 10, such as an artificial grass and/or sports surface 10, comprises a plurality of blades 5, and comprises a material or yarn 5 comprising a polyolefin or polymer material and at least one additive comprising a siloxane additive. Each of the blades 5 may be substantially straight. The artificial surface 10 may have a pile height of around 20mm to 75mm and/or a tuft gauge of at least 3/8 inch.



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Description**FIELD OF INVENTION**

[0001] The present invention relates to a material or yarn for an artificial surface, e.g., an artificial grass surface, a sports surface and/or sports playing surface. The present invention additionally or alternatively relates to a sports surface or sports playing surface or an artificial grass surface. The present invention also relates to a method of manufacturing a material or yarn for an artificial surface, and to a method of manufacturing an artificial surface, such as an artificial grass/turf surface and/or sports (playing) surface, field or pitch.

BACKGROUND

[0002] Implementations of the present invention relate to a polyolefin artificial grass yarn developed for contact sports, by which is meant sports where an athlete/player/sports person makes body contact with an artificial grass yarn sports surface. This could be during a slide, a tackle, scrummage or other such sports specific manoeuvres.

[0003] The artificial grass yarn of implementations of the present invention has been designed to reduce and/or eliminate incidence of skin injuries (commonly referred to as turf burns) to an athlete/player's skin. The yarn can, therefore, be said to be "a skin friendly contact sports yarn".

[0004] There has been an issue regarding skin injuries and artificial turf since artificial turfs inception in the 1960's. Nylon, polypropylene, polyethylene and other types of polyolefins have all been used in the production of artificial turf and have all caused skin injuries.

[0005] A skin injury or turf burn is commonly a combination of skin abrasion and a friction burn. Skin abrasion is a partial thickness wound caused by damage to the skin and can be in a range between superficial (involving only the epidermis) to deep (involving the deep dermis). Abrasions usually involve minimal bleeding. Mild abrasions - also known as grazes or scrapes - do not scar or bleed because the dermis is left intact, but deep abrasions that disrupt the normal dermal structures may lead to the formation of scar tissue. Abrasion injuries most commonly occur when exposed skin comes into moving contact with a rough surface, causing a grinding or rubbing away of the upper layers of the epidermis.

[0006] Friction burn is a form of abrasion caused by the friction of skin rubbing against a surface. As friction generates heat, extreme cases of chafing may result in genuine burning of the outer layers of skin. Skin will burn when it reaches 55-60°C. Burns that affect only the superficial skin layers are known as superficial or first-degree burns. They appear red without blisters and pain typically lasts around three days. Injuries that extend into some of the underlying skin-layer are partial-thickness or second-degree burns. Blisters are frequently present, and such are often very painful. Healing can require up to eight weeks and scarring may occur.

[0007] While turf burns can happen on natural grass surfaces (1-3% players report skin injuries data from the SFA, UEFA and FIFA), the incidence is much higher on artificial grass sports surfaces (2.5-6% players report skin injuries data from the SFA, UEFA and FIFA). It should also be noted that due to the way skin injuries are recorded, this may be an under representation of the true figure which could be higher.

[0008] Regardless of the numbers, players perceive turf burns as a real risk, which reduces acceptance of artificial surfaces for contact sports. Additionally, the fear of getting hurt by going to ground on the artificial surface is negatively influencing a player's performance and changing their style of play to avoid injury.

[0009] Considering the present invention in terms of the problem/solution approach, the following comments are offered.

[0010] Players/athletes come into contact with a surface while performing sports specific manoeuvres, for example a sliding tackle in soccer or scoring a try in rugby, or by falling, being dragged or losing traction on a surface.

[0011] During these constant surface contact events, a player could potentially suffer a turf burn - which is a skin injury caused by skin abrasion and heat from friction, as a moving object (player) moves quickly against an immobile object (surface).

[0012] These turf burns manifest as lacerations and blisters to the skin, sometimes several layers deep, potentially causing permanent scarring to the skin.

[0013] The capacity for the skin to reach the temperature required for a turf burn, 55-60°C, is significantly higher on artificial grass sports surfaces than it is on natural grass surfaces. This is because there is greater friction between the skin and an artificial grass surface than between the skin and a natural grass surface. This invention seeks to reduce this friction between the skin and the turf, hence reducing the capacity for skin injury. Each player has unique skin conditions, and so their interaction with the surface will be unique. By reducing the friction between the surface and the skin, one would reduce the risk of skin injury.

[0014] Other influencing factors, aside from the type of surface, include:

- (i) The skin care routine of the player - well-moisturised skin tends to suffer less injury, and some players will apply a layer of skin moisturiser prior to a match or game.

- (ii) The presence of hair - more body hair reduces the risk as it acts like a physical barrier.
 - (iii) The age of the player - older skin is more prone to injury.
 - (iv) Skin hydration level - higher hydration levels will suffer less injury as it is more flexible and elastic.
 - (v) The wetness of the surface - a very dry surface will increase the level of friction between the skin and the surface;
- some pitch owners will water the surface with water prior to a game.

[0015] A number of documents disclose artificial playing surfaces. For example, GB2601243 (Stephen) discloses an artificial surface which is particularly suited as a hockey playing surface. As such, the playing surface of GB2601243 has functional requirements which may be different from the requirements of artificial playing surfaces developed for other sports such as contact sports. For example, hockey playing surfaces are required to meet certain criteria for sports performance which are specific to hockey, which are associated with structural features that may be different from, or even incompatible with, the requirements and/or features of an artificial playing surface for contact sports. For example, hockey playing surfaces, typically requiring watering before use, must allow the hockey ball to travel fast but minimise bounce, allow a player to get under the ball with their stick and provide consistency of ball rolling and movement. This means hockey pitches tend to be free of infill material (sand or rubber), use texturised yarns, with filaments having a narrow tuft gauge (i.e. high pile density) of around 3/16" and a low pile height of around 10-18 mm.

[0016] Various documents disclose examples of artificial surface, infill, or treatment thereof, for example WO2020/142232A1 (Dow Global Technologies LLC) US2020/0121816A1 (Grossman), US2018/0016741A1 (Sirochman et al.), US2008/0124496A1 (Avery), US 5356344 A (Lemieux), and GB 0939053 A (Fabrication Ind De Moulage).

[0017] It may be an object of at least one embodiment of at least one aspect of the present invention to obviate or mitigate one or more disadvantages or problems in the prior art.

[0018] It may be an object of at least one embodiment of at least one aspect of the present invention to provide an improved artificial surface, such as an artificial grass and/or sports (playing) surface.

SUMMARY OF INVENTION

[0019] According to the present disclosure there is provided: a material or yarn for an artificial surface, such as a sports/artificial grass surface; an artificial surface; a sports field, pitch or court; a method of manufacturing a material or yarn for an artificial surface; a method of manufacturing an artificial surface; and use of a material or yarn in an artificial surface according to the appended claims.

[0020] A general solution of the present invention may be to alter a surface tension of an artificial grass yarn used in production of an artificial surface, e.g., sports field or pitch, so as to provide a more lubricated feel. In this way one can reduce friction which reduces horizontal velocity, the sliding coefficient of friction and in doing so reduce risk of skin injury.

[0021] A key objective of the present invention is to reduce the coefficient of dynamic friction on the surface while maintaining enough traction on the surface so the player retains grip. This is achieved utilising an additive (permanent slip additive). The specific additive example according to embodiments of the invention uses siloxane chemistry. For example, an additive containing Octamethylcyclotetrasiloxane (D4) CAS No 556-67-2; EC No 209-136-7).

[0022] In this invention the addition of an additive (permanent slip additive) to the polymer acts to reduce the coefficient of dynamic friction - which is defined as the force between two objects when one object is moving or if two objects are moving against one another. During processing, the (permanent slip) additive beneficially migrates to the surface as the polymer material cools (because of incompatibilities with the basic polymer). This may allow a (solid) lubricating layer to form. This may act to lower the dynamic friction or adhesion between contacting surfaces. Advantageously, the additive may not be chemically linked with the (base) polymer but is retained in the polymer due to the additives high molecular weight (and the resultant impaired mobility).

FIRST INVENTION

[0023] According to a first aspect there is provided a material or yarn for an artificial surface, such as a sports surface or artificial grass/turf surface.

[0024] The artificial surface may comprise or may be a contact sports playing surface, e.g. a long pile contact sports playing surface.

[0025] The artificial surface may not comprise or may not be a short pile or hockey playing surface.

[0026] The material or yarn may comprise a synthetic turf or grass yarn.

[0027] The material or yarn may comprise a metallocene catalysed polyolefin or polymer material. Metallocene-catalysed polyolefin/polymer offers a number of advantages such as impact strength and/or robustness.

[0028] The material or yarn may comprise at least one additive comprising a siloxane additive.

[0029] The material or yarn may comprise a filament. The filament may be a straight or linear filament. The filament may be self-supporting, i.e., capable of standing at least partially vertically unsupported. The filament may be a twisted

filament or a straight twisted filament. The filament may be a monofilament or a slit film. The filament may have a propeller or diamond shaped cross-section. The filament may have a cross-sectional width of around 1.0mm to 2.0mm, e.g. 1.2mm to 1.5mm, and a cross-sectional breadth of around 200 μ m to 450 μ m, e.g. 300 μ m to 380 μ m.

[0030] The provision of a straight or linear filament may be particularly well suited to the manufacture of an artificial playing surface for contact sports. Without wishing to be bound by theory, it is believed that using straight or linear filaments of any of the forms mentioned above, provides a larger smooth surface for the at least one additive, e.g. siloxane, to contact a player's skin, thus reducing friction and associated risks of burns to the player. In contrast, the provision of textured fibres or filaments, as typically found on hockey playing surfaces, does not provide such a continuous smooth surface, and therefore does not provide this advantageous effect. In addition, using straight or linear filaments, typically providing a longer pile height, may allow the use of infills within the playing surface which may help reduce impact.

[0031] The polyolefin or polymer may comprise a polyolefin, e.g. polyethylene, such as linear low-density polyethylene (LLDPE).

[0032] The at least one additive may comprise or include (at least) Octamethylcyclotetrasiloxane (D4).

[0033] The at least one additive may comprise or include at least one of, or may be selected from one or more of: Hexamethylcyclotrisiloxane (D3), Decamethylcyclopentasiloxane (D5), Dodecamethylcyclohexasiloxane (D6), Hexamethyldisiloxane (HMDS).

[0034] The polyolefin or polymer material may comprise 80% to 90% of the material or yarn.

[0035] The at least one additive may comprise 0.1 % to 10% of the material or yarn, or 0.5% to 5%, or beneficially 2% to 4%, e.g., 3% of the material or yarn.

[0036] The at least one additive may comprise or form a layer on the material or yarn or on the polyolefin or polymer material (or polyolefin/polymer material or yarn core), such as an outer layer on the material or yarn or on the polyolefin or polymer material.

[0037] According to a second aspect there is provided an artificial surface, such as an artificial grass and/or sports surface.

[0038] The artificial surface may comprise or may be a contact sports playing surface, e.g. a long pile contact sports playing surface.

[0039] The artificial surface may not comprise or may not be a short pile or hockey playing surface.

[0040] The artificial surface may comprise a plurality of (synthetic) blades.

[0041] Each blade may comprise a material or yarn comprising a synthetic turf or grass yarn comprising a metallocene catalysed polyolefin or polymer material and/or at least one additive comprising a siloxane additive.

[0042] The artificial surface may have a pile height of around 20mm to 75mm, e.g. 30 mm to 65 mm, e.g. 35 mm to 65 mm.

[0043] The artificial surface may have a tuft gauge of at least 3/8 inch (9.5 mm), e.g. at least 1/2 inch (12.7 mm), e.g. at least 5/8 inch (15.9 mm), e.g. at least 3/4 inch (19.0 mm). The artificial surface may have a tuft gauge of around 3/8 inch (9.52 mm), around 1/2 inch (12.7 mm), around 5/8 inch (15.9 mm), or around 3/4 inch (19.0 mm). This is in contrast with the typical tuft gauge of a hockey playing surface, which may be in the region of around 3/16 inch (4.8 mm).

[0044] The artificial surface may comprise a (primary) backing material to which the blades are woven or tufted.

[0045] The artificial surface may be provided with an infill material(s). In one implementation the infill material(s) may comprise or may be a particulate infill material, such as rubber, e.g. crumb rubber, and/or sand. In an alternative implementation, the infill material may be texturised yarns or filaments. For example, the texturised yarns or filaments may be formed from a same material as the material or yarn of the first aspect of the present invention. The texturised yarns or filaments may be woven or tufted to the backing material. In a further alternative implementation, no infill material may be provided.

[0046] Preferably, when an infill is used, the infill material(s) may comprise or may be a particulate infill material, such as rubber, e.g. crumb rubber, and/or sand. In such instance, the plurality of (synthetic) blades of the artificial surface may be straight or linear filaments, which may be selected from straight filaments, twisted filaments, straight twisted filaments, monofilaments, or slit film filaments. The filaments may have a propeller or diamond shaped cross-section. The filaments may have a cross-sectional width of around 1.0mm to 2.0mm, e.g. 1.2mm to 1.5mm, and a cross-sectional breadth of around 200 μ m to 450 μ m, e.g. 300 μ m to 380 μ m.

[0047] The plurality of (synthetic) blades of the artificial surface may not include crimped or texturised yarns.

[0048] The provision of a straight or linear filament may particularly well suited to the manufacture of an artificial playing surface for contact sports. Without wishing to be bound by theory, it is believed that using straight or linear filaments of any of the forms mentioned above, provides a larger smooth surface for the at least one additive, e.g. siloxane, to contact a player's skin, thus reducing friction and associated risks of burns to the player. In contrast, the provision of textured fibers or filaments, as typically found on hockey playing surfaces, does not provide such a continuous smooth surface, and therefore does not provide this advantageous effect. In addition, using straight or linear filaments, typically providing a longer pile height, may allow the use of infills within the playing surface which may help reduce impact.

[0049] The artificial surface may have a sliding coefficient of friction of between 0.7 and 1.0, such as around 0.94.

[0050] According to a third aspect there is provided use of the material or yarn of the first aspect in an artificial surface,

such as an artificial grass or sports surface or playing surface, such as a field or pitch.

[0051] The use may comprise use of the material or yarn of the first aspect in a contact sports playing surface.

[0052] According to a fourth aspect there is provided a method of manufacturing a material or yarn according to the first aspect of the present invention.

[0053] The method may comprise:

providing a raw material (polyolefin or polymer material);

providing at least one additive;

extruding the raw material and the at least one additive so as to form the material or yarn.

[0054] According to a fifth aspect there is provided a method of forming an artificial surface, such as an artificial grass and/or sports surface, according to the second aspect using filaments comprising the material or yarn of the first aspect.

[0055] The method may comprise:

providing the material or yarn for the artificial surface;

tufting the material or yarn to a (primary) backing or substrate.

[0056] The following optional features may apply to one or more of the foregoing first to fifth aspects of the present invention.

[0057] The material or yarn may comprise a synthetic turf or grass yarn.

[0058] The material or yarn may substantially comprise a polymer(ic) (base) material, e.g. a polyolefin or a polyamide. The polymer material may comprise a polyolefin such as polyethylene or polypropylene, preferably polyethylene. Alternatively the polymer material may comprise nylon.

[0059] The material or yarn may comprise at least one additive, for example, at least one slip additive, preferably a permanent slip additive. A slip additive may be an additive that can be added to polyolefin or polymer materials to control/lower friction. A slip additive may be added directly into a polyolefin or polymer material during an extrusion process and may migrate to a surface as the polyolefin or polymer material cools, thereby allowing a (solid) lubricating layer to form.

[0060] The at least one additive may comprise a further polyolefin or polymer.

[0061] The at least one additive may comprise or include a siloxane additive, a siloxane-based additive, and/or an additive that comprises a siloxane functional group.

[0062] The at least one additive may comprise or include an organosilicon, a silicone polymer or a silicone compound.

[0063] The at least one additive may comprise or include a cyclic siloxane.

[0064] The at least one additive may comprise or include a dimethylsiloxane or a cyclic dimethylsiloxane.

[0065] Preferably, the at least one additive may (at least or substantially) comprise or include Octamethylcyclotetrasiloxane (D4) (CAS No 556-67-2; EC No 209-136-7).

[0066] Alternatively or additionally, the at least one additive may comprise or include at least one of, or be selected from one or more of: Hexamethylcyclotrisiloxane (D3), Decamethylcyclopentasiloxane (D5), Dodecamethylcyclohexasiloxane (D6), Hexamethyldisiloxane (HMDS).

[0067] The siloxane additive may comprise an ultra-high molecular weight (UHMW) siloxane polymer. The siloxane additive may comprise an ultra-high molecular weight (UHMW) siloxane polymer, which may be dispersed in the/a polyolefin or polymer material, e.g., a low-density polyolefin material, e.g., polyethylene (LDPE).

[0068] The at least one additive, e.g., (permanent) slip additive, may act to reduce the coefficient of (dynamic) friction μ of the material or yarn. The coefficient of (dynamic) friction may be defined as the force between two objects when the two objects are moving relatively against one another.

[0069] Embodiments of the present invention may provide a material or yarn having an altered or engineered surface tension which may provide the material or yarn with an increased lubrication or lubrication feel

[0070] The material or yarn may comprise at least one further additive. The at least one further additive may be selected from one or more of: a colour pigment(s), an ultraviolet light stabiliser and an anti-oxidant.

[0071] The at least one additive may comprise a layer on the material or yarn or on the polymeric base material, e.g. polyolefin material, preferably an outer layer on the material or yarn or on the polyolefin material. The layer may be formed due to migration of the at least one additive during manufacture of the material or yarn, e.g., during a cooling process. The at least one additive may not be chemically linked to/with the polyolefin or polymer (base) material. The at least one additive may be retained in the polyolefin or polymer material due to a high molecular weight (and resultant impaired mobility) of molecules of the at least one additive.

[0072] The provision of the at least one additive may beneficially selectively control/lower the coefficient of friction μ of the material or yarn, e.g., an outer surface of the material or yarn. In this way slip or surface friction of the material or yarn can be selectively controlled.

[0073] Advantageously, the material or yarn may be straight. The provision of a straight or linear filament may particularly well suited to the manufacture of an artificial playing surface for contact sports. Without wishing to be bound by theory, it is believed that using straight or linear filaments of any of the forms mentioned above, provides a larger smooth surface for the at least one additive, e.g. siloxane, to contact a player's skin, thus reducing friction and associated risks of burns to the player. In contrast, the provision of textured fibres or filaments, as typically found on hockey playing surfaces, does not provide such a continuous smooth surface, and therefore does not provide this advantageous effect. In addition, using straight or linear filaments, typically providing a longer pile height, may allow the use of infills within the playing surface. The at least one additive may comprise or be provided in pelletised form, e.g., as a masterbatch.

[0074] The at least one additive may comprise a slip additive.

[0075] The at least one additive may comprise a siloxane additive.

[0076] The siloxane additive may comprise an ultra-high molecular weight (UHMW) siloxane polymer, which may be dispersed in a low-density polyethylene (LDPE).

[0077] The at least one additive may form or comprise a layer on the material or yarn or on the polyolefin material (or polyolefin material or yarn core), preferably an outer layer on the material or yarn or on the polyolefin material.

[0078] The layer may be formed due to migration of the at least one additive during manufacture of the material or yarn, e.g., during a cooling process, e.g., subsequent to extrusion.

[0079] The artificial surface may comprise a sports (playing) surface.

[0080] The artificial surface may comprise a synthetic turf or grass surface or system.

[0081] Preferably the artificial surface may comprise or may be a contact sports playing surface. The artificial surface may not comprise or may not be a hockey playing surface.

[0082] The (primary) backing or substrate may comprise a woven product. The woven product may comprise or be adapted to be used as a backing, such as a primary backing or as a substrate layer, for example, for a surface, ground or floor covering such as artificial or synthetic grass or turf. The woven product may comprise at least a woven layer. The woven product may consist of the woven layer.

[0083] The woven layer may comprise weft tapes or threads and warp tapes or threads.

[0084] The features described in the first to fifth aspects given hereinabove may be provided in combination with the features as defined in the sixth to eighth tenth aspects given hereinbelow.

SECOND INVENTION

[0085] According to a sixth aspect there is provided an artificial surface, such as an artificial grass/turf and/or sports surface.

[0086] The artificial surface may comprise or may be a contact sports playing surface.

[0087] The artificial surface may not comprise or may not be a hockey playing surface.

[0088] The artificial surface may comprise a plurality of blades or filaments.

[0089] Each of the blades or filaments may be substantially straight or linear. The/each filament may be self-supporting, i.e., capable of standing at least partially vertically unsupported.

[0090] The provision of a straight or linear filament may be particularly well suited to the manufacture of an artificial playing surface for contact sports. Without wishing to be bound by theory, it is believed that using straight or linear filaments of any of the forms mentioned above, provides a larger smooth surface for the at least one additive, e.g. siloxane, to contact a player's skin, thus reducing friction and associated risks of burns to the player. In contrast, the provision of textured fibres or filaments, as typically found on hockey playing surfaces, does not provide such a continuous smooth surface, and therefore does not provide this advantageous effect. In addition, using straight or linear filaments, typically providing a longer pile height, may allow the use of infills within the playing surface. Each blade or filament may comprise a material or yarn comprising polymeric material, e.g. a polyolefin, and at least one additive comprising a siloxane additive.

[0091] Each blade may comprise a filament.

[0092] Each or one or more of the filaments:

may be substantially straight or linear;

may be self-supporting, i.e., capable of standing at least partially vertically unsupported;

may be a twisted filament;

may be a straight twisted filament;

may comprise a monofilament or a slit film;

may have a propeller or diamond shaped cross-section; and/or

may have a cross-sectional width of around 1.0mm to 2.0mm or 1.2mm to 1.5mm and a cross-sectional breadth of around 200µm to 450µm or 300µm to 380µm.

[0093] The polymeric material may comprise:

a polyolefin, e.g. polyethylene, such as linear low-density polyethylene (LLDPE);
a metallocene-catalysed polyolefin and/or
a polyamide such as nylon.

[0094] The at least one additive may comprise or include (at least) Octamethylcyclotetrasiloxane (D4).

[0095] The at least one additive may comprise or include at least one of, or may be selected from one or more of: Hexamethylcyclotrisiloxane (D3), Decamethylcyclopentasiloxane (D5), Dodecamethylcyclohexasiloxane (D6), Hexamethylidisiloxane (HMDS).

[0096] The polyolefin or polymer material may comprise 80% to 90% of the material or yarn.

[0097] The at least one additive may comprise 0.1 % to 10% of the material or yarn, or 0.5% to 5%, or beneficially 2% to 4%, e.g., 3% of the material or yarn.

[0098] The at least one additive comprises or forms a layer on the material or yarn or on the polyolefin or polymer material, such as an outer layer on the material or yarn or on the polyolefin or polymer material.

[0099] According to a seventh aspect there is provided use of a material or yarn in an artificial surface, such as an artificial grass and/or sports surface or playing surface, such as a field or pitch, wherein the material or yarn is substantially straight and comprises a material or yarn comprising a polyolefin or polymeric material and at least one additive comprising a siloxane additive.

[0100] The material or yarn may comprise a filament.

[0101] The filament:

may be a straight filament;

may comprise a monofilament;

may have a propeller or diamond shaped cross-section; and/or

may have a cross-sectional width of around 1.0mm to 2.0mm or 1.2mm to 1.5mm and a cross-sectional breadth of around 200µm to 450µm or 300µm to 380µm.

[0102] The polymeric material may comprise a polyolefin, e.g. polyethylene, such as linear low-density polyethylene (LLDPE). The polymeric material may comprise nylon.

[0103] The at least one additive may comprise or include (at least) Octamethylcyclotetrasiloxane (D4).

[0104] The at least one additive may comprise or include at least one of, or may be selected from one or more of: Hexamethylcyclotrisiloxane (D3), Decamethylcyclopentasiloxane (D5), Dodecamethylcyclohexasiloxane (D6), Hexamethylidisiloxane (HMDS).

[0105] The polyolefin or polymer material may comprise 80% to 90% of the material or yarn.

[0106] The at least one additive may comprise 0.1 % to 10% of the material or yarn, or 0.5% to 5%, or beneficially 2% to 4%, e.g., 3% of the material or yarn.

[0107] . The at least one additive may comprise or form a layer on the material or yarn or on the polyolefin or polymer material (or polyolefin/polymer material or yarn core), such as an outer layer on the material or yarn or on the polyolefin or polymer material.

[0108] The artificial surface may comprise a (primary) backing material to which the blades are woven or tufted.

[0109] The artificial surface may be provided with an infill material(s). In one implementation the infill material(s) may be crumb rubber and/or sand. In an alternative implementation, the infill material may be texturised yarns or filaments. For example, the texturised yarns or filaments may be formed from a same material as the material or yarn of the first aspect of the present invention. The texturised yarns or filaments may be woven or tufted to the backing material. In a further alternative implementation, no infill material may be provided.

[0110] According to an eighth aspect there is provided a method of forming an artificial surface according to the sixth aspect of the present invention using the material or yarn of the seventh aspect.

[0111] The method may comprise:

providing the material or yarn;

tufting the material or yarn to a (primary) backing or substrate so as to form the artificial surface.

[0112] The following optional features may apply to one or more of the foregoing first to fifth aspects of the present invention.

[0113] The artificial surface may comprise a sports (playing) surface.

[0114] The artificial surface may comprise at least one and preferably a plurality of materials or yarns for an artificial surface, such as a sports surface.

- [0115] The material(s) or yarn(s) may be tufted to a (primary) backing.
 [0116] The material or yarn may comprise a synthetic turf or grass yarn.
 [0117] The material or yarn may substantially comprise a polyolefin or polymer material.
 [0118] The polymer material may comprise a polyolefin, preferably polyethylene, or alternatively may comprise nylon.
 [0119] The material or yarn may comprise at least one additive, for example, at least one slip additive, preferably a permanent slip additive.
 [0120] The at least one additive may comprise or include a siloxane-based additive.
 [0121] The method may comprise:

providing a raw material (a polymer, e.g. a polyolefin);
 providing at least one additive;
 extruding the raw material and the at least one additive so as to form the material or yarn.

- [0122] The at least one additive may comprise be provided in pelletised form, e.g., as a masterbatch.
 [0123] The at least one additive may comprise a slip additive.
 [0124] The at least one additive may comprise a siloxane additive.
 [0125] The siloxane additive may comprise an ultra-high molecular weight (UHMW) siloxane polymer, which may be dispersed in a low-density polyethylene (LDPE).
 [0126] The at least one additive may form or comprise a layer on the material or yarn or on the polyolefin material (or polyolefin material or yarn core), preferably an outer layer on the material or yarn or on the polyolefin material.
 [0127] The layer may be formed due to migration of the at least one additive during manufacture of the material or yarn, e.g., during a cooling process, e.g., subsequent to extrusion.
 [0128] The (primary) backing or substrate may comprise a woven product. The woven product may comprise or be adapted to be used as a backing, such as a primary backing or as a substrate layer, for example, for a surface, ground or floor covering such as artificial or synthetic grass or turf. The woven product may comprise at least a woven layer. The woven product may consist of the woven layer.
 [0129] The woven layer may comprise weft tapes or threads and warp tapes or threads.
 [0130] It will be appreciated that any features of any of the aforementioned aspects may be used either singly or in combination with any other features of any of the aforementioned aspects.
 [0131] The features defined in the sixth to eighth aspects given hereinabove may be provided in combination with the features as defined in the first to fifth aspects given hereinabove.

BRIEF DESCRIPTION OF DRAWINGS

- [0132] Embodiments of the present invention will now be described by way of example only, and with reference to the accompanying drawings, which are:

- Figure 1** a schematic view of an extrusion apparatus used in the manufacture of a material or yarn for an artificial surface according to the present invention;
Figure 2(a) a schematic view of a tufting process used in the manufacture of the material or yarn for an artificial surface according to the present invention;
Figure 2(b) a schematic view of the tufting apparatus used in the manufacture of the material or yarn for an artificial surface according to the present invention;
Figures 3(a) to (c) a schematic sectional top view and a schematic sectional side views of a (primary) backing for use in an embodiment of an artificial surface according to the present invention;
Figure 4 a schematic perspective view of a plurality of blades, filaments or yarns comprise a tuft of synthetic grass according to an embodiment of the present invention;
Figures 5(a) and (b) a perspective view from above and to one side and a perspective view from below and to one side of an artificial surface/grass/turf according to an embodiment of the present invention comprising the material or yarn according to Figure 4;
Figure 6 a perspective view from above and to one side of the artificial surface of Figure 5(a) including infill materials;
Figure 7 a test rig for testing the artificial surface of Figure 5(a)
Figure 8 a schematic perspective view of a plurality of blades, filaments or yarns comprising a tuft of synthetic grass according to a further embodiment of the present invention;
Figure 9 a perspective view from above and to one side of an artificial surface/grass/turf according to another embodiment of the present invention comprising a plurality of tufts according to Figure 8.

DETAILED DESCRIPTION OF DRAWINGS

[0133] Referring to **Figures 1 to 7**, there will be described a material or yarn, generally designated 5, for an artificial surface 10, such as a sports surface, for example, a sports playing surface, according to an embodiment of the present invention. There will also be described a method of manufacturing the material or yarn 5, the artificial surface 10 comprising the material or yarn 5, and a sports field, pitch or court or play/playing area, such as a field or pitch, comprising the artificial surface 10.

[0134] Herein the following terms are to be generally understood as follows:

Extrusion process: a means by which polyolefin raw materials by means of heat are melted and combined with other polyolefin additives, for instance colour additives, to form a homogenous mixture and be made into a new form.

Grass yarn: a synthetic fibre, a plurality of such forming a surface made to look like natural grass.

Monofilament yarn: a type of artificial grass yarn produced by extruding molten polymeric materials through a die to produce continuous strands.

Synthetic surface: an overall system, which comprises a sub-base, drainage, potentially a shockpad, and an artificial grass surface or carpet, and often an infill material(s) which sits between the grass yarn to keep such in place and assist in specific performance requirements.

[0135] Referring to **Figure 4**, according to an embodiment of the present invention, there is provided a material or yarn 5 for an artificial surface 10 or carpet, such as a sports surface.

[0136] The material or yarn 5 comprises a synthetic turf or grass yarn comprising a metallocene catalysed polyolefin or polymer material and at least one additive comprising a siloxane additive.

[0137] The material or yarn comprises a filament which:

is a straight or linear filament;

is a twisted or straight twisted filament;

is self-supporting, i.e., capable of standing at least partially vertically unsupported;

is a monofilament;

has a propeller or diamond shaped cross-section; and/or

has a cross-sectional width of around 1.0mm to 2.0mm or 1.2mm to 1.5mm and a cross-sectional breadth of around 200µm to 450µm or 300µm to 380µm.

[0138] The material or yarn 5 comprises a synthetic turf or grass yarn. The material or yarn 5 substantially comprise a polyolefin (base) material. In this embodiment, the polyolefin material comprises polyethylene, e.g., low-density polyethylene (LDPE), beneficially linear low-density polyethylene (LLDPE).

[0139] The material or yarn 5 comprise at least one additive, for example, at least one slip additive, preferably a permanent slip additive. The at least one additive can comprise a further polymer. In this embodiment, the at least one additive comprises or includes a siloxane additive, a siloxane-based additive, and/or an additive that comprises a siloxane functional group.

[0140] The at least one additive can comprise or include an organosilicon, a silicone polymer or a silicone compound. The at least one additive can comprise or include a cyclic siloxane. The at least one additive can comprise or include a dimethylsiloxane or a cyclic dimethylsiloxane.

[0141] Advantageously, the at least one additive comprises or includes (at least) Octamethylcyclotetrasiloxane (D4) (CAS No 556-67-2; EC No 209-136-7).

[0142] Alternatively or additionally, the at least one additive comprises or includes at least one of, or is selected from one or more of: Hexamethylcyclotrisiloxane (D3), Decamethylcyclopentasiloxane (D5), Dodecamethylcyclohexasiloxane (D6), and/or Hexamethyldisiloxane (HMDS).

[0143] The siloxane additive can comprise an ultra-high molecular weight (UHMW) siloxane polymer. The siloxane additive can comprise an ultra-high molecular weight (UHMW) siloxane polymer, which may be dispersed in the/a polyolefin material, e.g., a low-density polyolefin material, e.g., polyethylene (LDPE).

[0144] The at least one additive, e.g., (permanent) slip additive, may act to reduce the coefficient of (dynamic) friction of the material or yarn. The coefficient of dynamic friction may be defined as the force between two objects when the two objects are moving relatively against one another.

[0145] Embodiments of the present invention provide a material or yarn having an altered or engineered surface tension which can provide the material or yarn with an increased lubrication or lubrication feel.

[0146] The material or yarn comprises a monofilament.

[0147] The polyolefin material comprises 80% to 90% of the material or yarn.

[0148] The at least one additive comprises 0.1% to 10% of the material or yarn, or 0.5% to 5%, or 3% of the material

or yarn.

[0149] The material or yarn can comprise at least one further additive. Typically, the at least one further additive can be selected from one or more of: a colour pigment(s), an ultraviolet light stabiliser and an anti-oxidant.

[0150] Beneficially, the at least one additive comprises a layer on the material or yarn or on the polyolefin material (or polyolefin material or yarn core), preferably an outer layer on the material or yarn or on the polyolefin material. The layer can be formed due to migration of the at least one additive during manufacture of the material or yarn, e.g., during a cooling process.

[0151] Referring to **Figure 1**, according to the present invention, there is provided a method of manufacturing a material or yarn 5 for an artificial surface 10, the method comprising:

providing a raw material;
providing at least one additive;
extruding the raw material and the at least one additive so as to form the material or yarn 5.

[0152] The at least one additive is typically provided in pelletised form, e.g., as a masterbatch.

[0153] The at least one additive can comprise a slip additive.

[0154] The at least one additive can comprise a siloxane additive.

[0155] The siloxane additive can comprise an ultra-high molecular weight (UHMW) siloxane polymer, which can be dispersed in a low-density polyethylene (LDPE), e.g., linear low-density polyethylene (LLDPE).

[0156] Beneficially, the at least one additive forms or comprises a layer on the material or yarn 5 or on the polyolefin material (or polyolefin material or yarn core), advantageously an outer layer on the material or yarn or on the polyolefin material.

[0157] The layer can be formed due to migration of the at least one additive during manufacture of the material or yarn, e.g., during a cooling process, e.g., subsequent to extrusion.

[0158] Referring to **Figures 4 to 6**, according to the present invention there is provided an artificial surface 10 comprising at least one, and beneficially a plurality, of materials or yarns 5.

[0159] The artificial surface 10 comprises a sports (playing) surface, and in particular a contact sports (playing) surface. It will be appreciated that, as explained above, the requirements and structure of contact sports playing surface may be different from other types of playing surfaces such as hockey surface.

[0160] The artificial surface typically comprises a synthetic turf or grass surface or system.

[0161] According to the present invention there is provided a sports field, pitch or court, or a play/playing area, comprising the artificial surface 10. Referring to **Figures 2(a) and 2(b)**, according to the present invention, there is provided a method of manufacturing the artificial surface 10, the method comprising:

providing the material or yarn 5 for the artificial surface 10;
tufting the material or yarn 5 to a (primary) backing or substrate 15.

[0162] The material or yarn 5 is provided according to the method hereinbefore described.

[0163] The (primary) backing or substrate 15 comprises a woven product. The woven product comprises or is adapted to be used as a backing, such as a primary backing or as a substrate layer, for example, for a surface, ground or floor covering such as artificial or synthetic grass or turf. The woven product can comprise at least a first woven layer 20.

[0164] The woven product can consist of the single first woven layer 20 (see **Figures 3 (a) to 3(c)**).

[0165] The first woven layer 20 can comprise a plurality of warp tapes or threads 30 and a plurality of weft tapes or threads 35, the warp tapes or threads 30 and the weft tapes or threads 35 of the first woven layer being substantially perpendicular to one another.

[0166] The artificial surface 10 comprises at least one and preferably a plurality of materials or yarns 5.

[0167] The material(s) or yarn(s) 5 are tufted to (primary) backing 15.

[0168] Herein described is a method of manufacturing a material or yarn 5 for an artificial surface 10.

[0169] The method can comprise:

providing a raw material;
providing at least one additive;
extruding the raw material and the at least one additive so as to form the material or yarn 5.

[0170] Herein described is a sports field, pitch or court, or a play/playing area, e.g. a contact sports playing surface, comprising an artificial surface 10.

[0171] Herein described is a method of manufacturing an artificial surface, the method comprising:

providing 5 material or yarn 5;
tufting the material or yarn to a primary backing or substrate 15.

[0172] Herein described is an artificial surface 10, such as an artificial grass and/or sports surface, the artificial surface comprising a plurality of blades 7, wherein each of the blades comprises a material or yarn 5 comprising a synthetic turf or grass yarn comprising a polymer material and at least one additive comprising a siloxane additive.

[0173] The polymer material is preferably a metallocene-catalysed polyolefin.

[0174] The artificial surface has a pile height of around 20mm to 75mm, e.g. 30 mm to 65 mm, e.g. 35 mm to 65 mm. The artificial surface also has a tuft gauge of at least 3/8 inch (9.5 mm), e.g. at least 1/2 inch (12.7 mm), e.g. at least 5/8 inch (15.9 mm), e.g. at least 3/4 inch (19.0 mm). Typically, the artificial surface has a tuft gauge of around 3/8 inch (9.52 mm), around 1/2 inch (12.7 mm), around 5/8 inch (15.9 mm), or around 3/4 inch (19.0 mm). This is in contrast with the typical tuft gauge of a hockey playing surface, which may be in the region of around 3/16 inch (4.8 mm).

[0175] In some embodiments, the artificial surface is provided with one or more infill materials, which in this embodiment is crumb rubber, as illustrated in **Figure 6**.

[0176] The artificial surface 10 typically has a sliding coefficient of friction between 0.7 and 1.0, such as around 0.94.

[0177] Herein described is the use of the material or yarn 5 in an artificial surface 10, such as an artificial grass or sports surface or playing surface such as a field or pitch.

[0178] Herein described is a method of manufacturing a material or yarn 5, the method comprising:

providing a raw material;
providing at least one additive;
extruding the raw material and the at least one additive so as to form the material or yarn.

[0179] Herein described is a method of forming an artificial surface, such as an artificial grass and/or sports surface using filaments comprising the material or yarn 5, the method comprising:

providing the material or yarn 5 for the artificial surface 10;
tufting the material or yarn 5 to a (primary) backing or substrate 15.

[0180] Herein described is an artificial surface 10, such as an artificial grass and/or sports surface, the artificial surface 10 comprising a plurality of blades or filaments 7, wherein each of the blades or filaments 7 is substantially straight and comprises a material or yarn 5 comprising a polyolefin or polymer material and at least one additive comprising a siloxane additive.

[0181] The provision of a straight or linear filament may particularly well suited to the manufacture of an artificial playing surface for contact sports. Without wishing to be bound by theory, it is believed that using straight or linear filaments of any of the forms mentioned above, provides a larger smooth surface for the at least one additive, e.g. siloxane, to contact a player's skin, thus reducing friction and associated risks of burns to the player. In contrast, the provision of textured fibers or filaments, as typically found on hockey playing surfaces, does not provide such a continuous smooth surface, and therefore does not provide this advantageous effect. In addition, using straight or linear filaments, typically providing a longer pile height, may allow the use of infills within the playing surface. Herein described is the use of a material or yarn 5 in an artificial surface 10, such as an artificial grass and/or sports surface or playing surface, such as a field or pitch, wherein the material or yarn 5 is substantially straight and comprises a material or yarn comprising a polyolefin or polymer material and at least one additive comprising a siloxane additive. The material or yarn is beneficially capable of being self-supported, i.e., capable of at least partially standing in a vertical disposition akin to a blade of natural grass.

[0182] The present invention provides a method of forming an artificial surface 10 using the material or yarn 5, the method comprising:

providing the material or yarn 5;
tufting the material or yarn 5 to a (primary) backing or substrate 15 so as to form the artificial surface 10.

[0183] Specific embodiments and examples of the present invention will now be described in further detail.

Process

Extrusion Process

[0184] Referring to **Figure 1**, there is shown an extrusion apparatus, generally designated 100, for forming the yarn 5. *Inter alia*, the extrusion apparatus 100 comprises an extruder 115, a heated die 105, and a water bath 110.

[0185] The permanent slip additive - which is non migratory - is incorporated into the synthetic grass yarn 5 during the extrusion process.

[0186] Synthetic grass yarns 5 in this application are produced via monofilament extrusion or slit film extrusion. In these processes, raw material of polyethylene polymer pellets (dosage 80-90%), combination masterbatch - which contains colour pigments, ultra-violet light stabilisers and antioxidants in a carrier resin - (dosage 5-10%), a polymer process aid (dosage 0.2-1%) and a masterbatch containing slip additive (dosage 0.1 -10%), form the recipe.

[0187] These materials are all dosed in precise amounts according to the recipe into the extruder 115. The extruder 115 is a heated barrel which contains a screw. The materials drop into the heated barrel (enters barrel in excess of 200°C) containing the screw and the screw starts to transport the material, during this transportation the heat and the action of the screw cause the material to melt and mix together into a homogeneous mixture. At the end of the extruder 115 are a set of filters which remove any degraded or oversized material, the molten homogenous mixture is transported to the heated die 105 (heated in excess of 200°C) which contains plates with holes which the material is forced out of into a water bath to quickly cool the molten mixture into continuous filament/yarn like forms - these are called monofilaments. Alternatively, the material is pushed through a coat hanger die and formed into a sheet (width of the sheet can vary from 0.9 - 2.5m). The sheet is quickly cooled by either water bath or chill roll.

[0188] In the monofilament process the holes in the plates are homogenous in size and shape, for example, propeller or diamond shape, so that each monofilament is identical. Once these monofilaments or the sheet are cooled in the water bath 110 or chill roller (below 40°C), such are transported to a drying section; here the water is removed from the monofilaments or sheet.

[0189] During the slit film process after drying the sheet is slit into tapes (between 5 - 40mm in width) before it can go to the next stage.

[0190] After drying, the filaments and/or tapes can start to be drawn and annealed. In the drawing section the monofilaments/tapes are stretched using an oven (heated in excess of 80°C) in the machine direction this gives the monofilaments/tapes strength. In the slit film process the tapes are fibrillated to increase the flexibility of the tape for tufting and to make the tape appear more natural in appearance.

[0191] The monofilaments/tapes are then heated (in excess of 80°C) and then annealed in their new form. In the final section the monofilaments/tapes are cooled (below 40°C) and an application of spin oil (0.1-1% w/v) is applied via a lick roller.

[0192] In the monofilament process, the monofilaments are grouped into monofilament bundles and are collected onto spools for the next stage of the process. In the slit film process each tape is individually collected onto spools for the next stage of the process.

Twisting/Spiral wrapping Process

[0193] In order to ease downstream processing of the yarns 5, the filaments/tapes are either twisted or spirally wrapped to make the yarn a round shape. This assists in threading the yarns through the tufting machine tubes and needles.

[0194] Twisting involves taking the filaments/tapes and twisting on ne direction either "S" - left hand twist, or "Z" right hand twist. The twist is usually described as the number of turns per meter (TPM), commonly from 20 - 40 TPM. The twisted yarn is then conveyed onto a spool in either a precision or crosswound pattern.

[0195] Spiral wrapping the filaments/tapes also performs the same function as twisting, but instead of twisting the filaments/tapes into a round shape the yarns are wrapped with a draw-textured-yarn (DTY) commonly polyester though other materials can be used. The number of spiral wraps can be between 20 - 60 wraps per meter. The spirally wrapped yarn is then conveyed onto a spool in either a precision or crosswound pattern.

Tufting Process

[0196] Referring to Figures 2(a) and (b), there is shown a tufting process and a tufting apparatus, generally designated 300. **Figures 3(a) to 3(c)** shows a backing 15 for an artificial surface 10 according to an embodiment of the present invention.

[0197] In the tufting process, the carpet construction is described by three parameters: stitch rate - defined as the number of stitches over a given length; pile height - the length of the stitch protruding from the primary backing cloth; and tuft gauge - which is the distance between the tufting needles, commonly described in fractions of an inch. Less descriptive is the pile weight, which is the weight of the carpet per square meter which can range from 750 g/m² to over 5000 g/m². During tufting, good tension control on the yarn 5 to ensure consistency to the tufting needles and sharp blades are required to cut the pile length to the correct height, followed by consistent heat application in the coating process. All this should give evenness and surface consistency to the final synthetic grass surface. This is referred to commonly as the grass carpet.

[0198] The composition of the carpet can take many forms, from long pile carpet infilled with a ballast or first infill

material 12a (commonly round silica sand) and a second (performance) infill material 12b, which could be SBR rubber from end-of-life tires, EPDM, TPE, organic infills (such as cork, coconut husk, walnut shells etc.) as well as many commercially available infills.

[0199] The carpet is commonly filled with the infill materials 12a, 12b below the level of the grass fibre. For example, a carpet with a pile height of 55mm may have an infill level between 35mm to 50mm.

[0200] Another example is a carpet without any infill materials as described above. In this non-infill variant, the space the infill would have taken up is replaced by an alternate material, commonly a texturized monofilament artificial grass yarn, but could also be a slit film yarn.

[0201] In this instance the secondary yarn is introduced to the carpet during the tufting process. The secondary yarn is threaded into the needles in the required pattern and tufted with the primary yarn.

[0202] Both types of grass carpet are used in sports pitches where skin injuries can occur.

Supporting Data

Samples Tested

[0203] Two artificial grass yarns were converted into artificial grass carpets, according to the embodiment of Figures 4 to 6:

- Yarn 1 - control sample - containing no slip additive.
- Yarn 2 - yarn subject of the present invention containing slip additive - 3% of siloxane containing masterbatch. (Masterbatch concentration 50% siloxane additive, 50% low density polyethylene carrier polymer).

[0204] The composition of the artificial grass carpets was 5/8" tufting gauge, 60mm pile height at a stitch rate of 21-22 stitches/10cm.

[0205] These grass carpets were then tested with increasing infill rates to assess the effects of free pile height.

[0206] All carpets had a stabilising base infill layer 12a: sand 34 kg/m² approximately 22 mm.

[0207] The following infill rates refers to the performance SBR crumb rubber infill 12b.

	Approx. infill depth ≈	Equivalent free yarn pile height
• Low - 3.33 kg/m ²	7 mm	31 mm
• Mid - 6.67 kg/m ²	15 mm	23 mm
• High - 10 kg/m ²	20 mm	18 mm

Testing

[0208] To develop insights into the skin injury risk between the control carpet and the carpet produced with yarn containing the slip additive, the following parameters were assessed:

- 1) Sliding Coefficient of Friction.
- 2) Deceleration after initial impact / Change in Horizontal Velocity.
- 3) Simulated Skin Abrasion.
- 4) Rotational Resistance.

Test Methods

[0209] **Simulated Skin Abrasion Testing** - The test apparatus/device 400, shown in **Figure 7**, recreates a realistic knee-turf contact whilst monitoring temperature rises and the abrasive nature of turf. A horizontal impact velocity of 5 m/s was generated by adopting roller coaster technology. A linear induction motor rapidly accelerates a carriage up to the desired velocity by utilising electromagnets which provides the ability to monitor the natural deceleration of the impactor. The impactor was 3D printed, using anthropometric knee data, and wrapped in Lorica® Soft artificial skin. Lorica® Soft employs polyurethane and polyamide microfibres to produce a synthetic leather to provide similar frictional responses as hairless skin.

[0210] Lorica® artificial leather consisting of polyamide microfleece coated with polyurethane has been shown to

realistically simulate human skin friction against textiles under dry conditions. In addition to friction properties, the Lorica® skin model reproduces surface properties of human skin (roughness, topography, water contact angle) and shows similar force-deformation characteristics.

[0211] Accelerometers capture impact and dynamic frictional coefficients. Photographs are taken of this artificial skin after the deceleration and % abrasion damage calculated from grey scale images of the artificial skin samples.

[0212] Referring to **Figure 7** the test apparatus 400 comprises a test rig which aims to replicate a lifelike knee slide on an artificial turf surface 10 with the new 2-layer skin attached to the knee form.

[0213] The rig has a propulsion phase followed by a measurement phase. In the propulsion phase a realistic velocity and loading is applied.

[0214] Stage 1 of the test is acceleration. Stage 2 of the test is the knee drop. Stage 3 of the test is the impact. Stage 4 of the test is the slide.

[0215] In stages 2 and 3, the force experienced in the Y and Z axis (impact and direction of travel) is measured.

[0216] In stage 4, the temperature profile during constant contact with the artificial grass surface and the simulant skin and the COF is measured.

[0217] After the test is complete the Lorica® samples were flattened to give a flat surface that can be photographed. These photographs were then converted to greyscale threshold abrasion images and the % coverage of damage calculated.

[0218] **Sliding Coefficient of Friction** - The coefficient of friction (COF) is the ratio of the frictional forces resisting motion to the normal force pressing the two surfaces together. This is a dimensionless value which describes the relationship between the horizontal and vertical forces of two surfaces in relative motion where the literature associates a high COF value with an increased risk of abrasive injuries. This was measured on the above test equipment.

[0219] **Deceleration after initial impact / Change in Horizontal Velocity** - Deceleration on the above equipment was measured using an impactor mass was 39.22kg which would represent a static normal load of 385N. A high change in horizontal velocity represents an interaction that experiences the greatest deceleration between the initial impact and the end of the slide - which would suggest a player on that surface would be more vulnerable to receiving a skin injury. Deceleration is measured in metres/second.

[0220] **Rotational Resistance** - FIFA Quality Programme for Football Turf Handbook of Test Methods - Test Method 6. Traction between a sports shoe and the playing surface influences a players' ability to perform sport-specific movements. Too little traction means a player might slip. Too much traction is thought to increase the risk of injury due to foot fixation on the turf. The rotational resistance of a surface is defined as the torque measured using a torque wrench when a loaded foot is allowed to horizontally rotate when in contact with the surface. The test foot is a metal disc 150 ± 2 mm with 6 football studs equally spaced on the underside each 46 ± 1 mm from the centre of the disc. The total mass of the apparatus (test foot, shaft, torque wrench and weights) is 46 ± 2 Kg. The weighted test foot is dropped onto the surface from a height of 60 ± 5 mm and the torque wrench is attached. Then, without adding any vertical pressure on the torque wrench and applying minimum rotational torque to the torque wrench, turning the wrench and the test foot smoothly at a nominal speed of rotation of 12 ± 2 rev/min until movement of the test foot occurs and it has rotated through at least 45° . The maximum value displayed on the torque wrench is recorded to the nearest Nm.

Test Data

Sliding Coefficient of Friction

[0221]

	Low Infill Level	Mid Infill Level	High Infill Level
Control artificial grass carpet	1.10	0.83	0.72
Grass carpet containing slip additive (the invention)	0.98	0.94	0.72

[0222] The greater the coefficient of friction, the greater the resistance the artificial grass carpet is offering to the player sliding over its surface and the greater the possibility of an abrasion skin burn. The lower coefficient of friction observed as infill rate increases is consistent with the 'ball bearing effect', where the increasing level of infill rolls over itself offering a lubricating effect to the players knee sliding across its surface. The lowest infill rate represents a turf sample with the longest free pile height (~31mm) and is the sample where the maximum amount of yarn containing the slip additive is exposed to the skin, hence having the greatest effect on reducing the sliding coefficient of friction, reducing resistance offered by the pitch to a player sliding over its surface and hence minimising abrasion burns. This demonstrates that the introduction of a slip additive into the test yarn is making a positive contribution to reduction in abrasion skin burns.

% Simulated Skin Abrasion Testing**[0223]**

	Low Infill Level	Mid Infill Level	High Infill Level
Control artificial grass carpet	1.73%	10.6%	5.50%
Grass carpet containing slip additive (the invention)	0.51%	8.91%	4.35%

[0224] This data clearly shows the lower skin abrasion damage experienced with the carpet containing the slip additive - i.e., the invention.

Deceleration after initial impact / Change in Horizontal Velocity**[0225]**

	Low Infill Level	Mid Infill Level	High Infill Level
Control artificial grass carpet	2.07 m/sec	2.02 m/sec	1.91 m/sec
Grass carpet containing slip additive (the invention)	2.01 m/sec	1.96 m/sec	1.86 m/sec

[0226] The greater the change in horizontal velocity, the greater the deceleration of the players knee on the grass carpet, the greater the resistance offered by the carpet to the player and, therefore, the greater the chances of skin abrasion

[0227] A consistent trend of decreasing change in velocity was observed for increasing infill rates on both surfaces. This is consistent with the 'ball bearing effect' where the infill rolls over itself offering a lubricating effect to the player's knee sliding across its surface. The lowest infill rate represents a turf sample with the longest free pile height (~31mm) which corresponds to the highest reduction in speed. This is the sample where the maximum amount of yarn containing the slip additive is exposed to the skin, hence having the greatest effect on reducing horizontal velocity of the player on the pitch, hence reducing its deceleration, reducing resistance of the pitch and hence minimising abrasion burns. For each infill rate, the change in speed (and hence abrasion) was always greater for the control sample than for the yarn containing the slip (siloxane) additive.

Rotational Resistance

[0228] Carpets were tested at the high level of infill and after fifty (50) conditioning rolls with a heavy studded roller, such were laid on a Schmitz ProPlay 20 shockpad for test.

	High Infill Level
Control artificial grass carpet	39Nm
Grass carpet containing slip additive (the invention)	37Nm

[0229] The specification for professional levels of play at the time of writing is 32-43Nm. Both samples meet the requirement, and the sample containing the additive (the invention) allows the stud to release with more ease compared to the control sample. This demonstrates that although the invention gives a more lubricating feel, it does not affect the grip or traction between the player and the surface and, therefore, meets current safety standards. The lower value achieved by the grass carpet containing the slip additive allows easier release of the sports shoe - which will reduce the prevalence of the studs getting stuck in the pitch and hence reduce the risk of lower limb injury.

[0230] Referring now to **Figures 8 and 9**, there will be described a material or yarn, generally designated 5', for an artificial surface 10', such as a sports surface, for example, a sports playing surface, according to a further embodiment of the present invention. Like parts of the further embodiment are denoted by the same numerals as the preceding embodiment, but suffixed "'". Also, the composition of the yarns 5' is the same as that of the yarns 5.

[0231] **Figure 8** shows a schematic perspective view of a plurality of blades, filaments or yarns 5a comprising a tuft of synthetic grass according to the further embodiment of the present invention.

[0232] **Figure 9** shows a perspective view from above and to one side of the artificial surface/grass/turf 10a comprising a plurality of tufts according to **Figure 8**. The artificial surface 10' comprises a (primary) backing material 15' to which

the blades or yarns 5' are woven or tufted.

[0233] In this embodiment, the artificial surface 10' is provided with an infill material(s). In the embodiment of Figure 6, the infill material(s) are an upper layer of crumb rubber 12b and a lower layer of sand 12a. However, in the embodiment of Figure 9, the infill material 12' is texturised yarns or filaments 13'. Beneficially, the texturised yarns 13' are formed from a same material as the material or yarn 5'. The texturised yarns 13' or filaments are woven or tufted to the backing material 15'.

[0234] It will be appreciated that the embodiments of the present invention hereinbefore described are given by way of example only, and are not meant to be limiting of the scope of the invention in any way.

[0235] It will be appreciated that the present invention may find utility in various sports, and in particular contact sports, for example:

Football or soccer;
Rugby (e.g., rugby union or rugby league);
American football or gridiron;
Gaelic football (GAA);
Shinty or hurling;
Australian rules football.

[0236] It will also be appreciated that herein, by "straight yarn" or "straight filament" is meant a yarn or filament which has a length, e.g., around a length of a blade of grass of a lawn. However, it will be appreciated that the "straight yarn" or "straight filament" may be twisted along the length thereof. The twist may be a left-hand or right-hand twist (Z or S twist). Typically, the number of twists per meter may be around 20 to 50 TPM. Alternatively, the "straight yarn" or "straight filament" may be spiral wrapped. Typically, the number of wraps per meter may be around 20 to 60 WPM.

Claims

1. An artificial surface, such as an artificial grass and/or sports surface, the artificial surface comprising a plurality of blades, wherein each of the blades comprises a material or yarn comprising a synthetic turf or grass yarn comprising a polyolefin or polymer material and at least one additive comprising a siloxane additive, wherein the artificial surface has:

a pile height of around 20mm to 75mm; and/or
a tuft gauge of at least 3/8 inch.

2. An artificial surface, such as an artificial grass and/or sports surface, the artificial surface comprising a plurality of blades, wherein each of the blades is substantially straight and comprises a material or yarn comprising a polyolefin or polymer material and at least one additive comprising a siloxane additive.

3. An artificial surface as claimed in claim 1 or claim 2, wherein each blade comprises a filament which:

is substantially straight or linear;
is a monofilament or a slit film;
has a propeller or diamond shaped cross-section; and/or
has a cross-sectional width of around 1.0mm to 2.0mm, optionally 1.2mm to 1.5mm, and a cross-sectional breadth of around 200 μ m to 450 μ m, optionally 300 μ m to 380 μ m.

4. An artificial surface as claimed in any preceding claim, wherein the polyolefin or polymer comprises:

polyethylene, such as linear low-density polyethylene (LLDPE); and/or
a metallocene catalysed polyolefin.

5. An artificial surface as claimed in any preceding claim, wherein the at least one additive comprises one or more compound selected from Octamethylcyclotetrasiloxane, Hexamethylcyclotrisiloxane, Decamethylcyclopentasiloxane, Dodecamethylcyclohexasiloxane, and Hexamethyldisiloxane (HMDS).

6. An artificial surface as claimed in any preceding claim, wherein the polyolefin or polymer material comprises 80% to 90% of the material or yarn.

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7. An artificial surface as claimed in any preceding claim, wherein the at least one additive comprises 0.1% to 10% of the material or yarn, optionally 0.5% to 5%, or around 3% of the material or yarn.
8. An artificial surface as claimed in any preceding claim, wherein the at least one additive comprises or forms an outer layer on the material or yarn or on the polyolefin or polymer material.
9. An artificial surface as claimed in claim 1, wherein the artificial surface has a tuft gauge of at least 1/2 inch, optionally at least 5/8 inch, optionally at least 3/4 inch, and/or wherein the artificial surface has a pile height of around 30mm to 65mm.
10. An artificial surface as claimed in any preceding claim, wherein the artificial surface is provided with an infill material, optionally wherein the infill material comprises or consists of a particulate material, optionally wherein the particulate material comprises or consists of rubber and/or sand.
11. An artificial surface according to any preceding claim, wherein a sliding coefficient of friction of the artificial surface is between 0.7 and 1.0, optionally around 0.94.
12. An artificial surface according to any preceding claim, wherein the artificial surface is a contact sports playing surface.
13. A method of forming an artificial surface according to any preceding claim, the method comprising:
- providing the material or yarn;
tufting the material or yarn to a primary backing or substrate.
14. Use of a material or yarn in an artificial contact sports playing surface, wherein the material or yarn is substantially straight and comprises a polyolefin or polymer material and at least one additive comprising a siloxane additive.
15. Use of a material or yarn in an artificial contact sports playing surface, wherein the material or yarn comprises a synthetic turf or grass yarn comprising a polyolefin or polymer material and at least one additive comprising a siloxane additive,
wherein the artificial contact sports playing surface has:
- a pile height of around 20mm to 75mm; and/or
a tuft gauge of at least 3/8 inch..

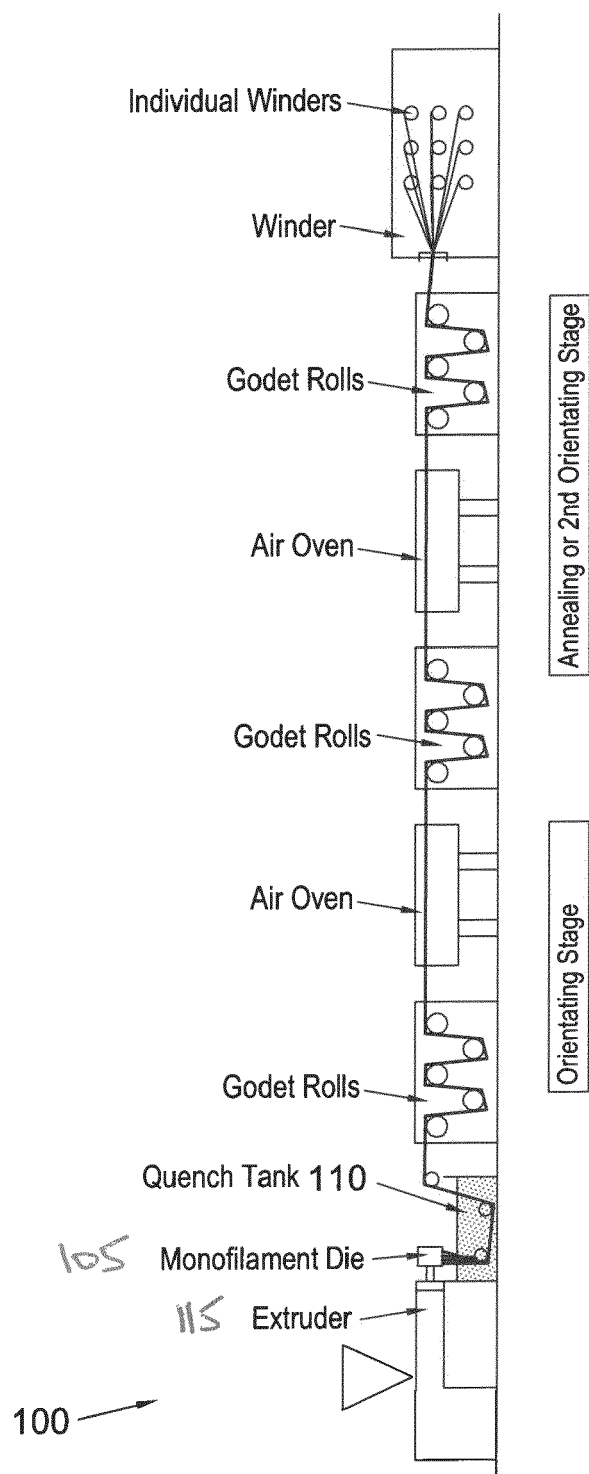


FIG. 1

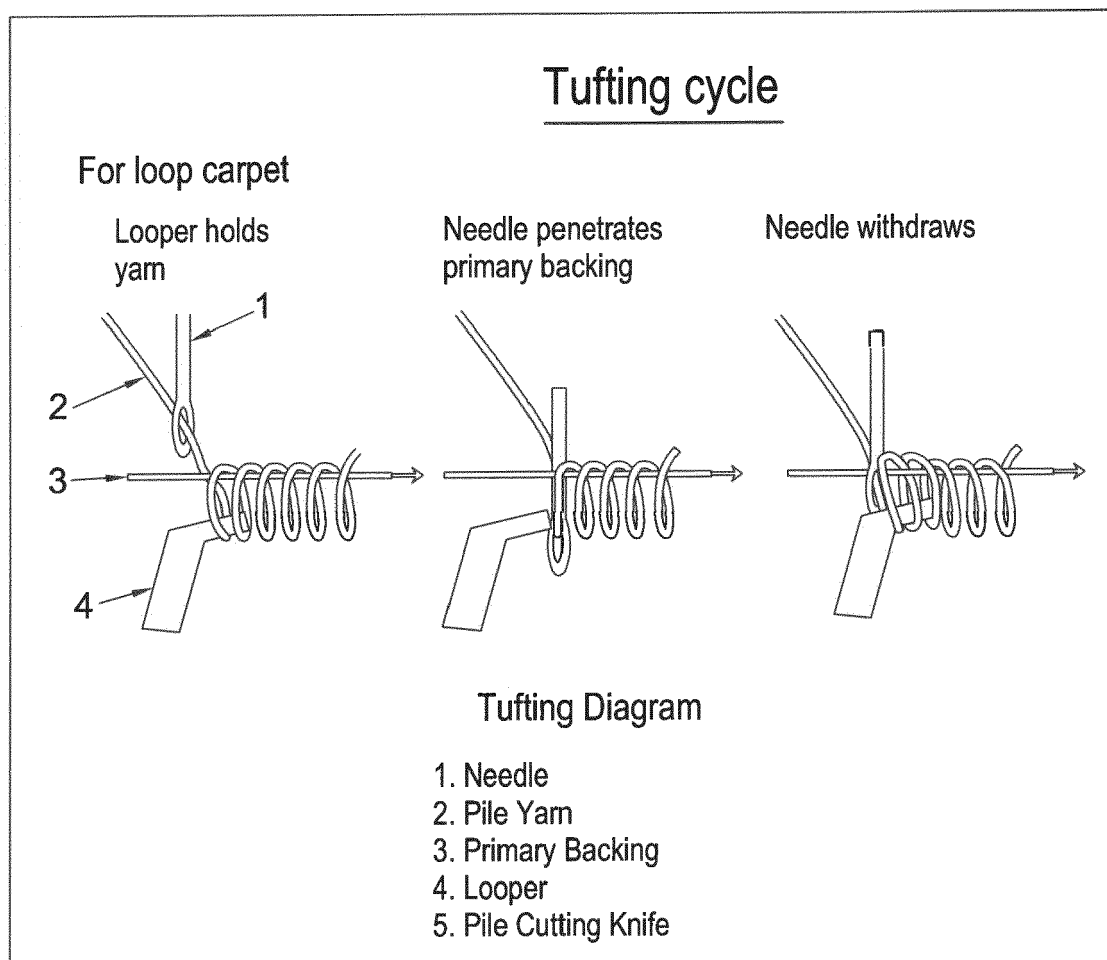
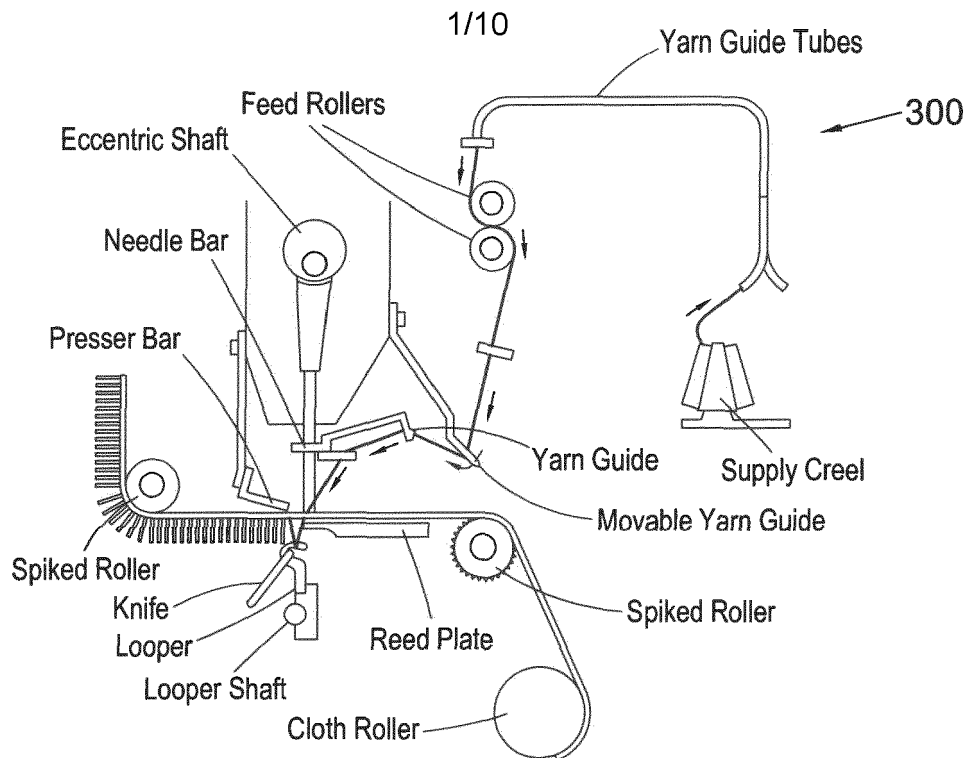


FIG. 2(a)

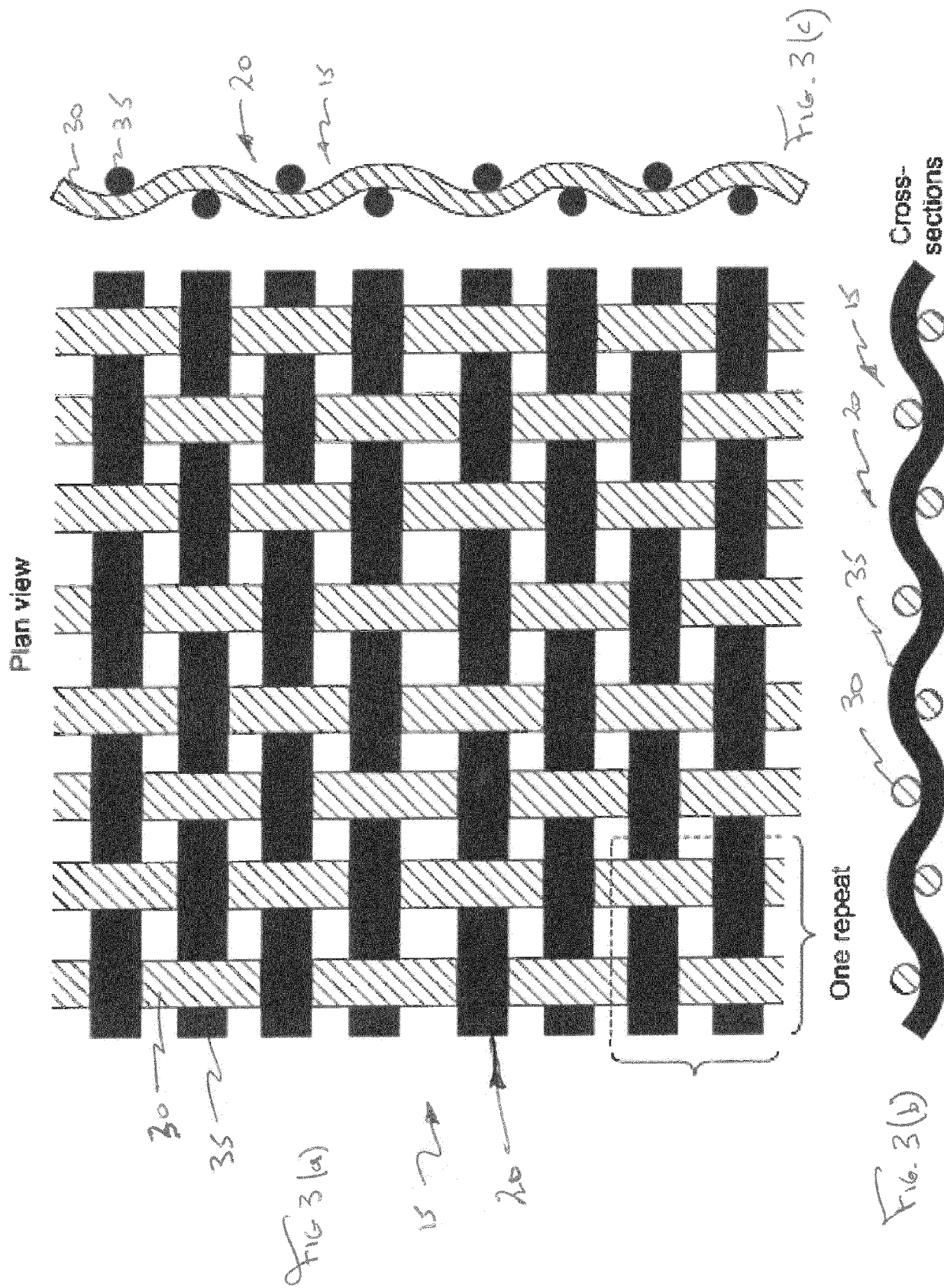
The tufting process

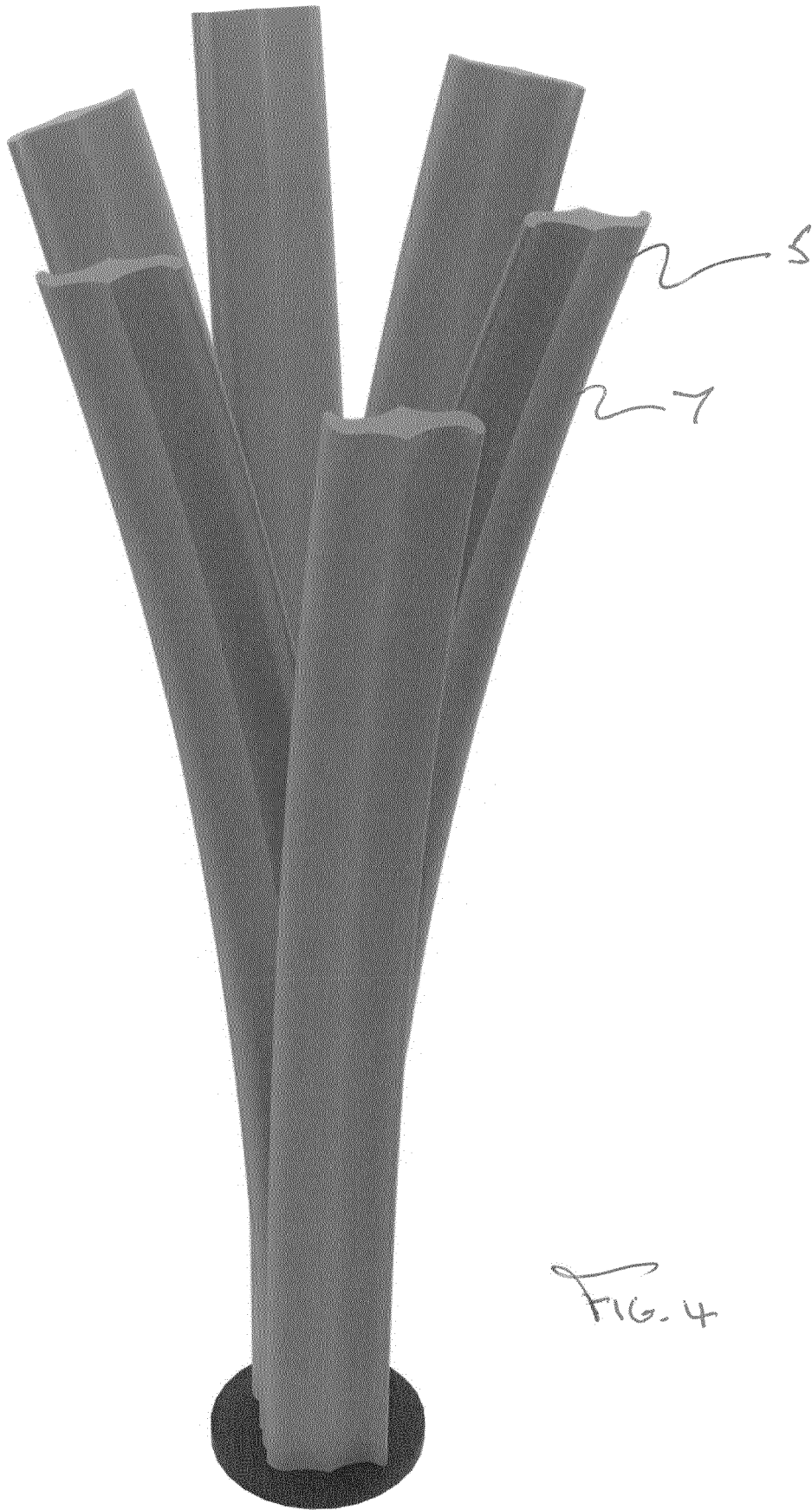
Below, the key steps in the tufting process are indicated

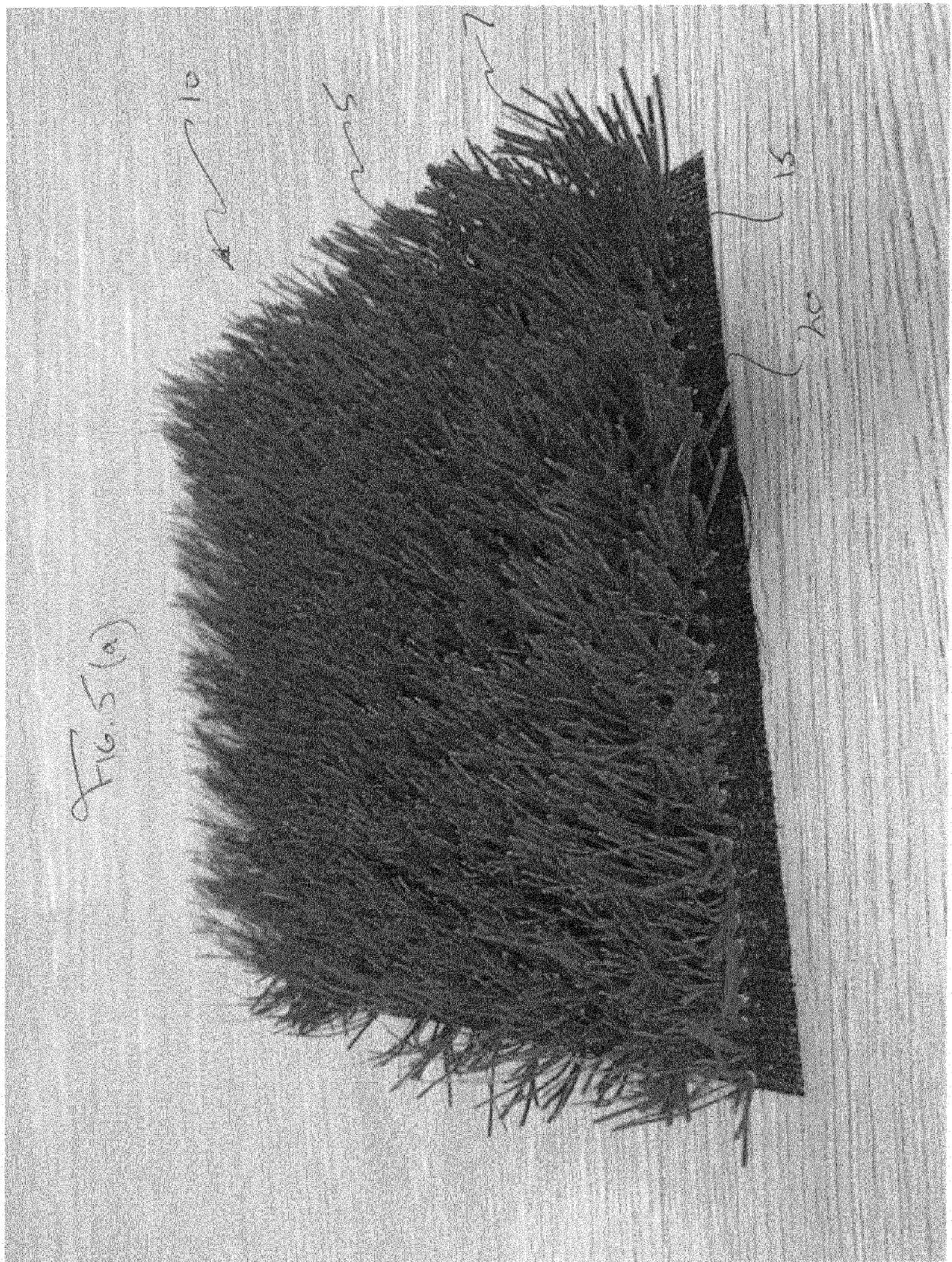


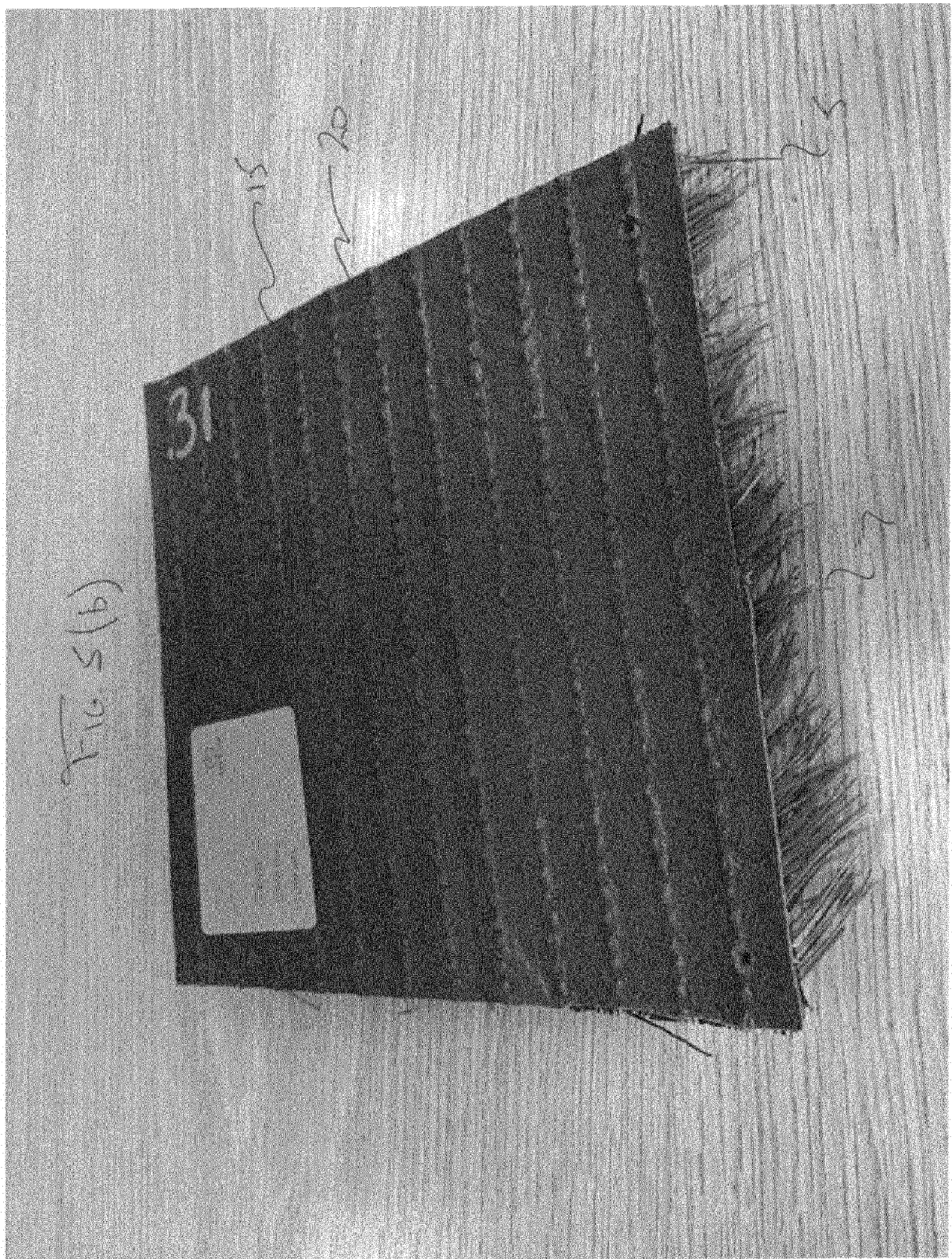
- Yarn comes from cones on creel racks (or from big spools called beams) into the machine
- The primary backing feeds into the machine
- Yarn and primary backing come together in the machine
- Yarn is fed through needles on a needle bar of a tufting machine
- Needles repeatedly penetrate or tuft into the primary backing
- Carpet is rolled onto large rolls for the next step whether it's to be dyed or to be backed)

FIG. 2.b)









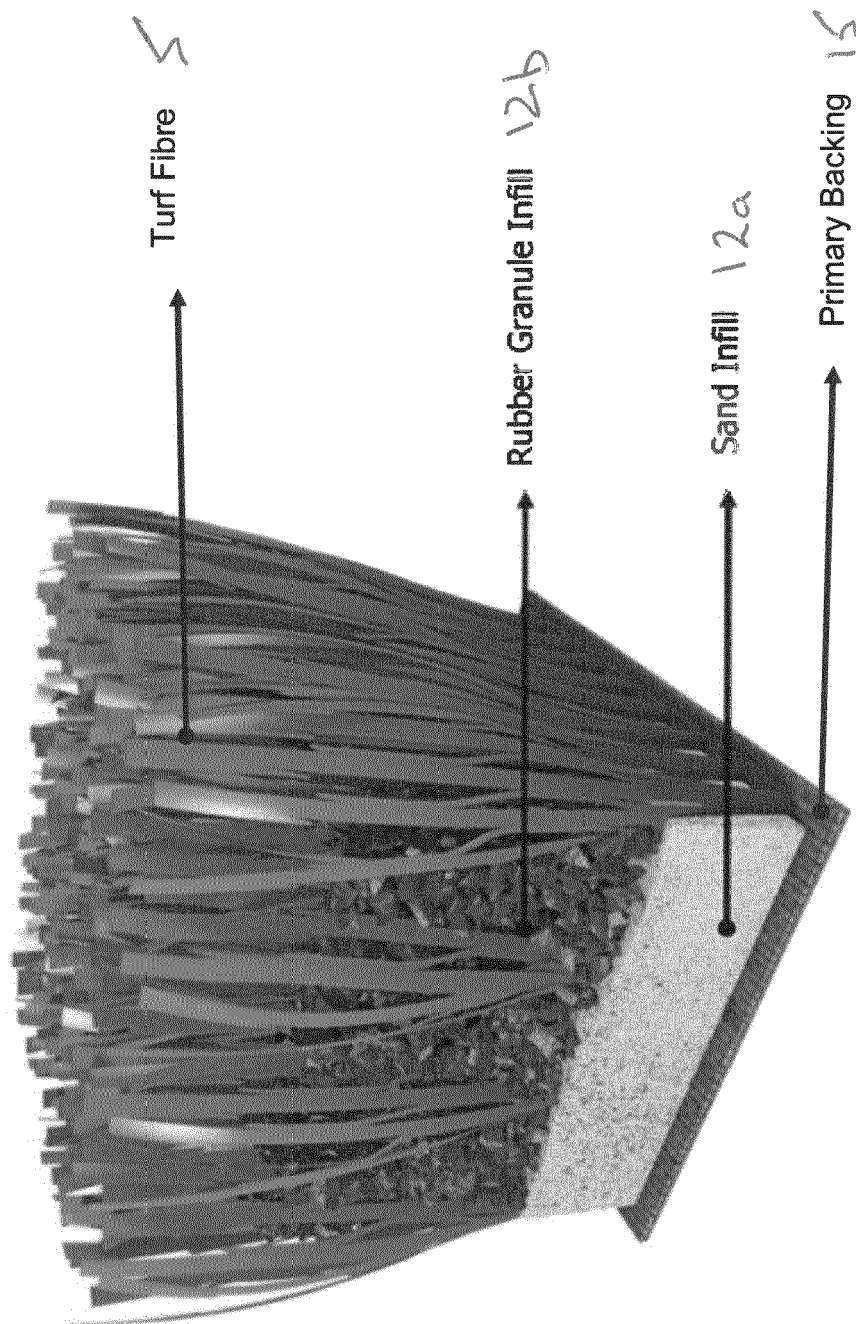


FIG. 6

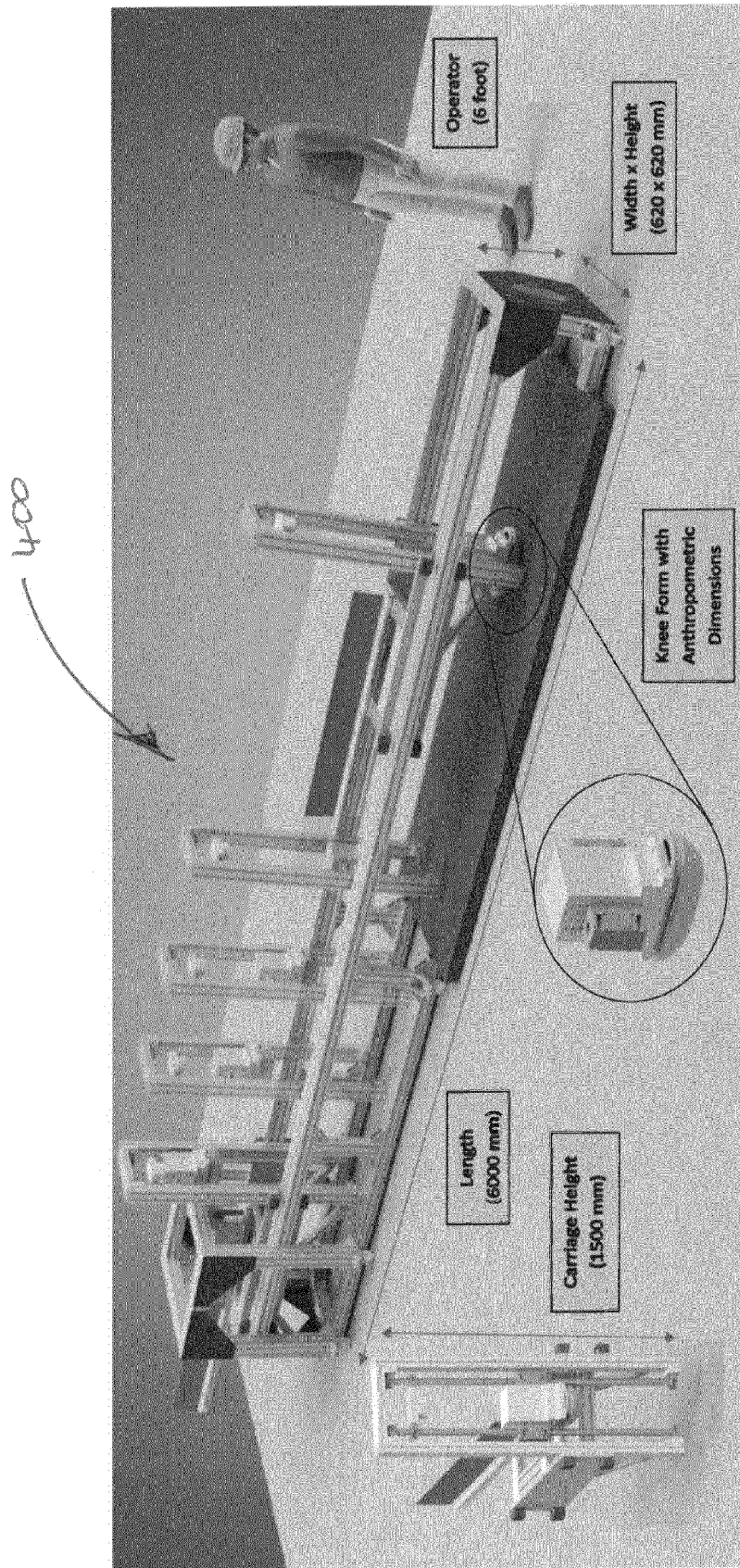
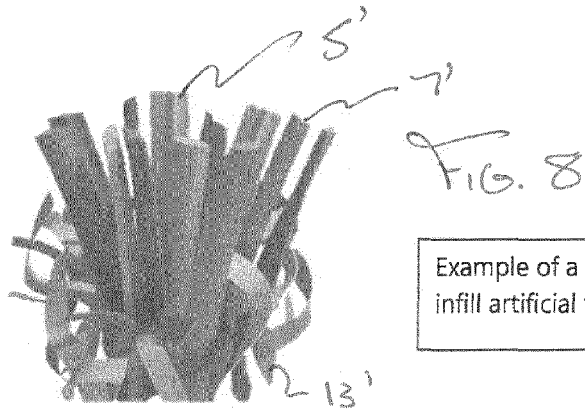


FIG. 7



Example of a tuft from a non-infill artificial turf carpet

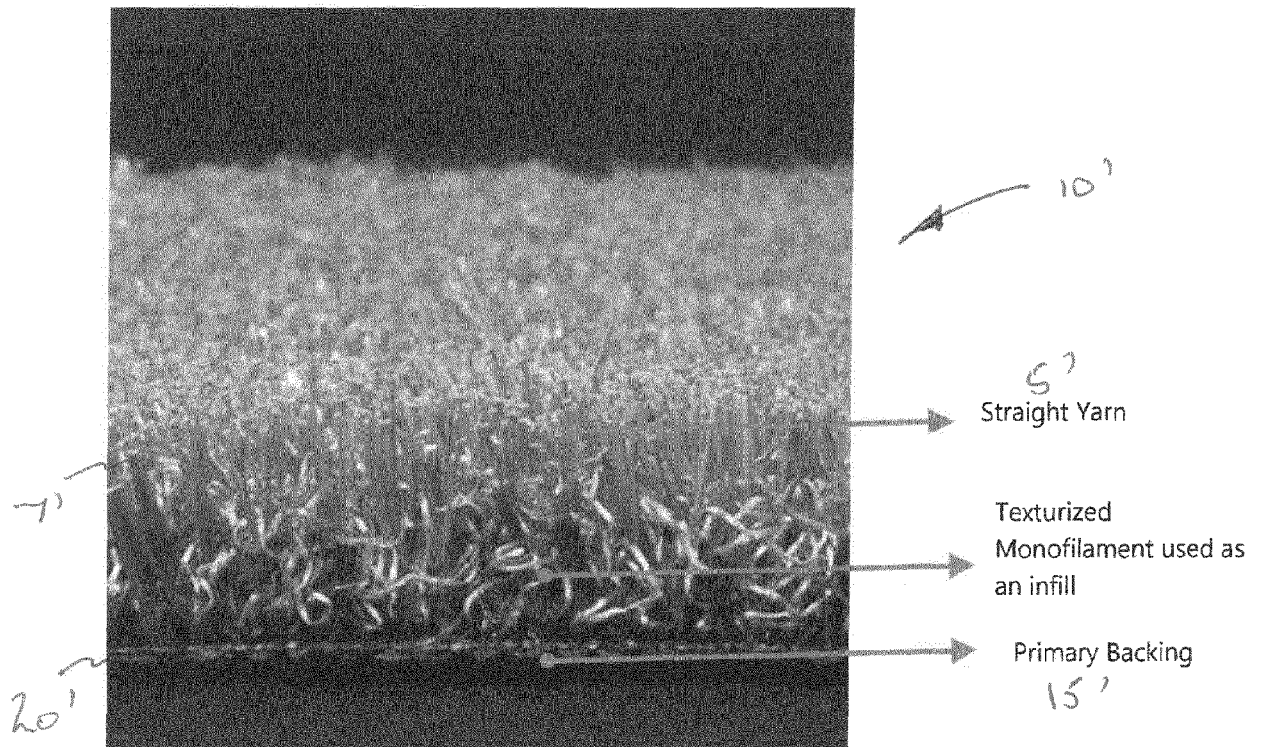


FIG. 9



EUROPEAN SEARCH REPORT

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X	EP 4 012 082 A2 (DON & LOW LTD [GB]) 15 June 2022 (2022-06-15)	2-8, 10-14	INV. D02G3/44
Y	* paragraphs [0023], [0032], [0039], [0040], [0048], [0049], [0112], [0177]; claims 1-8, 10, 11, 14; figure 4a *	1-15	D05C17/02 D06N7/00 E01C13/08
Y	WO 2018/101827 A1 (TEN CATE THIOLON BV [NL]) 7 June 2018 (2018-06-07) * paragraphs [0027], [0042]; claims 1-21; figure 3 *	1-15	
			TECHNICAL FIELDS SEARCHED (IPC)
			D02G D05C D06N E01C
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 17 November 2023	Examiner Braun, Stefanie
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

**ANNEX TO THE EUROPEAN SEARCH REPORT
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5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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