MONOFILAMENT RIBBON PILE PRODUCT

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This application is a continuation-in-part of our co-pending application Ser. No. 446,915 filed Apr. 9, 1965, now abandoned.

The present invention relates to an improved synthetic turf which simulates grass. More particularly, the invention relates to a grass-like turf useful both indoors and outdoors for a variety of recreational and sports activities.

The prior art reveals that attempts to make artificial grasses have been made during the past several years. In most instances, the inventive concepts have been concerned primarily with providing a decorative artificial grass and have not attempted to provide an artificial grass which will withstand permanent outdoor installation and the abrasive wear caused by spiked or cleated shoes. There are no known simulated turfs which have performance characteristics other than decorative that compare even closely with natural turf.

In accordance with the present invention there has been combined the characteristics of certain synthetic materials to produce an improved synthetic outdoor surface cover. The discovery has been made that a surface cover or turf consisting of a weather-resistant backing and heavy denier cut pile ribbons secured thereto with a suitable latex or adhesively bonded therewith and is not adversely affected by exposure to all types of weather conditions and abusive wear. It has been found that such turfs retain their grass-like similarity remarkably well for long periods of continued use as a cover for playfields and the like. Several of the performance characteristics of the turf contemplated by the present invention are comparable to those possessed by natural turf.

A primary object of this invention is to provide a synthetic product which simulates the physical characteristics and general appearance of natural turf.

Another object of this invention is to provide a weather-resistant turf constructed from synthetic materials which is suitable for permanent outdoor use.

A further object of this invention is to provide a grass-like turf which will not deteriorate either in color or physically when subjected to abusive treatment in outdoor weather conditions for extended periods.

Still another object of the invention is to provide a synthetic turf having a face comprising of vertically extending monofilament thermoplastic monofilament ribbons which are not matted down permanently or extracted when subjected to rough play and cleated or spiked shoes.

Another object of the invention is to provide a synthetic turf composed of vertically extending grass-like ribbons combined with a weather-resistant substrate having an adhesive applied on the underside thereof to lock in place the ribbons which simulate natural grass.

Another object of the invention is to provide a grass-like turf constructed from synthetic materials which are rendered dimensionally stable by applying a suitable latex and polymeric elastomeric to the underside of the backing.

Other objects and advantages of the invention will also be apparent from a detailed specification and the following drawings, in which,

FIGURE 1 is a perspective view of the turf illustrating its grass-like appearance in a woven construction;

FIGURE 2 is a cross-sectional view of the turf, enlarged, showing the construction of a preferred embodiment;

FIGURE 3 is a cross-section, greatly enlarged, of the thermoplastic ribbon which is preferred for the present invention;

FIGURE 4 is a cross-section, greatly enlarged, of a modified ribbon having striated surfaces; and,

FIGURE 5 is a transverse sectional view of the turf without an elastomeric layer adhered to the adhesive coated backing.

The objects of the present invention have been accomplished by conventional weaving, knitting, and tufting operations. A preferred woven embodiment is produced by weaving synthetic fibers on a Wilton cut-pile loom to form a structure consisting of a woven backing having a cut-pile face extending from one surface thereof and then applying a suitable latex formulation on the other surface of the backing to render the complete structure dimensionally stable. A polymeric elastomer is applied to the latexed backing to provide a more stable and improved structure.

The grass-like pile or face material of this invention normally consists of extruded monofilaments of 300 to 1200 denier, and preferably of 500 to 900 denier, which are extruded from polyamides, polyesters, and polypropylene, but preferably the polyamides which include nylon 66, nylon 6, nylon 4, nylon 610, nylon 11 and their filament forming copolymers thereof. The filaments should be preferably flat and ribbon-like to simulate natural grass and possess suitable bending properties. If preferred, the filament surfaces may be delustered to remove some of the shine produced by the flat surfaces of the ribbons. One means for accomplishing this is to impart to the ribbon longitudinal striations during the extrusion process. Filaments having round, oval, arcuate, or other cross-sectional configurations can be used but are not very suitable primarily because of their stiffness and unwillingness to bend. It has been demonstrated that a ribbon-like filament extruded from a rectangular, slotted orifice dimensioned to produce monofilament ribbon having a thickness of between 0.001 and 0.003 inch, and a width of between 0.01 and 0.20 inch is preferred for the product of this invention since ribbons having these cross-sectional dimensions possess good flexing and bending characteristics which promote its usefulness as a substitute for natural grass turf. If found advantageous, the ribbons may be treated with surfactants or other means for roughing the surface to facilitate fabrication thereof and prevent foot-slipage. The ribbon should be drawn and treated to provide the physical properties desired depending upon the polymer composition and the utilization planned for the turf. Preferably, the thermoplastic material is pigment green to simulate the color of grass, although other colors may be used for special effects. Multifilament single strand ribbons have been utilized, but without success, because the filaments comprising the strands become separated when they are subjected to the conditions as contemplated for the product of the present invention.

It is known that the addition of certain pigments to thermoplastic materials such as nylon and polyester may increase its resistance to degradation by ultraviolet light, although many pigments, particularly inorganic materials, tend to accelerate such degradation. We have found that a mixture of about 0.50 percent of a phthalocyanine green and 1.50 percent of a cadmium yellow based on polymer weight provides good color depth and sufficient stabilization against ultraviolet light for most applications.

Phthalocyanine green refers to the well-known chlorinated copper phthalocyanine chelate compounds widely
used as colorants; for example, Monastral Green and Mapaco Green pigments made by E. I. du Pont de Nemours, Pigment Department, Wilmington, Del. Cadmium Lixyphose yellow designates the common yellow inorganic pigment consisting principally of cadmium sulfide. The cadmium yellow pigments supplied by the Glidden Company, Baltimore, Md., and by Kentucky Color Company, Louisville, Ky., have proven quite satisfactory.

If desired, the nylon may be further stabilized by the incorporation of any of a number of well known UV absorbers which are compatible with the resin. These include such compounds as the aryl esters of phosphoric acid, the alkaryl phosphinates, zinc phosphates, manganous salts, chromium salts, and copper salts. For optimum weather resistance properties the nylon ribbons should be placed under the minimum tension possible.

The backing material may be formed with fibers prepared from polyesters, polyacrylonitrile, polypolyene and nylon, but preferably polyesters and polyacrylonitrile. Formation of the backing may be accomplished by weaving and knitting or any of the known processes for preparing non-woven, particularly needle punching. The backing fibers are preferably green solution dyed to add color depth to the turf and thus enhance the grass-like appearance thereof where this result is desired; however, white or conventionally dyed fibers of green or other colors may be employed.

For turf which will be used outdoors the acrylic fibers are preferred because of their excellent weather-resistant properties. Turf made for indoor installation are preferably constructed from backings formed from polyester fibers because they possess better strength properties than the acrylic fibers. Of course nylon fibers are stronger than polyester fibers, but the stretch characteristics of nylon fibers make them less desirable for most purposes.

In accordance with one embodiment of this invention, monofilament ribbon face fiber and the warp and fill backing fiber are woven together on a conventional Wilton cut-pile loom. The loom may be set to provide any desired face pile height, normally between 1/8 inch and 1 inch, with a face density between 10 and 40 ounces per square yard, and normally about 24 ounces per square yard. The pile height is determined by the particular utilization of the turf. It has been found that for general playground activities such as tennis, volleyball, baseball, softball, touch football, soccer and badminton, a pile height of about 3/8 to 1/2 inch is preferred. For other applications such as tee-off pads on golf driving ranges and par-3 courses, a turf having a nylon pile height of about 3/4 inch is preferred. A backcoated composition of fibers fashioned into a fabric having 9 picks per inch and 10 ounces per square yard is satisfactory for most common applications.

One alternative to weaving the turf fabric on a Wilton or similar loom, contemplates tufting the facing ribbon into a backing material to produce a turf of fair quality by tufting 5 or 6 plys monofilament ribbons on a 1/2 gauge machine and at a density of about 24 ounces per square yard into a dimensionally stable woven or non-woven backing fabric using standard tufting techniques.

An example of a suitable tufting medium or backing fabric is a 5 to 10 ounces per yard nylon scrim reinforced needle punched fabric formed from acrylic staple fibers which has been treated with a number of 80/20 mixture of Hycar 1571 Resin Mo–80 resin. Hycar 1571 is a water emulsion of butadiene-acrylonitrile copolymer sold by B. F. Goodrich Chemical Co., Cleveland, Ohio, and Resin Mo–80 is a melamine-formaldehyde resin sold by Monsanto Co., St. Louis, Mo.

Another backing material suitable for tufting is a nylon scrim reinforced polyurethane foam carpet backing which is marketed under the trademark, Chemback, by the Chemstrand Co., Division of Monsanto Co. Chemback is comprised of an open-mesh woven nylon scrim coated with foamed polyurethane having a density of approximately 2 lbs. per cubic foot. Chemback is produced in thicknesses of approximately 0.06 to 0.10 inch and in weights of 3 to 6 ounces per square yard.

Another preferred method for producing the product of this invention is accomplished by knitting the face ribbon and the backing fibers. The knitting operation may be performed on a conventional flat-bed, 52-knitting machine which has been provided with a cutting attachment adapted to cut the loops to produce a cut-pile face. A typical machine as described is manufactured by the Kidde Machine Co., Bloomfield, N.J.

After weaving, knitting or tufting the face ribbon with the backing to produce a turf fabric, a solution of latex or the like is applied to the back of the fabric by padding or other acceptable means. The latex provides dimensional stability to the fabric and also serves to anchor the ribbons in the backing material. It must therefore be of a composition which has good adhesion to both the synthetic ribbon and the synthetic backing material. One such latex composition is a dispersion of Lotol 7562, Pyratex, Dow Corning Antifoam, and Alcoignum.

A typical latex formulation suitable for use in this invention consists of by weight:

<table>
<thead>
<tr>
<th>Parts</th>
<th>Percent solids</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lotol 7562</td>
<td>830</td>
</tr>
<tr>
<td>Pyratex</td>
<td>175</td>
</tr>
<tr>
<td>D. C. Antifoam</td>
<td>0.25</td>
</tr>
<tr>
<td>Alcoignum</td>
<td>14.5</td>
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<td></td>
<td>11.5</td>
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</tbody>
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Lotol 7562 is a compounded natural rubber latex sold by the Naugatuck Chemical Division of U.S. Rubber, Naugatuck, Conn.; Pyratex is a vinyl pyridene terpolymer also sold by Naugatuck Chemical; Dow Corning Antifoam is a silicone oil sold by Dow Corning, Midland Mich.; and Alcoignum is a sodium polyacrylate viscosity control agent sold by Alco Chemical Corp., Philadelphia, Pa.

The Lotol, Pyratex, and Antifoam are combined and agitated to prepare the latex composition. The Alcoignum is added to the mixture until the viscosity of the solution is increased to about 2000 c.p. on the Brookfield viscometer. Between about 2 and 6 ounces per square yard based on solids of the latex solution is padded or otherwise applied to the backing fabric of the turf. The latex is dried and then cured at about 325° F. for 5 minutes.

After applying and curing the latex, the turf is dimensionally stable and may be employed as a useful product without further treatment. However, it has been found that the wear properties of the turf are enhanced if a resilient foam backing is applied before use. For outdoor applications, a PVC (polyvinylchloride) closed cell foam or solid PVC is preferred because of its excellent strength and well known weather resisting properties. An open cell PVC foam is suitable for indoor uses but generally is not desirable for outdoor installation because of its propensity to absorb large amounts of moisture. However, if the turf is to be used outdoors, other elastomers such as latex foam and polyurethane also may be used with good results.

The foam may be applied by any of the conventional techniques which are well known in the art. Either mechanical, physical, or chemical foaming may be employed, and the foam sheet may be either cast and cured directly on the back of the turf, or cast separately and cemented in place. The foam may be any thickness and density desired, but generally a PVC foam between 3/8 and 3/4 inch thick and having a density of 15 to 20 pounds per cubic foot is preferred. A polyurethane foam of a similar thickness having a density of 1.0 to 4.0 pounds per cubic foot and reinforced with an embedded nylon scrim is also satisfactory. It is noted however that for a preferred embodiment of this invention, a PVC plastisol containing a foam stabilizer is frothed with latex foaming equipment and cast directly upon the turf to form an open cell foam having a thickness of 1/4 inch and a density of about 35 pounds per cubic foot.
Referring to the drawing, there is shown in FIGURE 1 a portion of woven synthetic turf 10 which represents a preferred embodiment of the present invention. In FIGURE 2 there is shown a cross-section of the turf portion 10 greatly enlarged to illustrate the construction thereof. The pile 12 is formed from pigmented continuous monofilament ribbon having a substantially rectangular cross-sectional configuration as shown in FIGURE 3. As an alternative to a ribbon having substantially planar surface, the ribbon may preferably be provided with a saw-toothed or serrated surface configuration as illustrated in FIGURE 4. The striations should be staggered on opposite sides to maintain strength of the ribbon. Furthermore, the striations should be spaced close enough together to ovine the planar surface areas of the ribbon which normally have a tendency to produce an unwanted luster. The nylon pile is embedded in a woven synthetic fiber backing 14 and anchored securely therein by a bonding agent 16. A PVC foam 18 is applied on the backing to improve the physical properties of the turf 10. The product depicted in FIGURE 5 is shown to illustrate the turf without the polyvinylchloride layer 18. The invention will be more easily understood from the following examples, which are meant to be illustrative but not limiting. In these examples, parts and percentages are by weight unless otherwise specified.

**Example I**

Flat monofilament ribbons were produced by the conventional melt extrusion method with standard screw extruder and auxiliaries. The polypropylene polymer identified as “Escon 107,” Grade CD 70, was supplied by Enjay Chemical Company, New York, N.Y. A mixture of 1.4 percent cadmium yellow pigment and 0.6 percent phthalocyanine green pigment were incorporated in the polypropylene at the extruder inlet according to the pigment-slurrying method disclosed by Brignac in copending patent application Ser. No. 323,143 filed Nov. 12, 1963, now abandoned. The resultant grass-green filaments were 0.030 inch wide by 0.0018 inch thick.

A three-ply yarn composed of these polypropylene monofilaments is tufted into standard Chemback tufting medium and is sheared to ¼ inch pile height with 18 ounces of polypropylene face yarn per square yard of fabric. A latex adhesive is applied to the underside of a portion of the fabric and a non-woven rayon-polyolefin scrim is applied to the adhesive to form a secondary backing. Samples of backed fabric and plain tufted fabric are placed on a sidewalk leading to a large outdoor parking lot where the fabrics are exposed to extensive foot traffic. Both samples are found to have good durability characteristics. Negligible shedding is observed even in the plain fabric although the surface friction of polypropylene is notorious low. A secondary backing is still preferable, however, since it provides better form stability to the turf fabric.

**Example II**

Analogously to the procedure described in Example I, the same type of pigment composition and extrusion system was used to produce grass-green polyethylene terephthalate ribbon monofilament 0.045 inch wide by 0.0015 inch thick. The polyester polymer was supplied by the Chemical Division of Goodyear Tire & Rubber Company, and was designated VFR 1301-A. Five-ply yarn of the polyester filaments is tufted into standard Chemback tufting medium, and the tufts are cut to ½ inch pile height to provide 28 ounces of polyethylene per square yard of fabric. A very thin layer of adhesive latex is applied to the underside to bond the fabric to a pad of foamed PVC ¼ inch thick. The resultant composite has the appearance and plushness of a well-cultivated natural grass plot. A sample fabric runner is placed outside along the main entrance sidewalk of an industrial office building. The fabric exhibits superior durability characteristics after many months of exposure to outside weather conditions and to heavy foot traffic.

**Example III**

A 500 denier nylon 66 monofilament ribbon 0.0018 inch thick by 0.04 inch wide was prepared by conventional melt extrusion techniques. The ribbon was woven with an acrylic warp and fill backing on a Wilton cut-pile loom to produce a turf fabric having 24 ounces per square yard of nylon pile facing with a ½ inch pile height. The acrylic backing was woven from a 7/3's cotton count yarn spun from 3-denier, 2-inch acrylic staple, using 9 picks per inch to yield a fabric of 10 ounces per square yard. Both the nylon and the acrylic were pigmented to a grass-green color.

A latex solution consisting of 830 parts Lotol 7526, 173 parts Pyrates, 0.25 part D. C. Antifoam, and 14.5 parts Alcolon was padded onto the turf backing with an add on of 4 ounces per square yard based on dry solids. The solution was dried at 280°F. and cured at 325°F. for 5 minutes.

An open cell PVC foam having a thickness of ¼ inch and a density of 35 pounds per cubic foot was then cast upon the backing of the turf using conventional techniques to form a resilient pad. Evaluation of the turf as a covering for general playground activities showed excellent wear properties with no shedding or matting of the nylon pile even under this very severe evaluation.

It was observed that skin abrasions were suffered by children much less frequently while playing on the synthetic turf than while playing on natural turf or on gym floors. More important, however, is the fact that when skin burns were incurred healing was much more rapid for those caused on the synthetic grass than the injuries caused on the natural turf or gym floors.

**Example IV**

A synthetic turf was produced according to the procedure of Example III except the ribbons were polyethylene terephthalate monofilament ribbons 0.002 inch thick and 0.04 inch wide.

**Example V**

Example III was repeated except the nylon 66 monofilament ribbons had serrated cross-sections and the backing was prepared from polyethylene terephthalate staple fibers.

**Example VI**

A synthetic turf was prepared in accordance with Example III except the ribbon and backing yarn were knitted on a flat bed warp knitting machine provided with a cutting attachment to slit the ribbon loops.

**Example VII**

A synthetic nylon turf was produced according to the procedure of Example III except the PVC foam backing was not applied. Evaluation of the turf showed some shedding and matting of the nylon pile when subjected to heavy foot traffic, but the product was considered satisfactory for light service applications.

**Example VIII**

A synthetic nylon turf was produced according to the procedure of Example I using 900 denier nylon monofilament ribbon approximately 0.002 inch thick by 0.066 inch wide. The facing had a pile height of ½ inch and a density of 36 ounces per square yard. The resulting turf was stiff and had a harsh hand. Continued use of the turf indicated that it possessed excellent wear properties.

**Example IX**

A backing fabric was produced by needle punching a cross-laid batting of 5-denier, 2-inch acrylic staple fibers into a nylon scrim to form a reinforced non-woven fabric
weighing 5 ounces per square yard. The strength and dimensional stability of the fabric was increased by padding on 2.0 ounces per square yard of a resin solution consisting of 80 percent Hycar 1571 and 20 percent Resloomin M-80. The treated fabric was dried at 280° F. for 10 minutes and cured at 310° F. for 5 minutes.

The stabilized fabric was tufted with 6 ply 500 denier nylon monofilament ribbons on a conventional ½ gage Cobble tufting machine to provide 26 ounces per yard of nylon filament. The nylon tufts were cut to form a turf with a pile height of ½ inch, and the back of the tufted fabric was latexed as described in Example III to firmly anchor the nylon tufts and prevent shedding.

A closed cell polyurethane foam having a thickness of ½ inch and a density of 2 pounds per cubic foot was then cast atop the backing of the turf using conventional foaming techniques to form a resilient pad.

Example X

A synthetic nylon turf was produced according to the procedure of Example IX using 6 ply 350 denier nylon monofilament ribbon having a cross-section approximately 0.001 inch thick and 0.045 inch wide. The fabric had a pile height of ½ inch and a density of 22 ounces per square yard. The resulting turf had a considerably softer hand than the product of Example IV. Indoor wear properties were shown to be very good. The product made an excellent covering for gym floors.

Example XI

A nylon turf was produced by tufting 6 ply 500 denier nylon monofilament ribbons into a backing of ½ inch thick sheet of polyurethane foam which was reinforced by a nylon scrim. The tufts were cut to form a turf with a pile height of ½ inch, and the back of the fabric was latexed as described in Example III to firmly anchor the nylon and prevent shedding. The resulting synthetic turf was resilient and demonstrated excellent wear properties when used as a surface covering for an indoor playfield.

It will be apparent that the product of this invention is useful as a substitute for natural grass turf and conveniently may be employed both indoors and outdoors. The particular materials and their construction are combined to produce a new and novel product which is suitable for school sports and clipped or spiked-shoe sports.

Performance tests have proved that the synthetic turf of the present invention has ball-bounce characteristics somewhat similar to those of natural-grass turf.

For outdoor installations provisions must be made for adequate drainage of the synthetic turf. Depending upon local topography and type of subsurface, a slight slope may be sufficient to remove water by simple surface flow. In very flat regions one of the more permeable or perforated backing materials is preferred to aid water seepage into the subsoil. Synthetic turf according to the invention is not attacked by mildew or other fungi. Standing water in low areas should be avoided, however, since adventitious nutrient material may accumulate and support fungal growth that produces surface discolorations which are sometimes difficult to remove.

While the invention has been described for general purpose use, it is to be understood that certain modifications which will adapt the synthetic grass to meet the specific requirements demanded for individual circumstances are well within the concepts of this invention described herein and therefore the scope is not to be limited except as set forth in the appended claims.

What is claimed is:

1. A simulated grass-like woven product comprised of successive rows of extruded thermoplastic monofilament ribbons extending vertically from a warp and fill backing wherein the ribbons are woven and secured by an adhesive material, said ribbons having substantially rectangular cross-sections characterized by widths of at least three times greater than their thickness and having at least about 300 denier per ribbon.

2. The product of claim 1 further characterized by a resilient material adhered to the backing on the side opposite the vertically extending ribbons.

3. The product of claim 2 in which the resilient material is comprised of vinyl chloride.

4. The product of claim 3 in which the resilient material is polyvinylchloride foam.

5. The product of claim 1 in which the thermoplastic is nylon.

6. The product of claim 5 in which the nylon is pigmented.

7. The product of claim 6 in which the thermoplastic is polypropylene.

8. The product of claim 7 in which the polypropylene is pigmented.

9. The product of claim 1 in which the thermoplastic is polyethylene terephthalate.

10. The product of claim 9 in which the ribbons have from 300 to 900 denier per ribbon.

11. A simulated grass-like tufted product comprised of monofilament ribbons extruded from a thermoplastic composition and tufted into a backing to form successive rows of loops from the ribs which are cut to provide a cut-pile face, said ribbons having substantially rectangular cross-sections characterized by widths of at least three times greater than their thickness and having at least about 300 denier per ribbon and being secured in the backing by an adhesive material applied to the backing on the side opposite the cut-pile face.

12. The product of claim 11 in which a resilient material is bonded to the side of the backing having the adhesive applied thereon.

13. The product of claim 12 in which the thermoplastic composition is nylon.

14. The product of claim 13 in which the nylon composition contains pigments.

15. The product of claim 12 in which the thermoplastic composition is polypropylene.

16. The product of claim 15 in which the polypropylene composition contains pigments.

17. The product of claim 16 in which the thermoplastic composition is polyethylene terephthalate.

18. The product of claim 17 in which the ribbons have from 500 to 900 denier per ribbon and a cross-section having a width at least three times greater than the thickness.

19. A simulated grass-like product having a knitted, cut-pile construction which is comprised of successive rows of monofilament ribbons extruded from a thermoplastic composition extending vertically from a warp and lay-in backing wherein the ribbons are secured by an adhesive material, said ribbons having substantially rectangular cross-sections characterized by widths at least three times greater than their thickness and having at least about 300 denier per ribbon.

20. The product of claim 19 in which a resilient material is bonded to said adhesive material.

21. The product of claim 20 in which the resilient material is polyvinylchloride foam.

22. The product of claim 19 in which the thermoplastic composition is nylon.

23. The product of claim 22 in which the nylon composition contains pigments.

24. The product of claim 19 in which the thermoplastic composition is polypropylene.

25. The product of claim 24 in which the polypropylene composition contains pigments.

26. The product of claim 19 in which the thermoplastic composition is polyethylene terephthalate.

27. The product of claim 26 in which the composition contains pigments.

28. The product of claim 19 in which the ribbons have approximately 500 to 900 denier per ribbon.
29. The product of claim 28 in which the adhesive material is a latex solution.

30. The product of claim 29 in which a layer of polyvinylchloride foam is adhered to the backing.

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