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PILE FABRIC HAVING FIBRILLATED PILE YARN AND METHOD OF MAKING SAME

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9 Claims

ABSTRACT OF THE DISCLOSURE

A pile fabric and the process for its preparation, the process comprising hot-melt attenuating a foamed extrudate whereby a fibrillated polymeric strand is produced wherein the fibrils have cross-sections which are substantially devoid of planar surfaces. The strand is then secured to a backing to form the pile fabric.

This invention relates to pile fabrics, and more specifically, to tufted carpets having fibrillated yarn piles.

A recent development in the floor covering field has been the so-called indoor-outdoor carpet. Indoor-outdoor carpets are floor coverings which do not rot, mildew, stain, stretch, shrink, fade or discolor under severe weathering conditions and hence, are suitable for outdoor applications. Carpeting of this type must be prepared from materials which have the aforementioned degradation resistance properties in both the carpet backing and the carpet pile. Such materials preclude of course, the presence of all naturally occurring fiber materials as well as certain of the synthetic fiber materials, such as for instance, regenerated cellulose, and regenerated keratin. More specifically, those materials which have found widest application in indoor-outdoor carpeting are materials such as polyolefins, polyamides, acrylic fibers and the like. Most commonly, the carpet backing is prepared from a polypropylene yarn, although the pile may run the gamut of such materials as exhibit satisfactory resistance to weather induced degradation. While indoor-outdoor carpeting need not resemble grass, it has been found that a product which has the appearance of grass is very desirable for applications, such as for instance, patios, terraces, cabanas, breezeways, pool decks and the like. In general, these floor coverings which resemble grass have been prepared from standard textile grade yarn pile and from ribbon pile, the greatest application of ribbon pile being in polyamide ribbon and vinyl chloride-vinylidene chloride ribbon. Products employing these materials as pile have very grass-like appearance; however, it is readily apparent that uniform ribbon thicknesses as well as uniform fiber thicknesses, result in a pile end product which is distinctly different from an end product having varying fiber denier or thickness in the pile. It is obvious that a product having varying thicknesses in the pile would more nearly resemble natural grass and more nearly approach the tactile aesthetics of natural grass wherein the individual blades have an infinite variety of thicknesses. In addition to the need for the physical dimensions of the pile to resemble grass, it is also essential, where grass-like characteristics are desired, that the product have a color which is a tone on tone color as well as a color which is durable to outdoor weathering conditions.

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It is therefore an object of this invention to prepare a pile fabric having a pile, the individual fibrils of which are of multiple cross-sectional variety.

It is a further object of this invention to prepare a pile fabric wherein the pile has a tone on tone coloration which is durable to weathering conditions.

It is still another object of this invention to provide a pile fabric wherein both the pile and the pile backing are prepared from substantially the same durable yarns.

In accordance with this invention, it has now been discovered that a product suitable for use as indoor-outdoor carpeting may be prepared by securing a fibrillated polymeric strand pile to a weather resistant backing material. While the preferred method for securing the pile is by means of a tufting operation, it should be understood that any of the woven pile techniques commonly employed in the carpet industry may also be employed. Fibrillated polymeric yarn is produced by a process which consists of producing an extrudate from a mixture comprising a molten polymer and a foaming agent which is or evolves gas at extrusion temperature and then drawing the extrudate subsequent to extrusion. The molten extrudate is preferably hot-melt drawn or attenuated at temperatures above the glass transition temperature of the polymeric material. After stretching of the hot melt attenuated product, it is preferred to orient the polymer and thereby produce increased strength. It is also preferred that the melt, in addition to containing a foaming agent, also contain a coloring component, that is to say, it is preferred that the extrudate be a dope dyed extrudate.

The present invention is applicable to all thermoplastic resins which can be fabricated by melt extrusion. Suitable resins include one or more polymers and/or copolymers of materials such as polyethylene, polypropylene, polybutene, polymethyl-3-butene, polystyrene, polyesters, polyamides such as polyhexamethylene adipamide and polycaprolactam, acrylic resins such as polymethylmethacrylate and methyl methacrylate, polyethers such as polyoxymethylene, halogenated polymers such as polyvinyl chloride, polyvinylidene chloride, tetrafluoroethylene, hexafluoropropylene, polyurethanes cellulose esters of acetic acid, propionic acid, butyric acid and the like, polycarbonate resins and polyacetal resins. Resins which have been found to be especially suitable for use in conjunction with the present invention are polyethylene, polypropylene, polystyrene, polyester and polymethyl-3-butene.

The foaming agents which are useful in the extrusion of foam are known. As previously indicated, gases or solids or liquids which vaporize or decompose into gaseous products at the extrusion temperatures, as well as volatile liquids, may be employed. Solids which are suitably employed in the process of the present invention include azoisobutyric dinitrile, diazoamino benzene, 1,3-bis (p-xenyl) triazine azodicarbonamide and similar azo compounds which decompose at temperatures below the extrusion temperature of the forming composition. Commonly used solid foaming agents producing either nitrogen or carbon dioxide include sodium bicarbonate and oleic acid, ammonium carbonate and mixtures of ammonium carbonate and sodium nitrite. Volatile liquids which are suitable foaming agents include acetone, methyl ethyl ketone, ethyl acetate, methyl chloride, ethyl chloride, chlo-

roform, methylene chloride, methylene bromide and, in general, fluorine containing normally liquid volatile hydrocarbons. Foaming agents which are the normally gaseous compounds such as nitrogen, carbon dioxide, ammonia, methane, ethane, propane, ethylene, propylene and gaseous halogenated hydrocarbons are also desirable. A particularly preferred class of foaming agents are fluorinated hydrocarbon compounds having from 1 to 4 carbon atoms which, in addition to hydrogen and fluorine, may also contain chlorine and bromine. Examples of such blowing agents are:

dichlorodifluoromethane;
dichlorofluoromethane;
chlorofluoromethane;
difluoromethane;
chloropentafluoroethane;
1,2-dichlorotetrafluoroethane;
1,1-dichlorotetrafluoroethane;
1,1,2-trichlorotrifluoroethane;
1,1,1-trichlorotrifluoroethane;
2-chloro-1,1,1-trifluoroethane;
2-chloro-1,1,1,2-tetrafluoroethane;
1-chloro-1,1,2,2-tetrafluoroethane;
1,2-dichloro-1,1,2-trifluoroethane;
1-chloro-1,1,2-trifluoroethane;
1-chloro-1,1-difluoroethane;
perfluorocyclobutane;
perfluoropropane;
1,1,1-trifluoropropane;
1-fluoropropane;
2-fluoropropane;
1,1,1,2,2-pentafluoropropane;
1,1,1,3,3-pentafluoropropane;
1,1,1,2,3,3-hexafluoropropane;
1,1,1-trifluoro-3-chloropropane;
trifluoromethylethylene;
perfluoropropene and
perfluorocyclobutene.

The quantity of foaming agent employed will vary with the denier or filament size desired—a lower density requiring a greater amount of foaming agent—the nature of the thermoplastic resin foamed and the foaming agent employed. In general, the concentration of the foaming agent will be from 0.001–5 lbs. moles/100 lbs. of the thermoplastic resin.

Fibrillated products prepared by the hot melt attenuation technique contain individual fibrils, the cross-sections of which are irregular in shape and size. It should also be noted that within the same fibril there will be a plurality of geometrically different cross sections which are substantially devoid of planar surfaces. Preferably, the fibrillated product employed in the preparation of the indoor-outdoor carpeting of this invention is a fibrillated product which is extruded in sheet or film form and subsequently worked by means of suitable mechanical agitations including fluid jets such as air jets, so as to produce bulking and residual fibrillation. The film forming die is preferably such as to have an opening thickness of from .005 inch to .060 inch. When polypropylene is being extruded, it is preferred that the die have an opening thickness of from .02 inch to .04 inch. The fibrillated yarn prepared in this manner may be formulated into a carpet by tufting into a backing by means of any of the well-known needle tufting techniques. It is preferred however, that the pile be a cut pile in order that an end product having varying pile heights, which are of course more grass-like in appearance, may be produced.

It is also preferred that the backing employed in the preparation of the indoor-outdoor carpet of this invention be a backing which is resistant to weathering conditions and more specifically, be a synthetic plastic, either woven or non-woven, backing wherein the synthetic plastic is selected from the group consisting of polyethylene, polypropylene, nylon and polyester, and most preferably, poly-

propylene of the same formulation as that polypropylene employed in the preparation of the fibrillated yarns used in the pile.

A better understanding of the invention may be had from a description of the process for the preparation of the fibrillated yarns employed herein.

EXAMPLE A

Polypropylene polymer pellets (marketed by Hercules Company under the trademark Profax) 1.7 intrinsic viscosity are dry-blended with 1% of azodicarbonamide blowing agent and 1% by weight of green pigment VN665 (marketed by Ferro Corp. Color Division, Cleveland, Ohio). Blending is carried out in a tumbling vessel for fifteen minutes. The blended polymer is then loaded into an extruder having a chrome-plated single fluted uniform pitch screw, the extruder being fitted with a die of the horizontal ribboned type having a 1" x 0.020" slit. The die is equipped with a 500 watt electric band heater. The polymer is extruded at a throughput rate of 2.5 grams per minute. The extruded sheet is maintained at temperatures above the glass transition temperature by means of a quench fork, the quench fork having tubes disposed on either side of the extruded film. The tubes have air orifices disposed therein, said orifices having a diameter of 0.04", the orifices being spaced 0.125" apart, each tube containing two rows of orifices 60° apart. The extruded film is passed over a first roll at a speed of 25 to 35 meters per minute. At this point, a fibrillated product is obtained which is in a substantially undrawn, unoriented condition. The undrawn, unoriented fibrillated polypropylene material is then subjected to a drawing operation, the drawing operation being carried out by passage over a shoe heated to 130° C. and then taking the yarn over a roll having a winding speed of 50 to 70 meters per minute, thereby producing a draw ratio

$$\frac{\text{second roll speed}}{\text{first roll speed}}$$

of 2.5. The tensile properties of the yarn produced by this procedure is given in the table appearing hereinafter designated as Table I. A portion of the extruded and drawn product is twisted 5 turns per inch and is subjected to a second drawing operation, the second drawing operation being carried out by passage over a shoe which is maintained at a temperature of from about 140 to 150° C., e.g., 145° C. and then over a drawing roll at a speed of 20 meters per minute whereby a draw ratio

$$\frac{\text{second roll speed}}{\text{first roll speed}}$$

of from 1.5 to 2, e.g., 1.7, is maintained. The tensile properties of the yarn which is produced by this process are given in the table appearing hereinafter designated as Table II.

TABLE I.—TENSILE PROPERTIES OF FIBRILLATED POLYPROPYLENE YARN

[(b) Extruded, drawn]		
	Zero t.p.i.*	5 t.p.i.*
Denier.....	360	360
Elongation, percent....	17	38
Tenacity, g./d.....	2.5	3.4
Modulus, g./d.....	33	23

* Turns per inch.

TABLE II

Tensile properties of fibrillated polypropylene yarn

(c) Extruded-drawn—Twisted (5 t.p.i.)—Redrawn:

Denier	240
Elongation, percent	26
Tenacity, g./d.	4.8
Modulus, g./d.	54

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EXAMPLE B

Profax polypropylene (marketed by Hercules Company) having an intrinsic viscosity equal to 1.7 is blended with 1% azodicarbonamide blowing agent and 1% by weight of green pigment VN665 (marketed by Ferro Corp. Color Division, Cleveland, Ohio). The blended mix is then placed in a National Rubber Machinery extruder employing a screw 12" long and 1" in diameter. The extruder is equipped with a die for vertical extrusion, the die having a circular opening which is $\frac{9}{16}$ " in length and $\frac{1}{8}$ " in diameter. The rear temperature area or zone 2 is also maintained at 210° C. while the die-head is maintained at a temperature of 240° C. The hot-melt is extruded into a water quenching bath, the die-head being disposed 10" above the surface of the water. The extrudate, upon contacting water is cooled and is then passed under a snubbing pin disposed beneath the surface of the water in order to attenuate air voids in the extrudate. The extrudate is then withdrawn from the water quenching bath and passed over a series of godet wheels at a take-up speed of 200 meters per minute whereby the polypropylene is oriented. The oriented material is then led around a series of pins which are disposed so as to force the extrudate to travel through a tortuous path and thereby induce fibrillation. The fibrillated product is then taken up on a suitable take-up package.

Fibrillated yarn prepared according to Examples A and B may then be tufted into conventional backings such as, for instance, jute backings, or more preferably, tufted into a synthetic backing, such as, for instance, a polypropylene backing. While the tufted fabric of this invention is not limited to any particular construction, it is preferred that the pile yarns be from about 800 to about 4,000 denier and most preferably about 1,200 denier. A better understanding of the procedure employed for tufting the fibrillated yarns into the various backings may be had from the following examples:

EXAMPLE 1

An all-polypropylene carpet backing prepared from 1200 denier polypropylene yarn having $\frac{1}{2}$ turn per inch of S-twist in the warp and zero-twist in the fill and a count of 14 x 10 is prepared in a plain weave. The backing is then heat set and calendered. Yarn prepared according to the procedure set forth in the Example A so as to have a 1200 denier weight, is twisted with one turn of Z-twist per inch. A second end of 1200 denier one turn per inch Z-twist yarn is then plied therewith so as to produce a 2400 denier 2-ply yarn having $\frac{1}{2}$ turn of Z-twist in the ply. The 2-ply yarn is then tufted into the backing by means of a Cobble $\frac{5}{32}$ gauge cut pile tufting machine. The resulting carpet has a pitch count of 8, measured according to the ASTM standard methods of testing pile floor coverings. (See ASTM designation D-418-42, page 559 of the ASTM Standards on Textile Material published October 1954, by the American Society for Testing Materials, Philadelphia, Pa.) The length of the pile was $\frac{1}{2}$ " as measured with a steel scale. The carpet was then given a latex coating on the backing so as to secure the tufted pile. After the carpet is subjected to a 20,000 step wear trial, it is found that the pile yarns exhibit excellent abrasion and compression resistance as well as excellent appearance retention.

EXAMPLE 2

A polypropylene carpet backing is prepared in a plain weave from 1800 denier fibrillated polypropylene yarn in both the warp and filling direction, the carpet backing fabric having a count of 10 x 10. The fabric which has a weight of 5.3 ounces per sq. yd. is then heat set and calen-

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dered. A foam fibrillated polypropylene yarn prepared according to Example B is formulated so as to result in a two-ply 1200 denier yarn. The yarn which has one turn per inch of Z-twist is tufted into the backing by means of a Cobble $\frac{5}{32}$ gauge cut pile tufting machine set so as to produce a pitch count of 7. The measurements are made according to the ASTM standard methods of testing pile floor coverings, and specifically, ASTM designation D-418-42. Pile height, as measured with a steel scale, is found to be $\frac{1}{2}$ ". The backing is then given a latex coating in order to secure the tufted pile. The carpet is subjected to a 20,000 step wear trial, and is found to exhibit satisfactory abrasion and compression resistance and also exhibit a satisfactory appearance retention.

Having thus disclosed the invention, what is claimed is:

1. A pile fabric comprising a backing having hot-melt attenuated foam fibrillated polymeric strands secured thereto, said strands being characterized by the presence of fibrils which exhibit random cross-sections which are irregular in shape and size and substantially devoid of planar surfaces, the individual fibrils exhibiting a plurality of geometrically different cross-sections.

2. The article of claim 1 wherein said fibrillated polymeric strands are tufted foam fibrillated polymeric strands.

3. The article of claim 1 wherein said fibrillated polymeric strands are polymeric materials selected from the group consisting of polyethylene, polypropylene, polyamide, polyester, polystyrene and combinations thereof.

4. The article of claim 1 wherein said fibrillated polymeric strands are dope dyed fibrillated polymeric strands.

5. The article of claim 1 wherein said fibrillated polymeric strands are two ply strands each of which have been dope dyed to produce a tone on tone effect.

6. A process for producing a tufted article comprising hot-melt attenuation foam fibrillating a thermoplastic extrudate, processing said extrudate to strand form, said strand being characterized by the presence of fibrils which exhibit random cross-sections which are irregular in shape and size and substantially devoid of planar surfaces, the individual fibrils exhibiting a plurality of geometrically different cross-sections and then tufting said strand into a backing.

7. The process of claim 6 wherein foam fibrillation is conducted at temperatures above the glass transition temperature of said thermoplastic extrudate.

8. The process of claim 6 wherein said thermoplastic extrudate has a coloring component disposed therein.

9. The process of claim 6 wherein said thermoplastic extrudate is a thermoplastic material selected from the group consisting of polyethylene, polypropylene, polyamide, polyester, polystyrene and combinations thereof.

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