

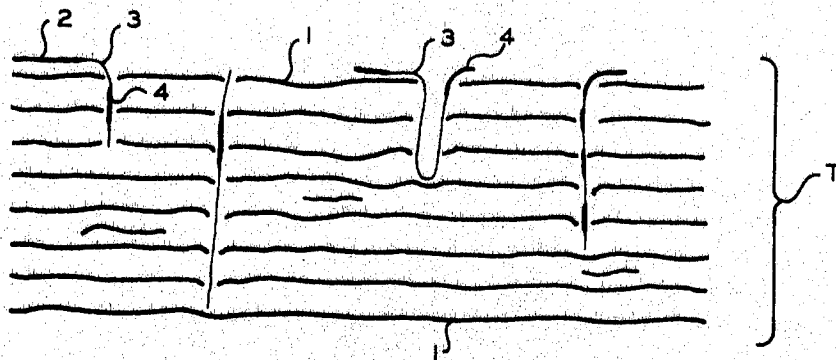
Dec. 16, 1969

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3,484,283

PLASTIC FELT

Filed Oct. 26, 1967



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3,484,283

PLASTIC FELT

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Filed Oct. 26, 1967, Ser. No. 678,408

Int. Cl. C08c 17/16; D06n 5/00

U.S. Cl. 117—140

5 Claims

ABSTRACT OF THE DISCLOSURE

Plastic felt-like material formed using unoriented fibers which are later at least partially molecularly oriented by needling. Said unoriented fibers are arranged so that their axes are substantially parallel to one another and are laid upon one another to form the thickness dimension of said felt. Said molecularly oriented fibers extend only in a direction substantially perpendicular to the long axes of said unoriented fibers and through at least a portion of the thickness of said felt.

This invention relates to a new and improved felt-like material formed from plastic fibers and a new and improved method for making same.

Heretofore in the production of felts such as those used for outdoor-indoor carpeting, a plastic filament was employed that was molecularly oriented by plasticly deforming same in a direction parallel to its longitudinal axis at a temperature substantially below its melting point thereby providing a filament which is molecularly oriented along its entire length and which is in the size range of 18 to 22 denier. The filament is molecularly oriented in any conventional manner well known in the art including supercooling the filament and then stretching same as well as heating the filament to a temperature below that at which it is in the molten state and then plasticly stretching same so that the filament in the stretched or molecularly oriented state is substantially longer, e.g. at least 2 to 3 times longer, than the unoriented filament and has a substantially reduced radius as compared to the unoriented filament. This completely oriented filament is then crimped in a conventional manner such as by being passed through a stuffer box to wrinkle or otherwise bend or deform the filament. Thereafter, the filament is cut into staple fibers which are a plurality of short fibers of 1 to 6 inches in length.

The completely molecularly oriented staple fibers are then formed into a batt in any conventional manner such as by use of well known garnett or carding machines. This process is simply the alignment of the staple fibers so that their longitudinal axes are substantially horizontal and parallel to each other and so that the fibers are piled beside and on one another to form a batt which has a relatively well defined length, width, and thickness, the longitudinal axes of the staple fibers in the batt being substantially parallel to the length of the batt. Carding and garnetting processes and machines are well known in the art for forming batts from plastic staple fibers. The batt is then cross-lapped over a scrim composed of a non-woven or loosely woven supporting material and then is needled in a conventional manner, i.e. pierced in a plurality of places with barbed needles to force some of the fibers in the batt down through the batt and scrim. Needling changes the position of some fibers in the batt so that their longitudinal axes extend substantially perpendicular to the long axis of the batt, and, therefore, perpendicular to the long axis of most of the fibers that make up the batt, and so that they extend through a substantial portion of the thickness of the batt. The needling process forms what is known as felt and is a conventional

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and well known process. Thereafter, the felt can be treated to cause shrinking of the fibers to cause further compacting and strengthening of the felt. A full and complete disclosure of the making of felts, including felts formed from synthetic fibers, by the use of carding, needling, shrinking, and similar steps can be found in the Man-Made Textile Encyclopedia published by Textile Book Publishers, Inc., a division of Interscience Publishers, Inc., New York, 1959, pages 484 through 497, the disclosure of which is hereby incorporated herein by reference.

According to this invention and in contrast to the prior practice of using completely molecularly oriented fibers of 18 to 22 denier, it has now been found that if 40 to 200 denier unoriented fibers are instead utilized and the normal felting process is carried out taking care so that no molecular orientation of the fibers takes place except that caused by the needling operation, the expensive and time-consuming step of orienting all the fibers used is eliminated and at the same time there is obtained a felt which is superior in thickness and resilience at the same fiber weight, is superior in wear resistance, is superior in ultraviolet radiation degradation resistance, and is superior in appearance.

Thus, by the process of this invention, an unoriented 40 to 200, preferably 70 to 90, denier filament is crimped, cut into staple fibers, and thereafter formed into a batt in the conventional manner except that care is taken not to plasticly deform the filament or fibers so that they remain substantially unoriented. Thereafter, the batt is needled in the conventional manner which needling process was found to partially orient longitudinal portion or portions of at least those fibers which are forced by the needles into a position substantially perpendicular to the long axis of the batt. Thus, the needling operation in the process of this invention causes at least partial molecular orientation of some of the fibers in the batt. Thereafter, the felt produced by the needling operation is heated to at least 240° F. for a time sufficient to cause longitudinal shrinkage of the fibers in the felt. Because the felt is composed of a mixture of unoriented and at least partially oriented fibers, the amount of shrinkage of the various fibers is different, the unoriented fibers shrinking more than the oriented or at least oriented portions of the oriented fibers, so that the ultimate result is uneven shrinkage of the fibers in the felt which tends to more effectively bind the fibers together and produce a stronger felt which will have greater wear resistance.

The felt of this invention is composed of 40 to 200 denier plastic fibers that are not molecularly oriented and a plurality of these 40 to 200 denier fibers which have been at least partially molecularly oriented, the at least partially molecularly oriented fibers extending substantially perpendicular to the long axes of the unoriented fibers and also extending through at least a portion of the thickness of the felt, the at least partially oriented fibers being characterized in that at least one finite longitudinal portion of each such fiber is molecularly oriented and has a diameter substantially less than the original diameter of that fiber when not so molecularly oriented. The longitudinal portion of the fiber that is oriented can be a single portion or a plurality of portions separated from one another by unoriented longitudinal portions of the same fiber. The oriented portion or the sum of the oriented portions of any given oriented fiber can vary widely from less than 1 percent of the length of the fiber to greater than 90 percent of the length of the fiber. The amount of diameter reduction of the oriented portion of the fiber can vary widely depending upon the degree of plastic elongation undergone by that portion of the fiber. Generally, the diameter will be at least 30 percent less than that of the unoriented diameter of the same fiber.

Generally, from about 3 to about 50 percent of the fibers in the felt will be oriented.

The felt of this invention as produced by the process of this invention has a wide variety of uses. A particularly good use for the felts of this invention is outdoor-indoor carpeting. Other uses include automotive and home wall coverings, automotive head liners, and the like.

Accordingly, it is an object of this invention to provide a new and improved plastic felt product. It is another object of this invention to provide a new and improved outdoor-indoor carpeting. It is another object of this invention to provide a new and improved method for making felt products.

Other aspects, objects, and the several advantages of this invention will be apparent to those skilled in the art from the description, the drawing, and appended claims.

The drawing shows a cross section of a felt of this invention produced according to the process of this invention. More particularly, the drawing shows a felt having a plurality of unoriented fibers 1 piled on one another with their longitudinal axes substantially parallel to one another so as to form a batt having a thickness T. The batt also contains a plurality of at least partially oriented fibers 2 which extend substantially perpendicular to the long axis of the batt and the long axes of fibers 1. Fibers 2 are at least partially oriented in that they have portions 3 which are molecularly oriented and therefore have a diameter substantially less than unoriented portions 4 of the same fiber. The number and length of oriented portions of any given fiber will vary widely depending upon the particular fiber itself, the fiber's composition, the needling operation, and the like. Although not knowing for a certainty and therefore not desiring to be bound thereby, it presently appears that under the action of the barbed needle forcing its way through the batt and pulling fibers 2 through the batt, localized stresses are raised in fibers 2 at various points along their length thereby giving rise to one or more oriented portions along the length of those fibers during the needling operation. It is possible that portions of fibers 1 can also be oriented by reason of their being in contact with one or more fibers 2 during the needling operation and this invention includes and is meant to include the aspect of some orientation of some of the fibers 1 of the batt. The drawing was made with exaggerated spacing between all of the fibers for clarity's sake and is not to be taken as an accurate representation of the proximity of the fibers in the felt product of the invention since in the actual product the fibers would be much closer to one another, i.e. contiguous with one another in many places.

The filaments employed in this invention can be formed from any known plastic material which can be molecularly oriented. Such plastics include polymers formed from 1-olefins having from 2 to 8 carbon atoms per molecule such as ethylene, propylene, butene-1, hexene-1, octene-1, and the like. Other orientable plastics include copolymers of 1-olefins and a blend of 1-olefin homopolymers and/or copolymers. Still other suitable plastics include polyamides, polyesters, polyvinyl alcohol, acrylic polymers, polyvinyl chloride, polyvinyl acetate, polyvinylidene chloride, and the like as well as blends of these polymers with one another and with homopolymers and/or copolymers of 1-olefins.

The unoriented fibers of 40 to 200 denier can be formed in any conventional manner such as by melt spinning or any other conventional filament forming process. The unoriented filaments can be crimped in any conventional manner such as by use of a conventional stuffer box and can then be cut into staple fibers having from 1 to 6 inch lengths. Care should be taken in the filament forming, filament crimping, and filament cutting steps so that the filament is not plastically deformed and therefore remains in its original unoriented state.

The unoriented staple fibers can then be formed into a batt using a conventional garnett or card and then needled in the conventional manner. Here again, care should be taken in the forming of the batt that the unoriented fibers are not plastically deformed or otherwise molecularly oriented. Thus, by puncturing the batt with a plurality of barbed needles a plurality of unoriented fibers are forced through a portion of the thickness of the batt and only at this time does any molecular orientation of any fibers in the batt take place. The batt can be needled as many times and with as many needles as is necessary to obtain the desired density felt. The density of the felt can vary widely depending upon the desired use of that felt. For example, a felt used for an outdoor-indoor carpet should be needled to a density such that the felt in carpet form will sustain no more than a 15 percent decrease in thickness under a pressure of 10 pounds per square inch of felt area.

The filaments employed in this invention can contain one or more coloring pigments so that a plurality of different colored staple fibers is employed in making the felt. In this manner the final felt will exhibit a tweed effect because of the use of blends of various hues of colored staple fiber. The filaments can be melt-colored or colored in any other manner conventional in the art.

The needled felt can then be heated to at least 240° F., preferably from about 285 to about 310° F., for a time sufficient to cause longitudinal shrinkage of the fibers in the felt, preferably at least 10 percent, still more preferably from about 25 percent to about 50 percent. The heating can be carried out directly or indirectly with respect to the felt and in a substantially inert liquid or gaseous atmosphere, preferably air.

Generally, in carrying out the process of this invention, to avoid molecularly orienting the filaments being treated or fibers of the batt, any tension load on those filaments or fibers which is sufficient to cause those fibers or filaments to plastically elongate should be avoided. This maximum tension load will vary widely depending on the size and composition of the filament or fiber as well as the temperature and type of tension loading employed. However, it is presently believed that a force of less than ¼ gram per denier would avoid molecularly orienting a filament or fiber.

The felt of this invention can be processed in any conventional manner to produce the desired final product. For example, when the felt is to be employed as outdoor-indoor carpeting, it is processed in the same manner as any other felt product, i.e. a rubbery backing is applied to the felt in the conventional manner and the felt is then cut into the desired carpeting size. The felt of this invention can be formed in substantially any length, width, or thickness depending upon the apparatus being employed. For example, the length can be substantially infinite and the width will depend upon the width of the original batt. The thickness can be varied by the amount of needling employed and by varying the thickness of the original batt and/or cross laying one or more batts on the original batt before the needling operation.

EXAMPLE I

In this example two runs were carried out, one using 18 denier molecularly oriented polypropylene fiber and the other using 90 denier unoriented polypropylene fiber. The fibers used in both runs were formed from the same polymer lot and batch, the polymer being a heat and ultraviolet light stabilized polypropylene having a melt flow of 2.3 (ASTM D-1238), identified as Avisun TD247, produced and marketed by Avisun Corp., Philadelphia, Pa. Both the oriented and unoriented fibers were formed by first mixing the polymer with pigment and then melt extruding the fibers at 600° F. The oriented fiber was then plastically drawn at about 270° F. until its drawn length was about five times greater than its original undrawn length and it was an 18 denier fiber.

Both the oriented and unoriented filaments were crimped using a conventional stuffer box type crimper and cut with a conventional Boulligny staple cutter produced and marketed by the Boulligny Co., Charlotte, N.C., into staple fibers having lengths of about 2½ inches. The oriented and unoriented staples were separately processed, using the same process each time, to form a felt. The process is composed of passing the staple through a conventional garnett and then cross laying 24 ounces per square yard of the crimped staple on a 4 ounce per square yard scrim of woven 15 x 8 fabric made from 2 x 100 polypropylene ribbon yarns, available from Patchogue-Plymouth, Inc., Hazelhurst, Ga., then passing the scrim supported staple through a Hunter needle loom Model 8.

The two felts thus formed were each coated with 10 ounces per square yard of a butadiene-styrene copolymer rubber latex of the SBR type purchased from Naugatuck Division of the U.S. Rubber Company. Each carpet thus formed weighed approximately 38 ounces per square yard.

Thereafter, the carpet formed from unoriented fibers except for what orientation took place during said needling step and the carpet formed from completely oriented fiber were both tested as follows:

Thickness, inches, ASTM D-1777-60T:

Carpet from oriented fibers	0.22
Carpet from unoriented fibers (invention)	0.32

Resilience, determined using a Custom Scientific Instrument Co. carpet crush resistance tester Model No. C-110. The carpet thickness was measured, then the carpet was compressed 360 times at the rate of 6 times per minute with a compressive load of 10 pounds per square inch of carpet area compressed. The carpet thickness is remeasured a fixed period of times after the last compression cycle. Carpet thicknesses are determined in accordance with ASTM D-1777-60T. Results are determined as percentages of original thickness and reported as percent recovery.

	Percent Recovery, After 5 Minutes	Percent Recovery, After 24 Hours
Carpet from oriented fibers	81	92
Carpet from unoriented fibers (invention) ..	94.5	100

Abrasion Resistance, ASTM D-1175 Item 23, Wyzenbeek-CCC-T-191-b Method 5304, 2 pound load, 2 pound tension, fine emery paper, filling-wise direction.

	Cycles	Percent Loss In Thickness
Carpet from oriented fibers	2,100	15
Carpet from unoriented fibers (invention) ..	4,000	14.7

Thus, it can be seen that by using an equivalent weight of larger denier, unoriented fiber and allowing orientation of the fiber to take place only during the needling operation, a carpet formed from the resulting felt had superior thickness, resilience and abrasion resistance as compared to one formed from oriented fibers.

EXAMPLE II

Using the polypropylene of Example I, four groups of 90 denier unoriented staple fiber samples were prepared and four groups of oriented 18 denier staple fiber samples were prepared. Each staple fiber group was formed from filaments that contained a pigment, the filaments were crimped by use of a conventional stuffer box crimper, and the filaments were cut using a Boulligny staple cutter, produced and marketed by Boulligny Co., Charlotte, N.C., into staple fibers of 2½ inch lengths. In addition, the oriented fibers were, before being cut into staple and before being crimped, molecularly oriented in the same manner set forth in Example I.

One group of the oriented and one group of the unoriented staple fibers were each colored with a pigment

identified as Ming Green No. D-6668, produced and marketed by Imperial Color and Paper Dept., a division of Hercules Powder Co., Inc. One group of the oriented and one group of the unoriented staple fibers were each colored with a pigment identified as Old Gold No. D-6523, also produced and marketed by Imperial. One group of the oriented and one group of the unoriented staple fibers were each colored by an apricot orange colored pigment identified as a blend of D-1161 yellow and D-1333 red, produced and also marketed by Imperial. The last group of both the oriented and unoriented staple fibers were each colored by 0.2 weight percent titanium dioxide, a pigment produced and marketed by Imperial also.

All eight groups of staple fibers were separately made into felts which simulated outdoor-indoor carpeting in appearance. The felting process comprised passing each group first through a Davis and Furber roller top card, Model C-2842, produced and marketed by Davis and Furber Machine Co., North Andover, Mass., and then through a Hunter Fiber Locker (needling machine), Model F-5520, produced and marketed by James Hunter Machine Co., North Adams, Mass. There was thus produced a felt from each group of staple fiber using the same process except that four of the groups used completely oriented fiber to start with and the other four groups used larger denier unoriented fibers. Eight inch by twelve inch samples were cut from each of the eight felts formed. The weight of each sample was about 16 ounces per square yard.

As a control, before making the eight felts, each group of staple fibers was blended with an equal amount of the same type polypropylene fiber, i.e. 90 denier unoriented or 18 denier oriented which contained black pigment. The black pigment was identified as a blend of D-1920 black and D-1724 blue, also produced and marketed by Imperial. In other words, before the carding step each group of staple fibers was blended with black control fibers. Thus, each of the samples contains an equal amount of black pigmented fiber. The ultraviolet life of black fiber is 2 to 3 times longer than that of other colors due to the stabilizing factor of black pigment itself. Therefore, the black fiber always survives after the other colored fibers in the felt are destroyed. The point of failure of the samples then is visually detected by observing a definite color change toward black.

The eight samples from each group of staple fibers were exposed side by side in an Atlas 18-W Carbon Arc Weatherometer. Hours to failure were as follows:

	Oriented 18 Denier, Hours	Unoriented 90 Deniers Hour,
Ming Green No. D-6668	840	1,210
Old Gold No. D-6523	520	1,020
Apricot Orange, Blend of D-1161 and D-1333	480	760
0.2 wt. percent TiO ₂	380	920

It can be seen that the carpeting made according to the process of this invention has substantially improved resistance to ultraviolet light degradation.

EXAMPLE III

The process of Example II was repeated using the same polymer and both 18 denier oriented and 90 denier unoriented staple fibers. However, instead of four groups of differently colored staple for both the oriented and unoriented classes, three groups for each class were formed. In both the oriented and unoriented classes, there was a group composed of a mixture of three differently colored fibers, this first group in each class was formed from a mixture of 38 weight percent fibers colored with Ming Green No. D-6668 pigment, 12 weight percent black pigment, a blend of D-1920 and D-1724, and 50 weight percent Sun Gold No. D-6663 pigment. The second group in each class was formed of a mixture of 70 weight per-

cent fibers colored with turquoise pigment, a blend of D-1724 blue and D-1129 yellow, and 30 weight percent fibers colored with apricot orange pigment, a blend of D-1161 yellow and D-1333 red. The third group of each class was formed from 60 weight percent fibers colored with black pigment, a blend of D-1920 and D-1724, 30 weight percent fibers colored with apricot orange pigment, a blend of D-1161 yellow and D-1333 red, and 10 weight percent fibers colored with Scarlet No. D-1333. All pigments were produced and marketed by Imperial Color and Paper. The pigments were incorporated in the fibers by physically mixing the pigment with the polymer pellets from which the fibers were formed before the polymer pellets were melt extruded into filament form.

The three groups of fiber blends in both the oriented and unoriented class were then formed into carpeting in the same manner as that set forth in Example II. A sample from each of the three groups from each of the two classes were then placed side by side and compared visually. The samples made from the denier fibers were strikingly superior in clarity of color, sharpness of tweed effects, and contrast between colors.

EXAMPLE IV

Samples of each of the six groups of fibers of Example III were embossed by rolling a fluted metal roller which was heated to a temperature of 285° F. over each sample at about 1 foot per minute under maximum hand pressure, each sample resting on the same hardness of surface. The flutes in the roller extended parallel to the longitudinal axis of the roller were $\frac{1}{8}$ inch in depth and were spaced $\frac{3}{32}$ of an inch from one another center-to-center. This process produced a pronounced ripple effect on the 90 denier unoriented carpet sample. The ripples on the 18 denier carpet samples were much less pronounced.

By reducing the applied pressure to approximately $\frac{1}{2}$ of the maximum attainable hand pressure and decreasing the temperature to 250° F., it was still found that the 90 denier unoriented samples embossed much more readily than the 18 denier oriented samples.

Reasonable variation and modifications are possible within the scope of this disclosure without departing from the spirit and scope thereof.

We claim:

1. A felt composed essentially of 40 to 200 denier plastic fibers that are not molecularly oriented and a plu-

ality of 40 to 200 denier plastic fibers which are at least partially molecularly oriented, said unoriented fibers being arranged so that their long axes are substantially parallel to one another and being laid upon one another to form the thickness dimension of said felt, and said plurality of said 40 to 200 denier fibers which are at least partially molecularly oriented extending only in a direction substantially perpendicular to the long axes of said unoriented fibers and through at least a portion of the thickness of said felt, said oriented fibers being characterized in that at least one finite longitudinal portion of each oriented fiber has a diameter substantially less than the original diameter of that fiber when not molecularly oriented.

2. The felt according to claim 1 wherein said fibers are formed from at least one of polymers of 1-olefins having from 2 to 8 carbon atoms per molecule, polyamides, polyesters, polyvinyl alcohol, acrylic polymers, polyvinyl chloride, polyvinyl acetate, polyvinylidene chloride, and blends thereof.

3. The felt according to claim 1 wherein said fibers have a length of from 1 to 6 inches and are crimped fibers, and from about 3 to about 50 percent of the fibers in said felt are at least partially oriented.

4. The felt according to claim 1 wherein said fibers are from 70 to 90 denier, are crimped, are formed from polypropylene, and wherein the at least one finite longitudinal portion of each oriented fiber which is molecularly oriented has a diameter at least 30 percent less than the original diameter of that fiber when not so molecularly oriented, and wherein said felt is coated on one side with a carpet backing material.

5. The felt according to claim 4 wherein said felt is composed of a mixture of separate, differently colored fibers.

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U.S. Cl. X.R.

28—72.2; 161—81, 154, 169, 170, 402