

- [54] CARPET EMBOSSING IN REGISTER WITH PRINT
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- [58] Field of Search 161/63; 156/277; 117/8.5, 117/9, 11; 26/69 B; 28/76 P

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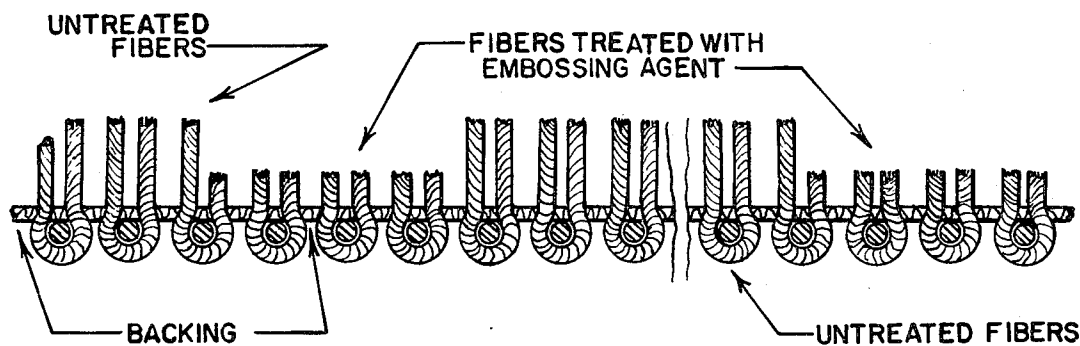
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2,020,698	11/1935	Platt	161/63
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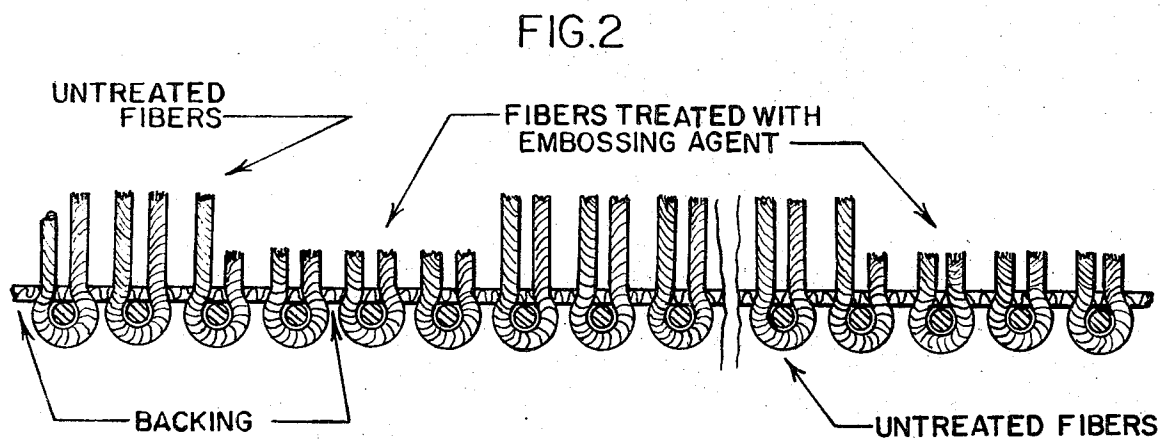
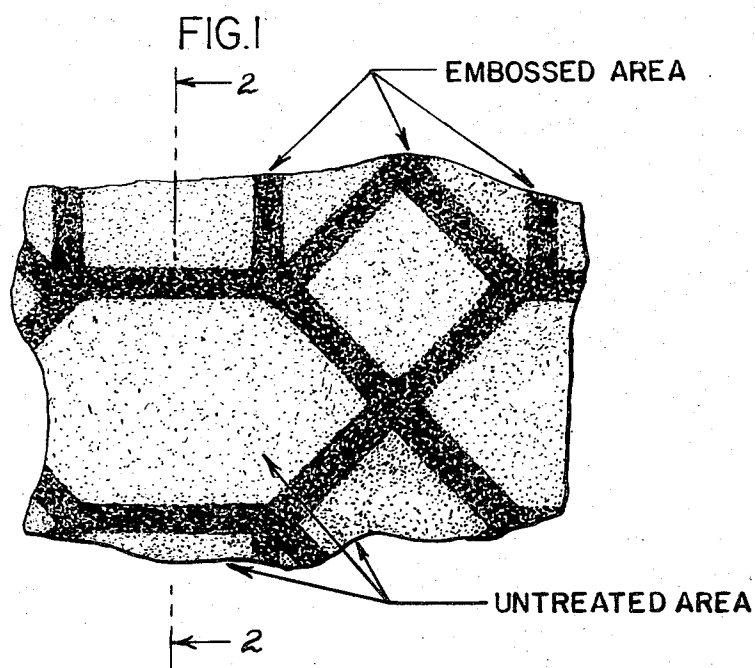
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[57] ABSTRACT

Pile fabrics prepared from nylon carpet fibers having a textured or embossed surface and a process of developing the textured effect which comprises selectively contacting the surface of said carpet with a chemical fiber shrinking agent therefor, allowing the shrinking action to occur and, thereafter, effectively removing the shrinking agent from the surface, said shrinking serving to reduce the height of the pile in the treated areas and creating said textured surface.

19 Claims, 2 Drawing Figures





CARPET EMBOSSING IN REGISTER WITH PRINT

BACKGROUND OF THE INVENTION

In the production of nylon pile fabrics, it is often desirable to emboss the surface thereof in order to provide added decorative appeal. In some instances, the embossed areas are printed with dyes to further embellish the surface design.

Embossing of pile fabrics is conventionally accomplished with a heating embossing roll or place which has been engraved or otherwise treated to create the design desired in raised relief on the surface. A method which eliminates the use of embossing rolls has been disclosed in U.S. Pat. Nos. 2,790,255 and 2,875,504. In accordance with these patents, the pile fabric is formed from a combination of shrinkable and non-shrinkable yarns. Upon subjecting the fabric to the influence of heat, the pile formed from the shrinkable yarns contracts while the base and the nonshrinkable yarns remains intact thereby yielding a pile made up of high and low areas to give the appearance of an embossed or carved product.

A chemical embossing method is disclosed in U.S. Pat. No. 2,020,698. According to this patent, fabric having a pile of organic ester of cellulose yarn is locally treated with an alkali or alkaline salt saponifying agent in order to obtain ornamental differential effects in the treated areas. Furthermore, since the organic ester of cellulose pile yarns that have not been saponified are more difficult to change from their position, after they are once set than are the saponified organic ester of cellulose yarns, it is possible to obtain a differential lay between the saponified and unsaponified organic ester of cellulose pile yarn. Thus, the fabric, after the application of the saponifying agent, may be washed, finished and dried with the pile erect, after which the fabric may be run through water and brushed across the piece to lay the pile towards the selvage and it is then dried. This causes the saponified pile yarn to lie flat while the unsaponified yarn remains substantially erect. Upon subsequent steaming and brushing the fabric in the opposite direction, any unsaponified yarn which may have been slightly bent from the vertical by the previous brushing toward the selvage is caused to stand erect without disturbing the position of the laid or crushed saponified organic ester of cellulose pile yarn.

SUMMARY OF THE INVENTION

It is the primary object of this invention to provide a simple process for producing a nylon pile having a textured or embossed surface.

Another object is to provide such a process which is readily adaptable to standard printing equipment.

Another object is to provide a process which allows the production of pile fabric having embossed areas in register with a printed design.

A further object is to provide an embossing process which is readily adaptable to curved and irregular surfaces.

Various other objects and advantages of this invention will be apparent from the following detailed description thereof.

It has now been discovered that it is possible to produce superior nylon fabrics having embossed surfaces by contacting selected portions of the surfaces with a

chemical embossing agent for the fibers of said pile fabric causing dimensional change by linear contraction of the treated fibers and, thereafter, effectively removing the embossing agent. The resulting product is thus depressed at the treated areas.

The embossing composition can be transparent so that the appearance of the product is not altered other than in being embossed. Alternatively, the embossing agent can be part of a dye or pigment composition used in printing the fabric so that the color appears in perfect register in the areas of embossing agent application.

The depth of the depressed areas can be controlled by varying the concentration and/or type of embossing agent. This variation in concentration can be effected by the amount of vehicle applied as well as by the strength of the embossing reagent.

Furthermore, the embossed depth can be controlled to some degree by the depth of penetration of the print paste carrying the embossing agent as well as the steamer time and steamer temperatures to which the pile fabric is subjected in order to activate the chemical embossing agent which provide the desired effect.

This discovery makes possible the production of a product having embossed surfaces which can be in complete register with a printed design. Additionally, the discovery makes possible the utilization of many types of printing apparatus for purposes of effecting embossing, thereby eliminating the need for expensive embossing equipment. Further, it allows the embossing of a surface without exerting sufficient pressure to permanently deform the pile fabric. A great number of products can be produced by the process. They can be used for floor, wall and ceiling coverings, drapery, upholstery and the like, and, in fact, wherever pile fabrics are utilized. They are readily adaptable to decorating any surface on which pile fabrics can be applied. Many additional applications will occur to those skilled in the art.

This invention will be better understood from the following detailed description thereof together with the accompanying self-explanatory drawings in which:

FIG. 1 is enlarged top view of a section of an embossed product of this invention; and,

FIG. 2 is an enlarged cross-sectional view of the same product taken through line 2—2.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In the production of the pile fabrics of this invention, the pile yarn employed is nylon. Synthetic fibers prepared from polyamides such as nylon are well known to those skilled in the art.

Likewise, the embossing agents which are applied to the nylon fibers in order to produce the desired effect are also known chemical compounds. For purposes of this invention, the term "embossing agent" is defined as any active chemical composition which when applied to the pile fabric produces a measurable reduction of pile height, but without significant deterioration of the nylon fibers. In fact, it is our objective to induce embossment and shrinkage without deteriorating the fiber. The exact chemical and physical mechanism by which this result is achieved is not completely understood. However, it is believed that the embossing agent may owe its effectiveness largely to its capability to function as a hydrogen bond breaker. Initially, the fi-

bers are in a stretched and crystalline state. When the hydrogen bond is broken between the polymer chains, the fibers relax and shrink. Regardless of the mechanism, the overall effect produced is one of dimensional change, the most desirable effect, involving linear contraction of the fiber.

In order to be applicable for the novel process of this invention, the embossing agent should provide a reduction of the pile height through a shrinkage reaction, should not adversely affect the printing means, e.g., print screens, and should be capable of being substantially removed or inactivated subsequent to the embossing action. Other characteristics of the embossing agent which are desirable, though not essential, include compatibility with dye print pastes, capability of being regulated by factors of time, temperature, and concentration, i.e., susceptibility to activation by a conventional steaming operation and exhibiting no residual embossing activity. Needless to say, minor adjustments in the nature of the components and process conditions, and/or the embossing apparatus can be employed to overcome the absence of certain of these desired characteristics.

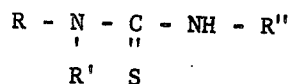
The embossing agent for the nylon fibers is applied to one surface of the pile fabric in any desired design, whether it be random or predetermined. One of the easiest methods of applying the agent is by utilizing conventional printing technique such as silk screen or block printing. The embossing agent can be applied as a concentrate, as part of a transparent vehicle, or as part of a dye composition utilized for pile fabric printing. The nature of the embossing agent dictates the nature of the vehicle to be utilized. Among such applicable vehicles are included: water, and alcohols such as methanol and isopropanol. Often thickeners, e.g., gums, and cellulose derivatives, are included in order to obtain viscosity characteristics demanded in print technology and to enable the embossing agent to adhere to and operate on the synthetic fiber and to hold the printed pattern.

In those instances where it is desired to achieve a single- or multi-colored printed decoration with a distinct color for the embossed areas, the embossing agent can be incorporated into a particular dye or pigment composition. The dye or pigment will generally be in the form of a print paste ink to which the appropriate amount of agent is added. It is to be noted that in preparing these modified dye composition, the pH levels, viscosities, and dye concentrations which are essential to an efficient dyeing operation must also be controlled. The resultant effect is an embossed design in register with the printed pattern. If different depths of embossing are sought, they are achieved by use of different concentrations of agent in the areas calling for such different depths.

Generally, it is desirable that the embossing agent be soluble or in solution in the solvent medium from which it is applied to the selected areas of the fabric. However, if the agent is not soluble it should be in the composition in a form at least sufficiently finely divided to pass through the print screen, that is, it should be present in a micro pulverized form which indicates particle diameter of the order of 100 microns or smaller. That is, it must not only pass through a screen but it must pass through freely, dispersed through the dye paste throughout the printing operation. The purpose of this, of course, is to make sure that the agent becomes uni-

formly dispersed over the fiber in the print process so that the shrinking effect will be uniformly developed in the fiber.

As previously indicated, the preferred embossing agent is one which is dormant during the successive printing operations but then is activated by the elevated temperature of a steam chamber usually utilized to fix the dye onto the fibers. Embossing agents which can function in this manner on nylon and produce shrinkage of the nylon fibers comprise thiourea and its derivatives preferably certain of its more water soluble lower 1,3 dialkyl derivatives having the structure.



wherein R, R' and R'' equals any combinations of H, N-acetyl, methyl, ethyl, propyl, butyl, isopropyl, pentyl, hexyl, and the like in combination with relatively low concentration of acids, such as formic, acetic, phosphoric, oxalic, and hydrochloric. Acids, such as monochloroacetic acid, are excluded if they react with thiourea or its derivatives by undergoing a substitution reaction with the mercaptide ion. At the individual concentrations employed in this process, thiourea or its derivatives alone, or the acid alone, are not useful. The advantages of this type of chemical embossing agent are that there is no need for rigid time control in the process and there is minimal concern regarding excessive uncontrollable embossing because other factors can be changed. Thus, the degree of diminution of the pile height can be controlled by adjusting the amount of dye paste applied, the concentration of embossing agent in the dye paste and the temperature and time of exposure in the steam chamber. All these factors can be adjusted according to properties of the nylon fiber comprising the pile fabric. While the depth of embossing will be determined by the practitioner in accordance with the type of embossed product being prepared, reduction in pile height will generally not exceed more than about 50 percent, this value being indicative of excellent embossing without exposing the backing materials.

Embossing can be achieved, if desired, by subjecting the treated fibers to heat. Thus, the treated surfaces may be subjected to the radiation from a bank of infrared lamps, particularly where the embossing agent is not part of a dye print paste. Additionally, even where the steaming operation is not essential to activate the embossing agent, such steaming may have the effect of increasing the penetration of the embossing agent and increasing the speed of its action on the fibers.

A critical step of the novel process of this invention involves terminating the embossing action and/or effecting substantial removal of the embossing agent from the pile fabric. It may be necessary to achieve complete elimination of all residues of the embossing process which may contribute undesirable properties to the finished fabric, such as odor, toxicity and color and texture change. Needless to say, any termination or quenching technique resorted to will depend on the particular embossing composition employed. The most useful technique for removing residues of the embossing process is by thoroughly washing the fabric with water and detergents. In those instances where the embossing agent is part of a dye or pigment composition, the washing cycle which is utilized to remove excess

dye or pigment serves also to removed traces of the agent. Where an acidic embossing agent is utilized, e.g., formic acid on nylon, it is possible to halt the embossing action more rapidly by rinsing with an aqueous ammonia or mildly alkaline solution. This neutralization of the acid serves to insure the total removal thereof.

Other techniques for terminating the embossing action and/or removing the embossing agent include evaporation and dry cleaning. Thus, if the agent is volatile, steaming of the treated pile fabric will serve to evaporate a large portion of the embossing pile content. Where rinsing techniques are not effective, it may be necessary to resort to a dry cleaning procedure to remove the embossing residues.

The invention has particular application to tufted carpets which are to have a printed decoration applied thereon. Unusual design effects can also be obtained when the pile fabric is printed with a multi-colored design wherein one or more of the dye compositions contain the appropriate embossing agent. The process of printing such carpets includes the steps of passing carpets, tufted of unpigmented or colored fibers, into a screen printing apparatus whereby a design is printed on the surface of the carpet. Each screen applies a separate color to make up the final design. The embossing agent can be added to one or more of these printing stations by addition to the dye composition, or it can be applied by a separate station in a transparent vehicle. The fabric is then passed into a steaming chamber to set the dyes and cause embossing and then to a washing cycle which serves to remove excess dye as well as to terminate the embossing action and/or remove the embossing components.

Accordingly, in the embossing of carpet or textured pile fabric, and for all practical purposes we are discussing the embossing of carpeting, it is important that any color design on the surface of the carpet which is related to the embossing be in accurate register with the embossing. Since we are concerned only with chemical embossing the problem is then one of inducing the differential fiber length between the embossed colored areas and unembossed areas and, while it is possible to induce shrinkage of synthetic nylon fibers, it is necessary for preparation of the carpet that the fiber shrinkage be induced with no significant deterioration of what is left. Thus, if the operation of embossing involves true shrinkage the shrunk fabric fiber should have a texture approximating that of the original.

In order to practically evaluate the utility of a particular chemical or combination of chemicals as an embossing agent for nylon carpet, the chemical system is incorporated in the dye printing paste and applied to a section of the nylon carpet by means of a screen printing technique so as to simulate plant production procedure as closely as possible. The treated carpet sample is steamed for 15 minutes at 215°-220°F. (102°C. - 104°C.), thoroughly rinsed with water and dried at 180°F. The depth of embossment is then measured and observations made regarding the character of the embossed nylon, e.g., strength, brittleness, softness, definition, color. Measurement of the pile height at the embossed and unembossed areas is made by means of a thin, steel ruler marked off in 1/64 inch (0.4 millimeter) intervals. Any method of measurement is useful so long as it is standardized from operation to operation and is reproducible to about 1/64 inch.

However, for the preliminary determination of whether or not a chemical composition is capable of shrinking nylon fibers and for thus determining its potential suitability as a chemical embossing agent for nylon carpet, we have devised a simpler, less time consuming beaker test procedure. Using this test, the per cent shrinkage and the per cent weight loss experienced by a 50 centimeter loop of nylon carpet filament or carpet yarn is determined by immersing the yarn loop in an aqueous solution or dispersion of the test chemical for 15 minutes at 215°F (102°C). This test affords a simple way of determining if a selected chemical will cause a shrinkage of the nylon fibers and provides a means of predicting whether or not a chemical will function as an embossing agent for nylon carpet. Also, the test provides a method for determining such effects as chemical concentration, temperature, time, print paste additives, solvents other than water, nylon type and construction and the like. Details of the test procedure are outlined as follows in Table I.

TABLE I

BEAKER TEST PROCEDURE

1. Prepare a solution or dispersion of the chemicals to be tested in Water.* If heated, cool to room temperature. Weigh 30 grams into a 32 × 200 mm test tube.
2. Place test tube in preheated Silicone bath and heat contents of test tube to the desired temperature (usually 215°F = 102°C).
3. Cut approximately 1 meter length of nylon yarn or filament and tie in a single loop.
4. Hang the loop under 50 gram load for 30 seconds and measure the length of the loop to 0.1 cm.
5. Weigh loop to nearest 1/10 mg.
6. Immerse nylon loop in hot chemical solution, agitate gently and observe any change in character of the nylon fibers. Generally hold for 15 minutes or less.
7. Remove the nylon loop and wash thoroughly in copious amounts of water. Blot and dry to constant weight at room conditions.
8. Measure length of nylon loop as in 4.**
9. Determine weight of nylon loop as in 5.
10. Calculate percent shrinkage and percent weight loss.

* Dye print paste may be used if desired. Other solvents may be used, especially when other solvent based printing systems are employed.

** If loop breaks or is already fragmented or disintegrated, or if insignificant shrinkage is obtained, repeat at lower or higher chemical concentration.

With the information thus obtained concerning the extent of shrinkage of the nylon fibers as well as any deterioration of the nylon fibers, it then becomes possible to determine whether or not the chemical composition has any potential as an embossing agent, and eventually proceed to the formulation of a printing paste which includes the shrinking material. Experience has shown, however, that while such test results prove that the chemical agent will shrink nylon fiber and thus has an embossing capability for nylon carpet, these results tell us only approximately what concentration of the chemical agent is required to emboss nylon carpet. Nor do we know the exact extent of the fiber deterioration that will be experienced on the nylon carpet. Generally, the following relationship seems to exist between beaker test results and screen printing test results on nylon carpet. Beaker test shrinkage results must reach at least

about 50 percent shrinkage in 15 minutes at 215°F (102°C) in order for an embossing agent to produce even trace to very weak carpet embossment. But beyond about 50 percent shrinkage via the beaker test, the nylon filament begins to deteriorate rapidly (test loop weakening and fragmentation). On the other hand, it appears that deeply embossed carpet can only be anticipated if the chemical shrinking agent causes fiber destruction in the beaker within about 60 seconds. The maximum depth of embossment obtainable without causing unacceptable nylon carpet fiber deterioration is usually about 50 percent.

Apparently, the difference between beaker test shrinkage results obtained on a loop of nylon filament of yarn, and screen printing test results obtained on nylon carpet, occurs because the chemical is utilized much less effectively on the carpet pile than in the beaker test.

Screen printing does not supply sufficient print paste (containing embossing agent) to the nylon carpet pile to provide a completely uniform coating of the nylon fibers. Furthermore, the depth of concentration into the carpet pile is often of the order of only about 50 percent. Also, during steaming, the concentration of the embossing agent may be reduced and chemical which may be consumed is not replaced. However, in the beaker test, the nylon loop is surrounded constantly and uniformly by a surplus of hot chemical solution of practically the same concentration throughout the duration of the test thus allowing the chemical to function more effectively.

The following examples will further illustrate the embodiment of this invention. In these examples, all parts given are by weight unless otherwise noted.

EXAMPLE I

The shrinkage and weight loss experienced by a test loop of DuPont type 846 bulk continuous filament nylon 6/6 (1300 denier, 68 filaments, *o* twist, semi-dull, regular acid dyeable) was determined by means of the beaker test procedure described in Table I using the following aqueous recipes comprising 50 percent thiourea and various concentrations of formic acid. Test temperature and duration was about 215° F (102° C) and 30 minutes respectively, except for water alone where the test temperature was 212° F (100° C). Test results are recorded in Table II.

It was found that the combination of 50 percent thio-

urea and 15 percent formic acid (90 percent) causes the nylon loop to shrink 47.5 percent accompanied by about 10 percent weight loss in the shrunk nylon fibers without deterioration of the fiber properties (Run No. 47). Lower concentrations of formic acid yield less shrinkage, while at 20 percent formic acid (90 percent) nylon fiber is critically deteriorated becoming very fragile (Run No. 53). Thiourea alone at 50 percent yields a much lesser shrinkage of only about 15 percent and formic acid (90 percent) alone at 15 percent yields a shrinkage of only about 9.0 percent, comparable to water alone at 10.0 percent. With thiourea at a concentration of 50 percent the nylon filament shrinkage and weight loss increased significantly as the amount of formic acid is increased from 5 to 20 percent. Hence, it appears that the thiourea-formic acid combinations is usually effective in developing nylon shrinkage.

TABLE II

Run No.	Chemicals	Nylon Filament		Loop Character
		Shrinkage (%)	Weight Loss (%)	
15,17,30,35 avg.	Water	10.0	1.50	Good
32	Thiourea, 50%	15.1	0.93	Good
26	90% Formic Acid, 5%	7.4	0.27	Good
46	90% Formic Acid, 10%	10.7	1.30	Good
49	90% Formic Acid, 15%	9.4	1.41	Good
54	90% Formic Acid, 20%	8.5	1.62	Good
33	Thiourea, 50%/90% Formic Acid, 5%	21.3	1.77	Good
44	Thiourea, 50%/90% Formic Acid, 10%	38.5	4.53	Good
47	Thiourea, 50%/90% Formic Acid, 15%	47.5	10.0	Good
53	Thiourea, 50%/90% Formic Acid, 20%	72.3	41.0	Fragile

While formic acid is the preferred acid, other acids may be used with thiourea with results as tabulated in Table III.

One of the practical requirements of the shrinking agent is that it remain in solution at room temperature or be dispersible to an extremely finely divided condition so that the individual particles contained in the room temperature printing paste can pass through the printing screen and reach a maximum area of the nylon fiber to develop the desired effect. Preferably the solubilizing medium should be mostly water although other solvents may be utilized. 50 percent thiourea is readily soluble in hot water or the hot acid solution at about 180° F. (82° C), but is soluble to the extent of only about 15 percent at room temperature. When the level of thiourea is reduced to 15 percent to gain room temperature solubility, the combination of 15 percent thiourea with 15 percent and 33.3 percent formic acid (90 percent) respectively produces only minimal shrinkage of 14.3 percent and 25.2 percent (Run Nos. 51 and 56). Formic acid alone at 30 percent concentration produces 16.6 percent shrinkage (Run No. 150).

From the foregoing tests, it is apparent that 50 percent thiourea, by weight, in water accompanied by 10–16 percent acid, by weight, such as 90 percent formic acid, 85 percent phosphoric acid, acetic acid, 37 percent hydrochloric acid, oxalic acid, 2-naphthalene-sulfonic acid will induce shrinkage approaching 50 percent or more in the nylon fibers. It is, of course, important that the fibers remain physically fibers and that the shrunk filaments and tufts retain their original physical character, appearance, and acceptable feel.

TABLE III

Run No.	Chemicals	Nylon Filament		Loop Character
		Shrinkage (%)	Weight Loss (%)	
15,17,30,35 avg.	Water	10.0	1.50	Good
59	Thiourea, 50%/85% Phosphoric Acid, 15%	45.2	11.0	Good
129	Thiourea, 50%/Acetic Acid, 15%	54.2	13.9	Good
48	Thiourea, 50%/37% HCl, 16%	40.6	10.6	Good
43	Thiourea, 50%/Oxalic Acid, 5%	20.7	1.71	Good
661	Thiourea, 50%/Oxalic Acid, 15%	40.0	8.68	Good
108	Thiourea, 40%/2-Naphthalenesulfonic Acid, 10%	43.5	8.9	Good
135	Thiourea, 50%/Trichloroacetic Acid, 5%	31.1	2.44	Good
62,133 avg.	Thiourea, 50%/Monochloroacetic Acid, 15%	16.3	1.14	Good
61	Thiourea, 50%/Zinc Chloride, 16.7	33.4	4.1	Good
137	85% Phosphoric Acid, 15%	12.3	+1.09	Good
136	Acetic Acid, 15%	12.5	0.53	Good
141	37% Hydrochloric Acid, 16%	13.9	2.75	Good
138	Oxalic Acid, 15%	14.3	+0.71	Good
98	2-Naphthalenesulfonic Acid, 10%	26.0	2.11	Good
49	90% Formic Acid, 15%	9.4	1.41	Good
134	Trichloroacetic Acid, 5%	19.8	0.66	Good
70	Monochloroacetic Acid, 25%	29.3	2.71	Good
27	Zinc Chloride, 35%	23.3	2.06	Good

EXAMPLE II

The shrinkage and weight loss developed by a test loop of DuPont type 846 bulk continuous filament nylon 6/6 (1300 denier, 68 filaments, 0 twist, semi-dull, regular acid dyeable) was determined by means of beaker test procedure described in Table I using the following aqueous recipes containing the readily room temperature water soluble dialkyl derivative of thiourea, 1,3 - dimethylthiourea, in combination with formic acid. The test temperature and maximum duration of test was 215° F. (102° C) and 15 minutes respec-

and proportion of chemicals used. Data also indicate that the dimethylthiourea/formic acid system has a strong potential as an embossing agent for nylon carpet being capable of causing fiber distegration within 60 seconds in the beaker test. When dimethylthiourea is used alone at 35 percent and 60 percent concentration, the shrinkage induced amounts to 18.0 percent and 31.3 percent respectively (Run Nos. 145 and 186) insufficient for carpet embossment. Similarly, when 90 percent formic acid is used alone even at 33.3 percent (Run No. 150) it yields only 16.6 percent shrinkage. these results may be compared to the 10 percent shrinkage obtained with water alone.

TABLE IV

Run No.	Chemicals	Nylon Filament		
		Shrinkage (%)	Weight Loss (%)	Loop Characters
15,17,30,35 avg.	Water	10.0	1.5	Good
145	Dimethylthiourea, 35%	18.0	1.62	Good
186	Dimethylthiourea, 60%	31.3	5.89	Good
150	90% Formic Acid, 33.3%	16.6	0.67	Good
54	90% Formic Acid, 15%	9.4	1.41	Good
120,122 avg.	DMT, 50%/Formic, 15%*	73.5	44.7	Fragile
124	DMT, 35%/Formic, 15%	35.7	3.74	Good
125	DMT, 40%/Formic, 20%	81.1	55.8	Fragile
126	DMT, 40%/Formic, 15%	42.9	8.44	Good
142	DMT, 35%/Formic, 22.3%	51.3	11.7	Good
146,233 avg.	DMT, 35%/Formic, 27.7%	Disintegrate		60 sec.
175	DMT, 40%/Formic, 20%	67.9	35.6	Fragile
187	DMT, 35%/Formic, 33.3%	Disintegrate		5 sec.
188	DMT, 40%/Formic, 22.3%	Disintegrate		5 sec.
189	DMT, 40%/Formic, 27.7%	Disintegrate		5 sec.
190	DMT, 45%/Formic, 16.7%	69.0	32.4	Weak
191	DMT, 45%/Formic, 22.3%	Disintegrate		10 sec.
192	DMT, 50%/Formic, 16.7	Disintegrate		60 sec.
193	DMT, 30%/Formic, 33.3%	Disintegrate		20 sec.
194	DMT, 30%/Formic 27.7%	73.0	37.6	Fragile

*DMT = Dimethylthiourea; Formic = 90% Formic Acid

tively. Test results are shown in Table IV.

Data in Table IV show that chemical compositions comprising dimethylthiourea (DMT) and formic acid can produce effects on nylon fibers ranging from strong shrinkage without fiber deterioration (about 50 percent) e.g., Run No. 142 to immediate disintegration e.g., Run No. 233 depending upon the concentration

While formic acid is the preferred acid, other acids may be used in conjunction with dimethylthiourea with results as shown in Table V. Acids which allow room temperature water solubility of the dimethylthiourea/acid combination and which generally function quite strongly, but less effectively than formic acid in the shrinking system include acetic, phosphoric, malonic,

citric, propionic, citraconic, benzenephosphonic, phenolsulfonic, toluenesulfonic and naphthalene sulfonic acids, and combination thereof.

Again, it is apparent that these chemical agents are capable of strongly shrinking nylon fibers.

Face Weight — 28 oz./sq. yd. (950 grams/sq. meter)

Machine Gauge — 5/32 inch (3.96 millimeters)

Machine Stitch Rate — 9.6 stitches/inch (3.8 stitches/centimeter)

Pile Height — 17/32 inch, singles (1.35 centimeters)

TABLE V

Run No.	Chemicals	Nylon Filament		
		Shrinkage (%)	Weight Loss (%)	Loop Character
219	DMT,* 35%/Hydroxyacetic Acid, 25%	30.0	4.3	Good
220	DMT, 35%/Monochloroacetic Acid, 25%	15.5	+2.05	Good
221**	DMT, 35%/Maleic Acid, 25%	Insol. at 220°F (103°C)		
235**	DMT, 35%/Maleic Acid, 15%	41.6	4.79	Good
222**	DMT, 35%/Oxalic Acid, Anhyd., 25%	Disintegrate 20 sec.		
224**	DMT, 35%/Oxalic Acid, 2H ₂ O, 25%	Fragmented 15 min.		
223	DMT, 35%/Malonic Acid, 25%	46.5	10.8	Good
241	DMT, 40%/Malonic Acid, 25%	59.0	21.4	Weak
242	DMT, 35%/Malonic Acid, 30%	83.2	58.6	Fragile
244	Malonic Acid, 35%	18.0	1.61	Good
247	DMT, 35%/Malonic Acid, 35%	Disintegrate 15 sec.		
225	DMT, 35%/Gluconic Acid, 25%	18.2	+0.54	Good
226	DMT, 35%/Maleic Acid, 25%	36.3	5.85	Good
227	DMT, 35%/Phenolsulfonic Acid, 15%	Disintegrate 2 min.		
236	DMT, 37.5%/Phenolsulfonic Acid, 12.5%	45.2	8.5	Good
229	DMT, 35%/Naphthalenesulfonic Acid, 15%	Disintegrate 15 min.		
237	DMT, 37.5%/Naphthalenesulfonic Acid, 12.5%	63.0	28.4	Fragile
230	DMT, 35%/Toluenesulfonic Acid, 15%	70.9	39.1	Fragile
231	DMT, 35%/Sulfamic Acid, 25%	30.3	1.45	Good
240**	DMT, 35%/Sulfamic Acid, 25%	Insol. at 220°F		
232**	DMT, 35%/Glutamic Acid HCl, 25%	Insol. at 220°F (103°C)		
234	DMT, 35%/Benzenephosphonic Acid, 25%	Disintegrate 2½ min.		
243	Benzenephosphonic Acid, 35%	73.0	10.5	Fragile
239	DMT, 35%/Citric Acid, 25%	40.6	6.18	Good
245	DMT, 35%/Citric Acid, 30%	56.6	14.4	Good
92	Citric Acid, 50%	23.8	+4.03	Good
238	DMT, 35%/Tartaric Acid, 25%	29.2	3.57	Good
250	DMT, 35%/Levulinic Acid, 25%	26.4	3.24	Good
251	DMT, 25%/Acetic Acid, 25%	65.5	28.9	Weak
290	DMT, 35%/Acetic Acid, 30%	Mostly disintegrated 75 sec.		
354	DMT, 25%/Acetic Acid, 35%	Mostly disintegrated 15 min.		
396	DMT, 40%/Acetic Acid, 25%	Disintegrate 40 sec.		
397	DMT, 35%/Acetic Acid, 35%	Disintegrate 20 sec.		
294	DMT, 35%/Acetic Acid, 22.5%/90% Formic Acid, 2.5%	Partial Disintegrate 15 min.		
297	DMT, 35%/Acetic Acid, 22.5%/Sulfuric Acid 2.5%	Disintegrate 2 min.		
253	DMT, 35%/Acetic Acid, 18.7%/85% Phosphoric Acid, 6.3%	Fragmented 15 min.		
252	DMT, 35%/Lactic Acid, 25%	37.1	6.87	Good
288	DMT, 35%/Propionic Acid, 25%	77.6	41.3	Fragile
289	DMT, 35%/Citraconic Acid, 25%	69.6	30.8	Fragile
143	DMT, 35%/85% Phosphoric Acid, 23.7%	42.4	8.15	Good
149	DMT, 35%/85% Phosphoric Acid, 29.3%	Fragmented 15 min.		
151	85% Phosphoric Acid, 29.3%	16.5	+2.36	Good

*DMT = Dimethylthiourea

**Insoluble at room temperature

EXAMPLE III

This example illustrates the preparation of an embossed pile fabric typical of the products of this invention.

A defined geometric area of nylon carpet was treated by means of a screen printing technique with a dye print paste containing 30 percent dimethylthiourea and 30.6 percent formic acid (90 percent), by weight, as the embossing agent.

Carpet construction was as follows:

Type — 100 percent nylon 6/6 spun yarn non heat set

The dye print paste was formulated as follows:

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RUN NO. 733SP

	Material*	Grams
1.	Water	20.1
2.	Cibaphasol AS	0.5
3.	Antifoam 73	0.8
4.	Kelzan (1½%) + 0.2 Dowicide A	18.0
5.	Formic Acid (90%)	30.6
6.	Dimethylthiourea	30.0
7.	Dye	0.05

*2 — Sulfuric Acid ester, levelling and penetrating agent.

3 — Alcohol ester, antifoaming agent.

4 — Xanthan gum thickener plus Dowicide A preservative yields a Brookfield viscosity of 560 cps. at 78°F (No. 3 spindle, 2½ rpm.).

6 — Add dimethylthiourea to the formic acid solution to facilitate solubility.

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There was no evidence of embossing while the nylon carpet was held at room temperature for several minutes. Upon subjecting the carpet to steaming for 15 minutes at about 220° F (104° C), significant embossing due to fiber shrinkage was observed. Thereafter, the embossed carpet was thoroughly rinsed with water and dried. The rinsing removed residual chemicals.

The resulting carpet exhibited good embossment with a 50 percent reduction in pile height in the treated area in perfect register with the printed design. Despite this degree of shrinkage, the nylon tufts retained their individuality and while increasing in firmness remained adequately soft, and showed no significant deterioration of physical properties.

Again, while formic acid is the preferred acid to use with dimethylthiourea, other acids may be employed. Table VI shows results obtained with formic acid, acetic acid, and phosphoric acid used in combination with dimethylthiourea, as well as the effect of changing concentrations and proportions in the dimethylthiourea system. In some cases corresponding beaker test results are shown. Phosphoric acid is generally unsatisfactory since it deteriorates fibers. As noted previously, a beaker test shrinkage of approximately 50 percent is equivalent to barely perceptible carpet embossment. Fiber disintegration within approximately 1 minute is generally required to provide a chemical embossing agent concentration which yields significant carpet embossment. Thus, it is apparent that the concentration and proportion of dimethylthiourea to acid must be properly adjusted to yield a desired depth of embossment without deterioration of the nylon fibers.

are very effective in acid solution (preferably formic acid) as shrinking agents for nylon fibers. Depending upon the ratio and concentration of thiourea derivative and acid, effects are produced ranging from strong shrinkage of the nylon fiber in 15 minutes to total disintegration within a few seconds. This latter effect signifies that the proper combination of dimethylethylthiourea or trimethylthiourea and an acid has the capability of embossing nylon carpet deeply.

It will be observed that the individual concentrations employed, neither of these derivatives of thiourea alone, or the acid alone, produce sufficient shrinkage of the nylon filament to produce carpet embossment. Usually at least 50 percent shrinkage of the nylon filament is required before any significant carpet embossment can be anticipated.

In order to demonstrate the utility of dimethylethylthiourea in acid solution as an embossing agent for nylon carpet, the nylon carpet construction described in Example III was treated by means of a screen printing technique using a dye print paste containing 25 percent dimethylethylthiourea and 33.3 percent formic acid (90 percent).

The dye print paste was formulated as follows:

SAMPLE NO. 981 SP-1		
Material*		Grams
1. Water		17.4
2. Cibaphasol		0.5
3. Antifoam 73		0.8
4. Kelzan (1½%) (0.2% Dowicide A)		23.0
5. Formic Acid (90%)		33.3
6. Dimethylethylthiourea		25.0
7. Dye		0.05

TABLE VI

Embossing System			Beaker Test Nylon Filament			Nylon Carpet			
Run No.	Chemicals *	% in Paste	Time (Mins)	Shrinkage (%)	Wgt. Loss (%)	Loop Character	Paste** visc. (cps.)	Embossed Depth (%)	Tuft Character
142I	DMT/90% Formic	35/22.2	15	57.7	22.2	Weak	320	10	Uneven, good
149I	DMT/85% Phosphoric	31.8/26.7	15	52.3	11.9	Good	720	Trace	Good
149I-2	DMT/85% Phosphoric	35/29.4	4	Disintegrate	—	—	240	25-75	Uneven, weak
154SP	DMT/90% Formic	35/27.8	1	Disintegrate	—	—	680	29	Good
155SP	DMT/Acetic	35/25	15	54.4	17.6	Good	720	10	Good
156SP	DMT/90% Formic	40/33.3	—	—	—	—	480	80	Hard, stiff
157SP	DMT/90% Formic	37.5/31.2	1	Disintegrate	—	—	480	50	harsh
210SP	DMT/85% Phosphoric	35/29.4	—	—	—	—	2520	25	Harsh, brittle
212SP	DMT/90% Formic	35/27.8	—	—	—	—	640	30	Brittle
213SP	DMT/90% Formic	35/27.8	—	—	—	—	4400	30	Good
313SP	DMT/Acetic	35/30	—	—	—	—	960	19	Good
397SP	DMT/Acetic	35/35	—	—	—	—	1040	41	Good
									Brittle

* Dimethylthiourea (DMT) + Acid

** Brookfield No. 3 spindle, 2½ rpm, 78°F

EXAMPLE IV

The shrinkage and weight loss developed by a test loop of DuPont type 846 bulk continuous filament nylon 6/6 (1300 denier, 68 filaments, 0 twist, semi-dull, regular acid dyeable) was determined by means of the beaker test procedure described in Table I using the aqueous recipes shown in Table VII containing dimethylethylthiourea or trimethylthiourea in combination with formic acid or acetic acid. Both of these derivatives of thiourea are soluble in acid solution at room temperature. The test temperature and maximum duration of test was 215° F) and 15 minutes respectively. Test results are shown in Table VII.

As can be seen from the test data, both trimethylthiourea and particularly dimethylethylthiourea (a liquid)

* 4 — Sulfuric acid ester, levelling and penetrating agent.

3 — Alcohol ether, antifoaming agent.

4 — Xanthan gum thickener plus preservative in water providing a Brookfield viscosity of 600 cps. at 78°F (No. 3 spindle, 2½ rpm.).

There was no indication of embossing while the nylon carpet remained at room conditions for several minutes. Upon subjecting the carpet to steaming for 15 minutes at 217°F, significant embossment due to fiber shrinkage was observed. Thereafter, the embossed carpet was thoroughly rinsed with water and dried. The rinsing removed residual chemicals.

The resulting carpet showed excellent embossing with a 50 percent reduction in pile height in the treated area in perfect register with the printed design. Despite this degree of shrinkage, the nylon tufts retained their

individuality and although increasing in firmness remained adequately soft. There was no significant deterioration of embossed yarn physical properties.

urea/acid embossing agent system are used alone, the effect on nylon shrinkage is not much greater than water alone.

TABLE VII

Run No.	Chemicals *	Nylon Filament		Loop Character
		Shrinkage (%)	Weight Loss (%)	
15, 17, 30				
35 avg.	Water (tap), 100%	10.0	1.5	Good
150	Formic Acid, 30%	16.6	0.67	Good
159	Formic Acid, 40%	31.3	2.98	Good
357	Acetic Acid, 30%	13.5	1.06	Good
659	Acetic Acid, 45%	27.0	3.92	Good
889	DMET, 30% **	19.3	+0.62	Good
893	TMT, 30% ***	15.7	0.37	Good
873	DMET, 25%/Formic Acid, 25%	79.2	26.7	Fragile
805	DMET, 30%/Formic Acid, 27.5%	Disintegrate 4 seconds		
887	DMET, 15%/Formic Acid, 40%	Disintegrate 2 seconds		
888	DMET, 10%/Formic Acid, 30%	40.2	3.57	Good
872	DMET, 30%/Acetic Acid, 30%	58.3	20.3	Weak
885	DMET, 15%/Acetic Acid, 45%	Fragmented 15 minutes		
869	TMT, 30%/Formic Acid, 27.5%	Disintegrated 10 seconds		
886	TMT, 25%/Formic Acid, 25%	64.8	18.7	Weak

* DMET - Dimethylethylthiourea (liquid)

TMT - Trimethylthiourea (solid)

Preferably add thiourea derivative to acid solution to speed solubility.

** Immiscible with water at room temperature and 215°F

*** Insoluble at room temperature. Some insoluble at 215°F

EXAMPLE V

The shrinkage and weight loss experienced by a test loop of DuPont type 846 bulk continuous filament nylon 6/6 (1300 denier, 68 filaments, 0 twist, semi-dull, regular acid dyeable) was determined by means of the beaker test procedure described in Table I using the following recipes containing 1,3 - diethylthiourea and an acid such as formic acid and acetic acid. The test temperature was 215°F (102°C) for a maximum time of 15 minutes. Results are tabulated in Table VIII.

These data show that a chemical composition comprising diethylthiourea and an acid such as formic acid or acetic acid can cause effects on nylon fibers ranging from strong shrinkage, about 50 percent without fiber deterioration, to immediate fiber disintegration depending upon the concentration and proportion of the chemicals used. Further, these results indicate that the diethylthiourea acid combination is a potentially strong embossing agent for nylon carpet.

At the concentration employed, diethylthiourea is largely insoluble in water alone or in formic acid at room temperature. Thus, when diethylthiourea is used with formic acid, a portion of a water miscible solvent such as isopropyl alcohol, cellosolve acetate or cellosolve solvent is used to provide a solvent system at room temperature. But in the case of the diethylthiourea/acid system, acetic acid serves as an excellent solubilizing agent for diethylthiourea as well as shrinkage of the nylon filament. Consequently, acetic acid is the preferred acid to be used in conjunction with diethylthiourea. Observe also that a combination of dimethylthiourea and diethylthiourea may also be used effectively with an acid such as formic acid. (Run No. 180.) Again, it will be observed from the data in Table VIII, that when the components of the diethylthi-

EXAMPLE VI

The nylon carpet construction cited in Example III was again treated by means of a screen printing technique. However, in this case the embossing agent comprised a dye print paste containing diethylthiourea 25 percent and acetic acid 35 percent, by weight. It will be noted that similar proportions in the beaker test caused the nylon filament loop to disintegrate within 30 seconds at 215°F. (Run No. 351, Table VIII.)

The print paste recipe was as follows:

Materials	RUN NO. 351SP	
	Grams	
Water	17.2	
Cibaphasol AS	1.0	
Antifoam No. 73	0.8	
Kelzan (1½%) + 0.2% Dowicide A	21.0	
Acetic Acid	35.0	
Diethylthiourea*	25.0	
Dye	0.05	

* Add diethylthiourea to acetic acid solution to facilitate solubility.

Once again, there was little evidence of embossing while the nylon carpet was held at room temperature. Upon subjecting the carpet to steaming at 215°-220°F (102° - 104°C) for a period of 15 minutes, significant embossing due to shrinkage of the nylon fibers was noted. Thereafter, the embossed carpet was rinsed and dried.

The resulting carpet exhibited an area with a 22 percent reduction in pile height in register with the printed pattern. The shrunk tufts were soft, strong and well defined.

TABLE VIII

Run No.	Chemicals *	Nylon Filament		
		Shrink-age (%)	Weight Loss (%)	Loop Character
**	Water	10.5	1.27	Good
150	90% Formic Acid, 33.3%	16.6	0.67	Good
357	Acetic Acid, 30%	13.5	1.06	Good
659	Acetic Acid, 45%	27.0	3.92	Good
176	Diethylthiourea, 40%	Insoluble at 220°F		
660	DET, 40%/Cellosolve Solvent, 20%	20.9	0.54	Good
172	DET, 40%/90% Formic Acid, 20%	Disintegrate 10 sec.		
179	DET, 30%/90% Formic Acid, 16.7%	69.4	6.5	Fragile
180	DET, 20%/DMT, 10%/90% Formic Acid, 22.3%	62.1	15.3	Weak
181	DET, 30%/90% Formic Acid, 16.7%/ Isopropyl Alcohol, 16.7%	50.7	13.3	Good
196	DET, 30%/90% Formic Acid, 16.7%/ Cellosolve Acetate 26.7%	52.3	19.8	Good
205	DET, 30%/90% Formic Acid, 16.7%/ Cellosolve Solvent 20%	47.8	11.9	Good
206	DET, 40%/90% Formic Acid, 20%/ Cellosolve Solvent 20%	Disintegrate 15 sec. Brittle 15 mins.		
341***	DET, 25%/Acetic Acid, 30%	Disintegrate 60 sec.		
350***	DET, 30%/Acetic Acid, 30%	Disintegrate 30 sec.		
351***	DET, 25%/Acetic Acid, 35%	Partial Disintegrate 15 min.		
352***	DET, 20%/Acetic Acid, 40%	Disintegrate 15 sec.		
410***	DET, 30%/Acetic Acid, 35%	Fragment 60 sec.		
422***	DET, 15%/Acetic Acid, 45%			

* DET = diethylthiourea, DMT = dimethylthiourea

** Avg. of 13 runs.

*** Dissolve DET in acid

EXAMPLE VII

The shrinkage and weight loss experienced by a test loop of DuPont type 846 bulk continuous filament nylon 6/6 (1300 denier, 68 filaments, *o* twist, semi-dull, regular acid dyeable) was determined by means of the beaker test procedure described in Table I using the following recipes containing various relatives of thiourea and an acid such as formic. All of these derivatives were largely insoluble in water at room temperature requiring a temperature in the neighborhood of 200°F (95°C) to solubilize at the concentration employed. Tests were conducted for 15 minutes at 215°-220°F (102° - 105°C). Results are recorded in Table IX.

N-acetylthiourea, 1,3 - diisopropyl-thiourea and ethylene-thiourea with formic acid showed a capability for nylon fiber shrinkage. The 1,3 - dihydroxyethylene thiolethylene thiourea had little effect.

In recapitulation, it is to be understood that the process of embossed carpet involves manipulation corresponding to that of printing a pattern on the carpet. Where mesh embossment is sought the printed composition is colorless. Where the design combines color with the embossment a dye paste is the vehicle generally, whether the operation be a mere embossment or an embossment combined with dyeing. It is preferred

that there be no shrinkage of the nylon fibers at ambient temperatures, even up to 50°C. In plant operations the delay from printing to steaming may be as much as 8-10 minutes. Hence, if there is no significant effect on the material at temperatures below 50°C for 15 - 20 minutes there is ample time for operations. That is, activation of the shrinkage is reserved for the stage where the printed material enters the steaming operation. In standard carpet handling the steaming is a 10 - 20 minute operation to fix the dye and in this stage the embossing is completed in the first few minutes.

For effective embossment there should be at least perceptible shrinkage in the tufts. Generally, penetration of the embossing print paste will be of the order of 50 - 75 percent. Where it is desired to have full depth coloration of the printed area uniformly to the back of the fabric, this can be accomplished by predyeing the carpet completely to the back by means of an operation such as pad dyeing. It should be apparent that in operations where mere embossment is sought there is no significant problem in the placement of the design on the fabric. Where embossment is combined with a multi-colored print there is the register problem and the color area will be in perfect register with the embossed design when the shrinkage agent is combined with the color paste as set forth in detail in the examples.

TABLE IX

Run No.	Chemicals	Nylon Filament		
		Shrink-age (%)	Weight Loss (%)	Loop Character
*	Water	10.5	1.27	Good
54	90% Formic Acid, 20%	8.5	1.62	Good
121	1,3 - dihydroxyethylene thiourea, 50%/90% formic acid, 15%	17.8	1.11	Good
171	Ethylenethiourea, 40%/90% Formic Acid, 20%	30.0	3.33	Good
198	1,3 - diisopropylthiourea, 30%/90% Formic Acid, 16.7%/butyl carbitol, 26.7%	40.2	7.98	Good
85	N-acetylthiourea, 50%/90% Formic Acid, 15%	48.4	11.5	Good

* avg. of 13 runs

In the production of the pile fabrics of this invention, the pile yarn employed is prepared from fiber-forming synthetic linear polyamides. Examples of these fiber-forming synthetic linear polyamides are those obtainable from polymerizable monoaminomonocarboxylic acids and their amide-forming derivatives including caprolactam and those obtainable from the reaction of suitable diamines with suitable dibasic carboxylic acids or their amide-forming derivatives. Such synthetic linear polyamides are referred to as nylon.

Nylon or polyamide polymers, filaments and fibers are well known to those skilled in the art and extensive discussion is, therefore, unnecessary. Thus the term "polyamide" or "nylon" is known to include any long chain synthetic polymeric amide which has recurring amide groups as an integral part of the main polymer chain and which is capable of being formed into a filament in which the structural elements are oriented in the direction of the axis of that chain.

Polyamide resins coming within this definition and contemplated in the practice of the present invention are formed generally by reaction of a dicarboxylic acid with diamine or by the self-condensation of an aminocarboxylic acid. Illustrative of these polyamide resins are nylon-6,6, prepared by the condensation of hexamethylenediamine and adipic acid; nylon-6,10, prepared from hexamethylenediamine and sebacic acid, both of the foregoing having, as prepared, molecular weights exceeding 10,000; nylon-6 produced by thermal polymerization of epsilon-aminocaproic acid or caprolactam; nylon-11, the self-condensation product of 11-aminoundecanoic acid; as well as a variety of polymers prepared from polymerized, unsaturated fatty acids and polyamino compounds.

The practice of the present invention has, however, particular application to solid melt-extrudable and orientable fiber-forming polyamides and more particularly to fibers and filaments prepared therefrom which have a denier and tenacity appropriate, and well known to those skilled in the art, for use in carpet, rugs, tapestry and the like. Illustrative of these polyamides are those having a filament denier of 2-30 or higher or nylon yarns in the denier range of 15-15,000 or higher. The tenacities of nylon yarn for use herein are within the range of 3-10 grams per denier. The elongation of commercial fibers can range between 16 and 65 percent. The undrawn filament is capable of being stretched as much as 5 times. It is understood additionally that encompassed within the polyamides that can be employed in the practice of this invention are high molecular weight synthetic linear polyamides, in addition to those described hereinabove, that have been modified, for example, to enhance their usefulness for particular applications.

An extended discussion of polyamides of sufficiently high molecular weight to be capable of being melt spun into filaments and coming within the contemplation of this invention appears in D.E. Floyd, *Polyamide Resins*, Reinhold Plastics Applications Series, Reinhold Publishing Corporation, New York, New York, (2nd Printing 1961), and H.R. Mauersberger, *Matthews' Textile Chemical Properties*, John Wiley & Sons, Inc., New York, New York, pp. 933-971, 1034., (6th ed. 1954), Mary E. Carter, *Essential Fiber Chemistry*, Marcel Dekker, Inc., New York 1971, pp. 91-109, and H.F. Mark, S.M. Atlas, E. Cernia (Edited by), *Man-Made*

Fibers, Science and Technology Volume 2, Interscience Publishers 1968, pp. 181-295, and Tech.-Talk from Monsanto Textiles Division, Bulletin TT-35 August 1969.

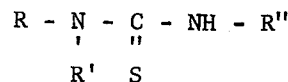
5 Summarizing, it is thus seen that this invention provides a novel and effective method for embossing nylon pile fabrics.

Variations may be made in procedures, proportions, and materials without departing from the scope of the invention as defined in the following claims.

What is claimed is:

1. A process for producing an embossed effect on nylon pile fabric having a surface of nylon fibers which comprises,

15 applying to defined areas of the pile surface of said fabric a chemical embossing agent for said fibers, said agent being blended into a liquid base vehicle and corresponding to the following formula:



wherein R, R' and R'' may be any combination of H, N-acetyl, methyl, ethyl, butyl, isopropyl, pentyl, or hexyl, said aqueous base vehicle also including an acid,

allowing said embossing agent in its vehicle to remain in contact with said fibers for a period of time and at a temperature sufficient to reduce the height of said pile, without deterioration of said fibers and, thereafter, effectively removing the embossing agent from the fabric,

said reduction in height of the fibers being in the area contacted by said embossing agent only and being a reduction sufficient to display a significant embossed effect in the overall fabric.

2. The process of claim 1 wherein said embossing agent is dimethylthiourea with formic acid in concentrations of 5 per cent to 60 per cent dimethylthiourea and 10 per cent to 50 per cent formic acid, by weight, of total embossing composition.

3. The process of claim 2 wherein said embossing agent is incorporated in a transparent vehicle therefor.

4. The process of claim 2 wherein said embossed effect is made in register with a printed color design on said fabric and

said vehicle is a dye printing paste carrying said embossing agent.

5. The process of claim 2 wherein said embossing action occurs within approximately 15 minutes at a temperature above 50°C.

6. The process in accordance with claim 5 wherein said embossing action occurs in a steam environment.

7. The process of claim 6 wherein said embossing composition is present in a concentration of about 55 to 70 per cent in the vehicle therefor.

8. The process of claim 7 wherein said embossing agent is thiourea and formic acid.

9. The process of claim 7 wherein said embossing agent is dimethylthiourea and acetic acid.

10. The process of claim 7 wherein said embossing agent is dimethylthiourea and phosphoric acid.

11. The process of claim 7 wherein said embossing agent is dimethylthiourea and oxalic acid.

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12. The process of claim 7 wherein said embossing agent is dimethylthiourea and hydrochloric acid.
13. The process of claim 7 wherein said embossing agent is diethylthiourea and formic acid.
14. The process of claim 7 wherein said embossing agent is diethylthiourea and acetic acid.
15. The process of claim 7 wherein said embossing agent is diethylthiourea and phosphoric acid.

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16. The process of claim 7 wherein said embossing agent is diethylthiourea and oxalic acid.
17. The process of claim 7 wherein said embossing agent is diethylthiourea and hydrochloric acid.
18. The process of claim 7 wherein said embossing agent is dimethylethylthiourea and formic acid.
19. The process of claim 7 wherein said embossing agent is trimethylthiourea and formic acid.

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