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YARN PRODUCT AND METHOD

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FIG. 1

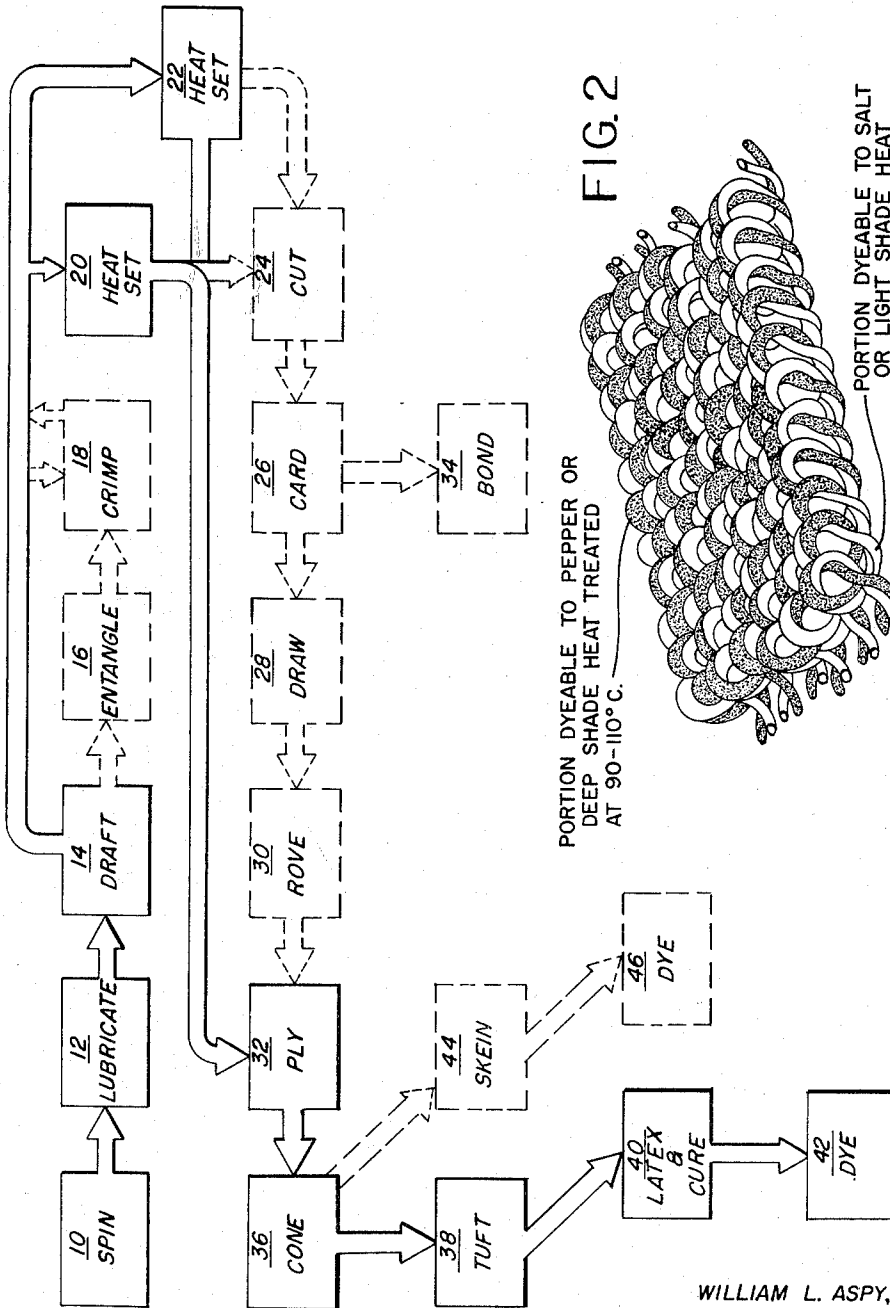
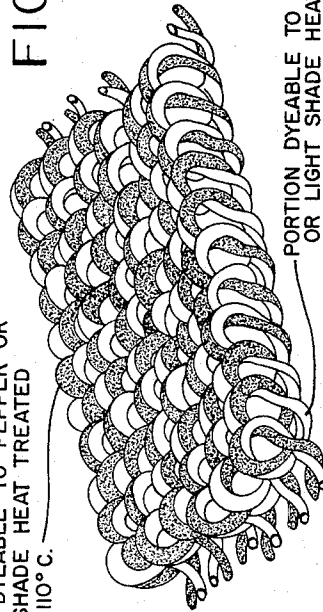


FIG. 2

PORTION DYEABLE TO PEPPER OR
DEEP SHADE HEAT TREATED
AT 90-110° C.



PORTION DYEABLE TO SALT
OR LIGHT SHADE HEAT
TREATED AT 120-150° C.

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1

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YARN PRODUCT AND METHOD

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This invention relates to the production of carpet yarn. More particularly, it concerns the imparting of a plurality of dye-types to carpet yarn.

In our co-pending application Serial No. 150,320, filed November 6, 1961, of which the present application is a continuation-in-part, we have disclosed a high-bulk carpet yarn and process for the preparation thereof. In said process the tow is heat-set subsequent to being crimped, the heat-setting at this point of the process imparting a high-shrink property to said tow which enables it to have a highly desirable, high-bulk and high crimp recovery upon being tufted into carpets or processed for other uses. Upon piece dyeing, such a yarn when tufted into carpets may sometimes exhibit a characteristic streaky appearance. Therefore, the minimizing of what may aptly be called "carpet streak" represents a highly desirable result. After extended investigation we have found a way to produce a salt-and-pepper or tone-contrast pattern which substantially eliminates any such streaky makeup.

It is accordingly one object of this invention to provide a dyed yarn having a salt-and-pepper pattern. Another object is to provide a method for the heat-treatment of yarn to produce a varying dye-acceptability. Still another object is to provide a method of eliminating streaks in carpet yarns. A further object is to provide a method of making modacrylic fibers which have substantially the same denier and substantially the same strength but yet when dyed together in a dye solution dye to different lusters and depths of colors. Other objects will be apparent from the further description which follows.

In its broad aspects this invention comprises using at least two different heat-setting or tow-drying temperatures to produce different degrees of dye-acceptability in synthetic-filament yarn. Thus the combining of two or more different dye-affinity types into a yarn of a salt-and-pepper pattern adapted for use in carpets having substantially no streaking is possible. Particularly surprising is that within reasonable controlled limits as explained hereinbelow this does not tend to cause the yarn to lose its strength, although prior art indicates that the heat treatment temperature is quite critical and in fact eliminates shrinkage tendency. Modacrylic yarn is especially suitable for heat treatment in accordance with our invention to produce a novel plural dye-type yarn. By modacrylic we means modified acrylonitrile fibers containing less than 85% and at least 35% acrylonitrile units in the polymer for example, such as described in U.S. Patent Nos. 2,811,409, 2,831,826 and 2,843,572 and in our abovementioned co-pending application Serial No. 150,320.

In one embodiment of our invention we employ the following process steps:

(1) Make two or more different dye-types of continuous filament modacrylic yarn. The two or more types preferably have a fairly wide difference in dye affinity.

(2) Combine the two or more modacrylic types into a combination yarn, for example, two-or-three ply.

(3) The yarn may then be dyed or first tufted into a carpet and then dyed, for example, by piece dyeing, to produce a salt-and-pepper pattern having tone contrast of sufficient magnitude to hide normal variations in dye take-up.

2

According to our invention both dye types may be dyed with the same shade dye.

The two different dye-types of continuous filament modacrylic yarn are made in the first of these steps by controlling the level of heat-setting or tow-drying temperatures, that is, by using different levels of heat-setting temperature for the two or more different dye-types. The heat setting may be done in tow dryers. In the tow dryer, hot air is circulated through the tow. According to our invention the yarn or tow is heat-set in the tow-dryer in preferably two separate stages. The temperature may be somewhat higher in the second stage than in the first. Adjustment of the temperatures to which the particular tow undergoing heat-setting is subjected in the tow-dryer provides the degree of dye affinity or dye acceptability desired, with the result that tow heat-set at one temperature level may be combined with tow heat set at other levels into a two-or-three ply or other appropriate yarn. The yarn may then be dyed as is into a multi-tone yarn or tufted into a carpet which when piece-dyed exhibits a salt-and-pepper color contrast which hides any variations in dye take-up which might otherwise occur. The heat-setting temperatures according to our invention control the extent of fiber dyeability. In other words, the color blend or appearance of dyed, heat-set modacrylic fibers or yarn product is affected by the temperature to which they have been subjected in the tow dryer during heat-setting. The portion of the yarn which has been heat-set at high temperatures, dyes to a light, dull appearance while the portion which has been heat-set at low temperatures dyes bright and dark.

Modacrylic yarns heat-set at tow dryer temperatures of 90° C. in each of two dryer stages and yarns heat-set at temperatures of 140° and 150° C. respectively in first and second dryer stages show good tone contrast when they are dyed together in the same dye solution. We have produced this tone-on-tone effect in carpet samples tufted of continuous filament modacrylic yarn and piece-dyed these colors: Light Green, Light Beige, Purple, Gold, Maroon, Rose Beige, Brown and Blue.

By control of heat-setting temperatures, dye-type extremes can be made which dye into a sharply contrasting, salt-and-pepper, tone-on-tone carpet. Yarns made with lesser heat-setting temperature extremes can be used where subtler but variation-masking dye differences are wanted.

Heat-setting temperatures may also be used to control denier of crimped modacrylics. The measured denier of crimped, heat-set yarn is markedly affected by the heat-setting temperature. To have the same measured denier as crimped yarn heat-set at 120° and 140° C. respectively in first and second dryer stages, crimped yarn heat-set at 90° C. in each of two dryer stages should enter the dryer at 13% higher denier. On the other hand, to have the same measured denier as crimped yarn heat-set at 120° and 140° C. respectively in the first and second dryer stages, crimped yarn heat set at 140° and 150° C. respectively in first and second dryer stages should enter the dryer at 21% lower denier.

Heat-setting temperatures affects not only the dye take-up and heat-set denier of crimped yarn but also the carpet hand, which is related to crimp recovery. The higher the heat-setting temperature, the firmer the hand of the carpet. Dye take-up tends to diminish with increased firmness of hand.

Although the high and low heat-setting temperature ranges do not appear to be critical provided they are sufficient to heat-set the tow and not high enough to damage it by fusion or the like, we have obtained best results when the high temperature range for heat-treating one end or dye-type is from about 120°-150° C. and the low temperature range for another end or brighter dye-type is from about 90°-120° C. The high-heat drying is pref-

erably done in two stages, the former being at a lower temperature than the latter. Best results in such a two-stage high-temperature, dull-end type are obtained at about 120°–140° C. and 140°–150° C. respectively. Preferred in the first stage is a temperature of about 120° and in the second a temperature of about 140° C. Although a higher temperature may be used in a second stage of the heat-setting of the low-temperature, bright-end yarn type, we prefer in this instance to use a two-stage dryer with about the same temperature in each of the two stages. We have found the optimum for such a two-stage, single-temperature, bright-end dye-type to be about 110° C.

The high temperature limit of our low temperature tow-drying may be approximately the same as the low temperature limit of our high-temperature tow-drying. Of course, to produce at least a slight difference in dye affinity, there must be at least a slight temperature differential between the heat-setting temperature for any two different dye-affinity types of yarn ends.

The yarn may be dyed after it has been tufted into a carpet, or before, for example, by skeining and skein-dyeing. The same color contrast between the brightness or darkness of the lower-temperature dried yarn and the dullness or lightness of the higher-temperature dried yarn is obtained either way.

Processing limits appear to be the only limits as to average denier of the yarn which may be heat-set and dyed to a two-tone color according to our invention. However, we prefer to use yarn having an average denier of from about 2,000 to about 6,000.

For a more complete understanding of our invention reference is made to the attached drawing forming a part of the present application.

FIG. 1 is a block diagram of an apparatus assembly that may be used for carrying out our invention. In this figure dotted lines are used to indicate alternative arrangements.

FIG. 2 is a drawing of a yarn product according to the present invention showing a section of a modacrylic yarn carpet as it is described herein and in the appended claims.

Reference is now made to FIG. 1. In the spinning operation 10 one or more spinning cabinets (not shown) of any usual dry spinning or melt spinning equipment construction may be used to produce a plurality of individual filaments of suitable denier and cross-sectional shape, for example 8–16 denier per filament and regular clover-section, Y or C yarn. More detailed descriptions of methods of spinning and spinning equipment which may be used in the process of this invention are found in our co-workers' U.S. Patents 2,829,027, 2,750,653 and 3,000,053. Yarn ends produced by the spinning operation may be passed through lubricating zone 12. An appropriate amount of lubricant may be added prior to a drafting operation indicated at 14 or after the later heat-setting operation. Lubricant may be applied as described in our co-workers' U.S. Patent 2,807,864. After drafting up to 750%, that is, stretching to a length of up to 7½ times their original length, the yarn ends may be subjected to a jet treatment at 16. When desired, a small amount of interlooping may be imparted to the yarn by use of a gas jet which may be of a construction such as shown in U.S. Patent 2,924,868. The pressure may be controlled in such a way as to limit the amount of looping to the desired degree. The yarn may be approximately treated in such a jet at a speed of take-up approximately equal to or slightly lower than the input speed. Another method of jet treatment is disclosed in U.S. Serial No. 102,880, filed April 13, 1961, of our co-worker Haynes, now U.S. Patent 3,099,064. The yarn ends thus drafted and exposed to the jet treatment when desired may next be conducted into a crimping zone 18 prior to drying separate portions of the crimped yarn at two different heat-setting temperatures at zones 20 and 22. At this point the yarn may be converted to cut-staple form and processed accordingly,

packaged for movement to another point for further processing, or subjected to further processing in continuous filament form. If a cut-staple yarn is to be used, as indicated in the drawing the yarn is first cut into staple at 24, next carded at 26, then subjected to drawing at 28, and roving at 30 prior to plying at 32 into a yarn product having portions that have been heat-set at different temperatures. When continuous filament yarn is used the plying may be performed substantially directly after the heat-setting step. When the yarn is cut into staple fiber, after carding at 26 it may be converted to non-woven fabric containing yarns heat set at more than one temperature, as indicated at 34 using an appropriate bonding agent. After plying at 32 the yarn is formed on cones at 36 from which it may be tufted into carpet at 38 and then subjected to latexing and curing at 40 and dyed into a non-streak bi-colored pattern at 42. If it is desired to impart the characteristic salt-and-pepper effect to the yarn prior to converting it to a carpet or other appropriate product, it may be formed into skeins at 44 and then subjected to an appropriate dye treatment at 46.

In FIG. 2 the characteristic multi-shade or salt-and-pepper pattern of the yarn product of our invention having at least part thereof which has been heat treated at a different temperature level from a remaining portion is clearly shown.

A further understanding of our invention will be had from a consideration of the following examples which are set forth to illustrate certain preferred embodiments.

Example 1.—5400 denier texturized filament modacrylic yarn

Six ends of 5400 denier texturized filament modacrylic yarn were heat-set at the conditions delineated in the following chart:

Set-up number	Dryer first stage temp., °C.	Dryer second stage temp., °C.	Ends watered at dryer entrance	Ends forced-air cooled after dryer	Strength, g./d.
1.....	120	140	No.....	Yes.....	1.11
2.....	120	140	Yes.....	Yes.....	1.26
3.....	120	140	Yes.....	No.....	1.22
4.....	96	140	No.....	Yes.....	1.11
5.....	96	140	No.....	No.....	1.19
6.....	96	140	Yes.....	Yes.....	0.89
7.....	96	140	Yes.....	No.....	1.04
8.....	140	150	No.....	Yes.....	1.15
9.....	140	150	No.....	No.....	1.33
10.....	140	150	Yes.....	Yes.....	1.11
11.....	140	150	Yes.....	No.....	1.19
12.....	110	110	No.....	Yes.....	1.04
13.....	110	110	No.....	No.....	1.07
14.....	110	110	Yes.....	Yes.....	0.96
15.....	110	110	Yes.....	No.....	1.04
16.....	110	110	Yes.....	No.....	1.04

The above yarns were beaker-dyed brown. The following observations were made as to these yarns.

(1) The yarn heat-set at 110° C. in both two dryer stages was darker and brighter than yarn heat-set at 140° and 150° C. respectively in the first and second dryer stages.

(2) Raising first and second stage dryer temperatures from 120° and 140° C. respectively to 140° and 150° C. produced a duller dyed yarn. Lowering dryer temperatures from 120° and 140° C. respectively to 110° and 110° C. produced a brighter dyed yarn. The latter effect was somewhat greater than the former.

(3) The forced-air cooling at dryer discharge appeared to have dulled the yarn somewhat.

(4) Watering yarn before it enters the dryer apparently brightened it somewhat, possibly due to a lowered yarn temperature in the first dryer stage.

Example 2.—Carpet test of 5400-denier texturized filament modacrylic yarn dye types

With standard processing techniques and conditions, six ends of 5400-denier texturized filament modacrylic

5

6

yarn were heat-set at the two temperature levels shown in the following chart:

Dryer first stage temp., ° C.	Dryer second stage temp., ° C.	Time in dryer (minutes)	Average denier
140-----	140	2	6,089
110-----	110	4	4,357

5

stage and 140° in the second dryer stage. All three yarns were tufted into a carpet in alternate 1½-inch wide bands. 8 four-foot lengths of this carpet were dyed 8 different colors, viz., Light Green, Light Beige, Purple, Gold, Maroon, Rose Beige, Brown and Blue. In every color, the dye contrast was clear. Yarn skeins were beaker dyed all the above eight colors. The skeins also showed a sharp color contrast. Yarn preparation conditions were as follows:

Dryer first stage temp., ° C.	Second stage temp., ° C.	Time in dryer (minutes)	Extrusion speed, M/M	Average denier	Average, g./d.	Stretch, percent	Average hot water shrinkage, percent
120-----	140	2	37.2	2689	1.21	45.0	2.38
140-----	150	2	43.5	2751	0.81	29.9	3.37
90-----	90	8	31.0	2866	0.95	36.4	3.37

Portions of yarn heat-set at 140° C. in both dryer stages were tufted with portions of yarn heat-set at 110° C. in both dryer stages into adjacent bands in a small carpet sample. This sample was dyed a reddish light-brown. The yarn heat-set at 110° dyed to a much darker appearance than that heat-set at 140°.

Example 3.—2700 denier texturized filament modacrylic yarn dye types

2700-denier filament modacrylic was processed the same as the 5400 denier modacrylic in Example 2. Three yarn types were made at temperatures shown in the following chart:

Dryer first stage temp., ° C.	Dryer second stage temp., ° C.	Time in dryer (minutes)	Average denier	Hot water shrinkage (percent)
110-----	110	8	2,225	1.33
120-----	140	2	2,525	1.90
140-----	140	2	3,030	0.65

Some of each of the three yarns, each having been heat-set at different dryer temperatures, were beaker dyed brown. There was a progression of tone depth from high to low heat-setting temperature.

Example 4.—Dye difference test of denier-adjusted 2700-denier texturized filament modacrylic yarn

In this example any possible effect of differences in denier on appearance of dyed temperature-treated, filament modacrylic yarn was eliminated. Extrusion speed was adjusted to compensate for those changes in measured denier that resulted from changes in temperatures in the tow dryer.

Dryer first stage temp., ° C.	Dryer second stage temp., ° C.	Extrusion speed, M/M	Average measured denier
140-----	140	45.0	2,836
110-----	110	35.3	2,580
120-----	140	39.4	2,613

Samples of yarns made at each of the three temperature conditions were simultaneously beaker-dyed brown. A progressive contrast from dark-dyed at low temperature to light-dyed at high temperature was apparent. The dark and light areas completely obscured sample-to-sample differences and streaking.

Example 5.—Eight-color test of two dye-types of modacrylic yarn

Two modacrylic yarns, one heat-set at 90° C. in both dryer stages and one heat-set at 140° in the first dryer stage and 150° in the second dryer stage were made along with a control yarn heat-set at 120° in the first dryer

The preceding examples illustrate the production of a yarn product characterized by at least a portion thereof comprising yarn heat-set at a different temperature level from the remainder.

Although the invention has been described in considerable detail with particular reference to certain preferred embodiments thereof, variations and modifications can be effected within the spirit and scope of the invention as described hereinabove, and as defined in the appended claims.

We claim:

1. A process for the preparation of a modacrylic yarn product which comprises the steps of

(1) spinning a plurality of filaments of a total denier of from about 2,000 to about 6,000 and a denier per filament of from about 2 to about 10 from a solution of modacrylic polymer;

(2) drafting said filaments to up to 750 percent of their original length;

(3) crimping said filaments to from about 5 to about 15 crimps per inch;

(4) dry heat treating a first portion of said filaments in two stages at temperatures of from about 120° C. to 140° C. and from about 140° C. to 150° C. respectively;

(5) separately dry heat treating a second portion of said filaments in two stages at a single temperature of between about 90° C. and 110° C.;

(6) combining said first and second portions into a plied yarn;

(7) tufting the plied yarn into a fabric product; and

(8) piece-dyeing said product to a salt-and-pepper pattern of sufficient tone contrast to hide substantially all non-uniform variations in dye take-up.

2. In a process for producing a modacrylic yarn product characterized by its ability to be piece-dyed to a salt-and-pepper tone-contrast pattern comprising spinning from a solution of a polymer containing less than 85% and at least 35 percent acrylonitrile units, drafting the modacrylic filaments formed by said spinning of a denier per filament of about 2 to 10 and a total denier of up to 6,000, and then combining separately heat treated portions of said modacrylic filaments, the improvement step which comprises dry heat treating a first portion of said modacrylic filaments in at least one stage at a temperature range of 120° to 150° C. while heat setting said modacrylic filaments and separately dry heat treating a second portion of said modacrylic filaments at a single temperature range of 90° C. to 110° C. while heat setting said modacrylic filaments, accomplishing said separate dry heat treating of said first and second portions prior to said combining, and then combining said portions of filaments separately dry heat treated as aforementioned to produce a yarn product adapted for piece dyeing to a salt-and-pepper pattern of sufficient tone con-

trast to minimize any non-uniform variations in dye take-up.

3. A modacrylic yarn product heat set during drying and dyeable to a salt-and-pepper pattern of sufficient tone contrast to minimize the effect of any non-uniform variations in dye take-up, said product consisting of a combination of two portions of modacrylic filaments of a denier per filament of about 2 to 10 and a total denier of up to about 6,000 spun from a solution of a polymer containing less than 85 percent and at least 35 percent acrylonitrile units, said portions characterized in that after spinning they were first drafted to up to 750 percent of their original length and crimped to from 5 to 15 crimps per inch, the first portion next dry heat treated while being heat set in two steps from temperatures of about 120° to 140° C. and about 140° to 150° C. respectively, with the second portion separately dry heat treated while being heat set in two stages at a single temperature of between about 90° and 110° C., and said

separately dry heat treated portions of filaments then combined into a modacrylic yarn product dyeable to said salt-and-pepper pattern of sufficient tone contrast to minimize the effect of any non-uniform variations in dye take-up.

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