US 20220341089A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2022/0341089 A1**

**Brindle et al.** (43) **Pub. Date: Oct. 27, 2022**

(54) **BATH RUG SCOURING MODIFIER**

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(21) Appl. No.: **17/811,783**

(22) Filed: **Jul. 11, 2022**

**Related U.S. Application Data**

(63) Continuation of application No. 17/293,551, filed on May 13, 2021, filed as application No. PCT/US2019/060414 on Nov. 8, 2019.

(60) Provisional application No. 62/760,667, filed on Nov. 13, 2018.

(30) **Foreign Application Priority Data**

Nov. 27, 2018 (EP) ..... 18208540.7

**Publication Classification**

(51) **Int. Cl.**

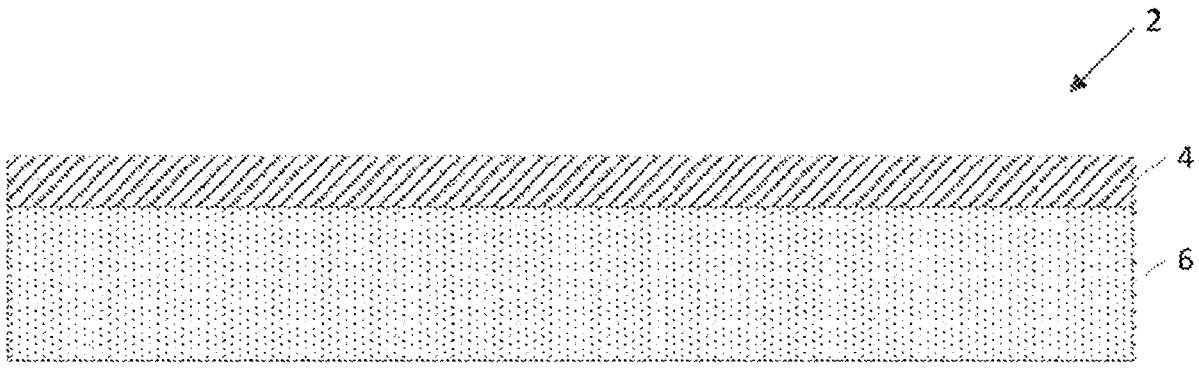
| | |
|---|---|
| ***D06N 3/00*** | (2006.01) |
| ***A47G 27/02*** | (2006.01) |
| ***D06N 7/00*** | (2006.01) |
| ***D06P 3/34*** | (2006.01) |
| ***D06P 5/02*** | (2006.01) |

(52) **U.S. Cl.**

CPC ..... ***D06N 3/0036*** (2013.01); ***A47G 27/0212*** (2013.01); ***D06N 7/0065*** (2013.01); ***D06P 3/34*** (2013.01); ***D06P 5/02*** (2013.01); *D06P 1/0008* (2013.01)

(57) **ABSTRACT**

The invention relates to cushioned rugs comprising polyester yarn, particularly polyethylene terephthalate (PET) yarn, comprising a crystallinity-reducing modifier in the polyester yarn, such as a branched polyester modifier. The invention further relates to methods of preparing such cushioned rugs.



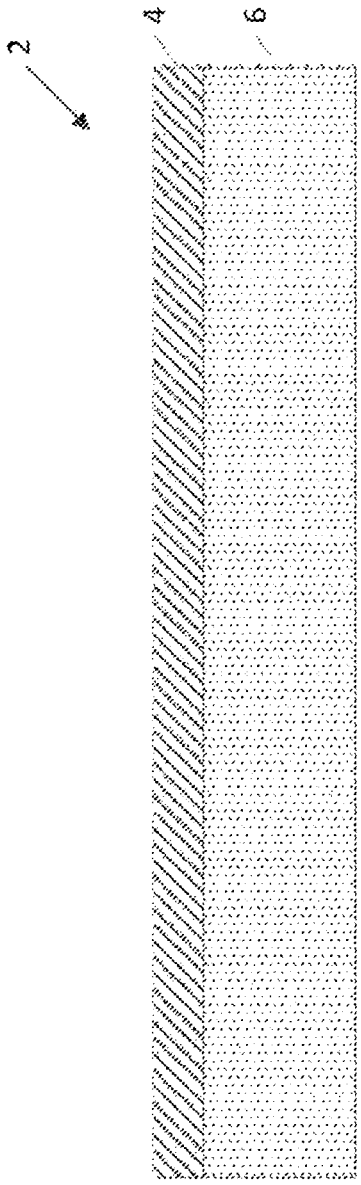



Fig. 1

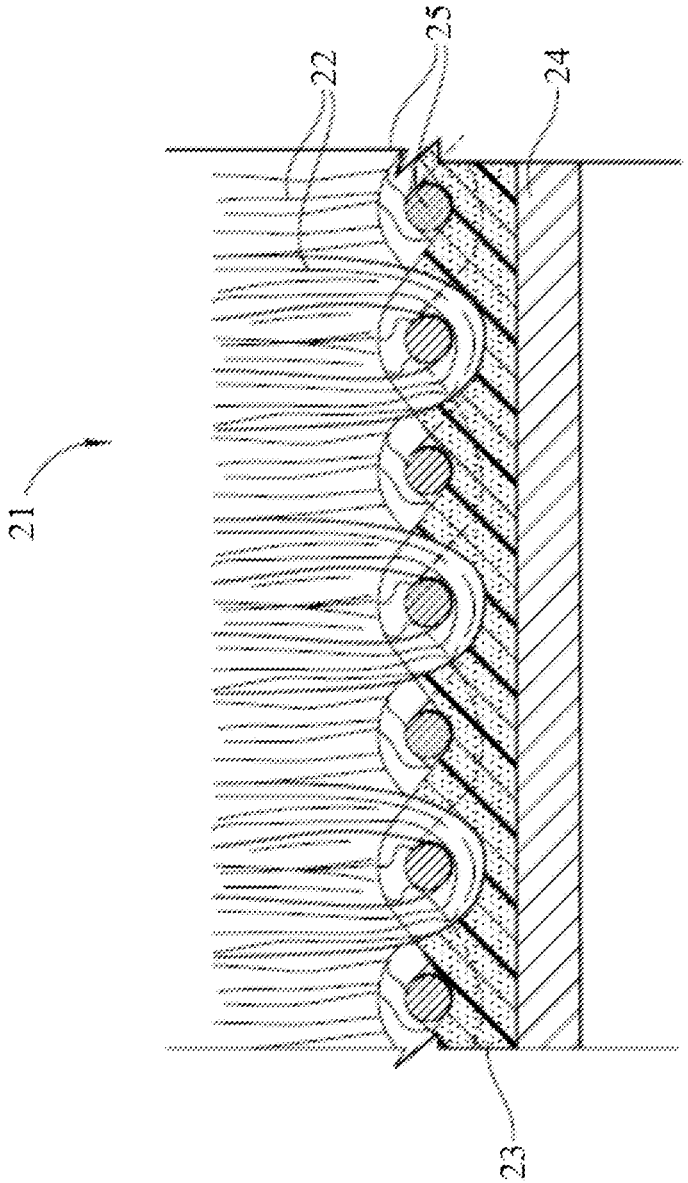



Fig. 2

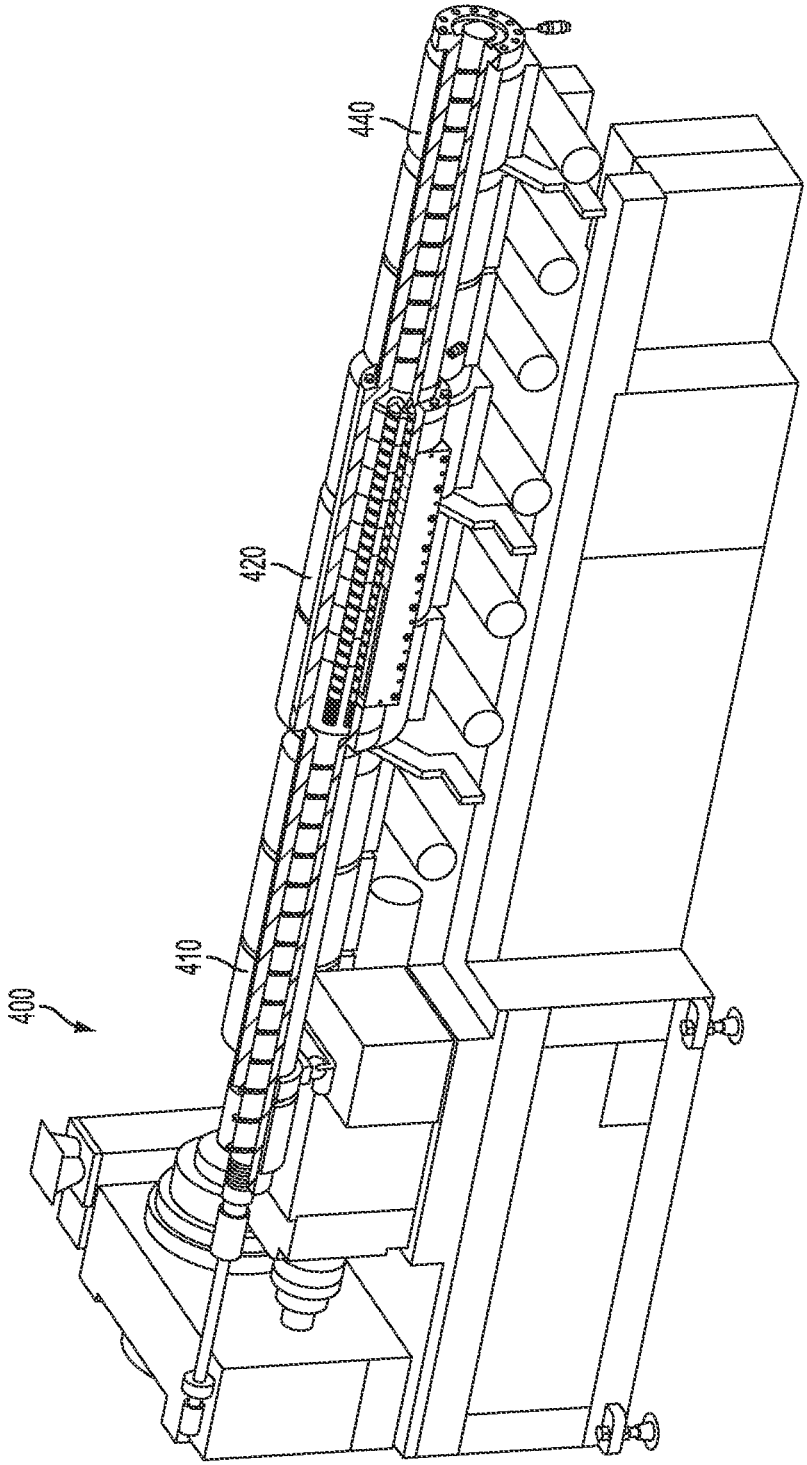



FIG. 3

# BATH RUG SCOURING MODIFIER

## CROSS REFERENCE TO RELATED APPLICATIONS

**[0001]** The application is a continuation of U.S. application Ser. No. 17/293,551, filed May 13, 2021, which is a U.S. National Stage entry of International Application No. PCT/US2019/060414, filed Nov. 8, 2019, which claims the benefit of U.S. Provisional Application No. 62/760,667, filed Nov. 13, 2018, and of European Application No. 18208540.7, filed Nov. 27, 2018, the entire contents of each of which are incorporated herein by reference.

## FIELD

**[0002]** The invention relates to washable rugs comprising polyester yarn, particularly polyethylene terephthalate (PET) yarn, having a sufficiently low degree of crystallinity so as to improve dye pickup and enable a rinsing or scouring process to remove excess dye molecules following the dyeing cycle. The invention further relates to methods of preparing such washable rugs.

## BACKGROUND

**[0003]** In the production of rugs and carpets, there are several known methods for dyeing the rugs and carpets to a desired color. These methods include: 1) solution dyeing, in which the dye is included in the polymer for the fiber before the fibers are spun; 2) yarn dyeing, in which the yarn is dyed after being spun but prior to being tufted into the primary backing; 3) jet dyeing, in which the dye is sprayed onto the fiber tufts after tufting and 4) beck dyeing, in which the rugs and carpet are submerged in a vat comprising dye and water. One advantage of beck dyeing is that it is more economical to dye carpet in smaller batches of different colors than the other methods.

**[0004]** Polyethylene terephthalate (PET), a thermoplastic fiber polymer resin in the polyester family, is a commonly-used polymer for carpets and rugs. PET carpets and rugs are dyed with disperse dyes, which are generally water-insoluble. The dye used for PET acts more like a stain that is adhered to the PET fiber. This dye also stains most other materials in the backings of carpet and rugs. In carpet manufacturing the finished backing is applied after the dyeing process to avoid staining. For beck dyed rugs, the backing is applied before dyeing. Therefore the backing is exposed to staining from the disperse dyes.

**[0005]** In order to produce washable rugs, such as might be used in a bathroom or kitchen, a thickness of foam and/or adhesive is attached to the underside of a section of a tufted primary backing. The foam and/or adhesive may provide cushioning and support. Unlike carpet, rugs of this type are preferably washable by the consumer.

**[0006]** Until now, PET rugs have primarily been produced using solution dyeing or yarn dyeing for the tufts. However, in order to satisfy consumer demand for variety and décor, there would be a competitive advantage for a rug manufacturer if the PET rugs could be dyed using beck dyeing (which is also referred to as piece-dyeing in this context). Smaller batches of rugs produced in multiple colors could be manufactured more efficiently. However, in light of the previously attached foam and/or adhesive backing (or "backing"), a person of skill in the art would not have thought it possible to use beck dyeing for PET rugs. The entire rug, including the tufted primary backing and the rug backing would be submerged and saturated in the dye vat. The amount of dye required to properly dye the PET fibers would be thought to have one or more several undesirable features, such dyeing or staining of the backing, the inability for a consumer to wash the rugs, and crocking and transfer of dye, in which some of the dye is rubbed off of the rug and onto adjacent surfaces, such as the floor. This would be thought to be especially problematic with regards to darker colors, which require the absorption of more dye; this often results in more excess dye remaining in the rug backing when the rug is in the possession of the consumer, which in turn increases the risk and severity of crocking and transfer of dye.

**[0007]** The process for removing excess dye following beck-dyeing is called "scouring," and typically involves submerging the dyed carpet or rug in caustic chemicals. This is not always completely effective, especially when an excess of dye is used, due to the low dyeability of PET fibers and/or to the need to prepare darker-colored fibers.

**[0008]** Accordingly, a need exists for a PET washable rug with improved dyeability and less crocking, as well as improved methods of making and scouring such washable rugs.

## SUMMARY

**[0009]** According to a first aspect of the invention, a rug is provided, said rug comprising

**[0010]** a) a textile face fabric comprising a polyester yarn, said polyester yarn comprising polyester fibers or filaments, said fibers or filaments having an average percent crystallinity of less than about 30%, and said fibers or filaments comprising a crystallinity-reducing modifier; and

**[0011]** b) a backing layer secured to the textile face fabric.

**[0012]** According to a second aspect of the invention, a method of manufacturing a cushioned rug is provided, said method comprising:

**[0013]** providing a greige fabric comprising polyester yarn, said polyester yarn comprising polyester fibers or filaments, said fibers or filaments having a percent crystallinity of less than about 30%, and said fibers or filaments comprising a crystallinity-reducing modifier;

**[0014]** securing a backing layer to the greige fabric, so as to form an intermediate rug;

**[0015]** beck-dyeing the intermediate rug with disperse dye, so as to form a dyed rug; and

**[0016]** scouring the dyed rug with a caustic liquid.

**[0017]** According to a third aspect of the invention, a cushioned rug is provided, said cushioned rug being prepared by any of the above methods.

## BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING(S)

**[0018]** Reference will now be made to the accompanying drawings, which are not necessarily drawn to scale, and wherein:

**[0019]** FIG. **1** is a cross-sectional schematic view of a cushioned rug according to one embodiment of the present invention.

**[0020]** FIG. **2** is a cross-section diagram of a tufted carpet face fabric in accordance with a portion of an embodiment of the present invention.

**[0021]** FIG. **3** is a perspective view of an MRS extruder that is suitable for use in a process for manufacturing bulked continuous filament.

## DETAILED DESCRIPTION

**[0022]** The present invention now will be described more fully hereinafter with reference to the accompanying drawings, in which some, but not all embodiments of the inventions are shown. Indeed, these inventions may be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure will satisfy applicable legal requirements. Like numbers refer to like elements throughout. In the following description, various components may be identified as having specific values or parameters, however, these items are provided as exemplary embodiments. Indeed, the exemplary embodiments do not limit the various aspects and concepts of the present invention as many comparable parameters, sizes, ranges, and/or values may be implemented. The terms "first," "second," and the like, "primary," "exemplary," "secondary," and the like, do not denote any order, quantity, or importance, but rather are used to distinguish one element from another. Further, the terms "a," "an," and "the" do not denote a limitation of quantity, but rather denote the presence of "at least one" of the referenced item.

**[0023]** Each embodiment disclosed herein is contemplated as being applicable to each of the other disclosed embodiments. All combinations and sub-combinations of the various elements described herein are within the scope of the invention. Further, the invention illustratively disclosed herein suitably may be practiced in the absence of any element which is not specifically disclosed herein.

**[0024]** It is understood that where a parameter range is provided, all integers and ranges within that range, and tenths and hundredths thereof, are also provided by the embodiments. For example, "5-10%" includes 5%, 6%, 7%, 8%, 9%, and 10%; 5.0%, 5.1%, 5.2% . . . 9.8%, 9.9%, and 10.0%; and 5.00%, 5.01%, 5.02% . . . 9.98%, 9.99%, and 10.00%, as well as, for example, 6-8%, 7-9%, 5.1%-9.9%, and 5.01%-9.99%.

**[0025]** As used herein, "about" in the context of a numerical value or range means±10% of the numerical value or range recited or claimed.

**[0026]** As used herein, "recycled" refers to any material that is post-consumer or post-industrial material.

**[0027]** As used herein, a "backing" refers to a foam and/or adhesive layer. This is distinct from the primary or secondary backings found in carpet.

**[0028]** As used here, "face fabric," or "carpet," refers to yarns or fibers in combination with a primary backing, and optionally a secondary backing.

**[0029]** As used herein, "percent crystallinity" (Xc) of a polyester material means the portion of the material that is crystalline, compared to the entirety of the material (which may contain both crystalline and amorphous portions). The percent crystallinity may be assessed using differential scanning calorimetry, commonly referred to as DSC and calculated using the formula:

$$Xc=(\Delta H_f/\Delta H_o)*100$$

where: $\Delta H_f$=enthalpy of melting of test sample in joules per gram (J/g) and $\Delta H_o$=the enthalpy of melting for a fully crystalline polymer. The heating rate of the DSC method may be from 0.1-30° C./min, or from 1-10° C./min, in some embodiments. In a preferred embodiment, the heating rate is 10° C./min.

**[0030]** As used herein, a "crystallinity-reducing modifier" is a modifier which reduces the crystallinity of a fiber or filament, compared to the crystallinity of a fiber or filament lacking the modifier, when added to the polymer from which the fiber or filament is made. In an embodiment, the crystallinity-reducing modifier reduces the crystallinity by about 1-90%. In an embodiment, the crystallinity-reducing modifier reduces the crystallinity by greater than about 1-90%.

**[0031]** As used herein, a "greige" fabric is a fabric that is unfinished in some way, such as not being dyed.

**[0032]** As used herein, to "secure" two objects together means to fix or attach the objects to each other, by means such as an adhesive or otherwise.

**[0033]** As used herein, "synergistic," in terms of an effect, refers to the case where the interaction or presence of two elements produces a greater effect than would be expected based on the effect created by each of those elements individually. In the present case, the term may refer to a case where a fiber, F1, comprising a modifier and having decreased crystallinity compared to another fiber, F2, which lacks said modifier and has higher crystallinity, exhibits a greater improvement in dyeability, or some other property or metric of performance, compared to F2, than would be expected based on the improvements exhibited by two other fibers, the first of which contains the modifier but has the same degree of crystallinity as F2, and the second of which lacks the modifier but has the same degree of crystallinity as F1.

**[0034]** Non-limiting examples of classes of disperse dyes include azobenzene derivatives and anthraquinone derivatives. Certain disperse dyes may comprise nitro, amine, or hydroxyl groups.

**[0035]** According to a first aspect of the invention, a rug is provided, said rug comprising

**[0036]** a) a textile face fabric comprising a polyester yarn, said polyester yarn comprising polyester fibers or filaments, said fibers or filaments having an average percent crystallinity of less than about 30%, and said fibers or filaments comprising a crystallinity-reducing modifier; and

**[0037]** b) a backing layer secured to the textile face fabric.

**[0038]** According to some embodiments, said rug consists essentially of said textile face fabric and said backing layer. According to some embodiments, said rug consists of said textile face fabric and said backing layer.

**[0039]** According to some embodiments, the average percent crystallinity is less than about 29%, 28%, 27%, 26%, 25%, 24%, 23%, 22%, 21%, 20%, 19%, 18%, 17%, 16%, 15%, 14%, 13%, 12%, 11%, 10%, 9%, 8%, 7%, 6%, 5%, 4%, 3%, 2% or 1%.

**[0040]** According to some embodiments, said polyester fibers or filaments comprise polyethylene terephthalate (PET).

**[0041]** According to some embodiments, said backing layer comprises foam, said foam having a density ranging from about 2 oz per square yard to about 50 oz per square yard. In a further embodiment, said backing layer comprises

a polyurethane foam. In an embodiment, said backing layer comprises a viscoelastic foam material. In an embodiment, said backing layer comprises adhesive. In a further embodiment, said adhesive is a foamed adhesive. In an embodiment, said adhesive is not a foamed adhesive. In an embodiment, said rug does not comprise adhesive.

**[0042]** According to some embodiments, the polyester fiber or filament comprises the modifier in an amount from about 0.5% to about 16% by weight. According to some embodiments, the polyester fiber or filament comprises the modifier in an amount of less than, greater than, or equal to about 1%, 2%, 3%, 4%, 5%, 6%, 7%, 8%, 9%, 10%, 11%, 12%, 13%, 14%, 15%, or 16% by weight. According to some embodiments, the polyester fiber or filament comprises the modifier in an amount from about 1% to about 15%, about 3% to about 14%, about 5% to about 12%, or about 8% to about 10% by weight. Preferably, the polyester fiber or filament comprises the modifier in an amount from about 8% to about 10%. According to some embodiments, the modifier is a branched polyester. According to some embodiments, the modifier is polybutylene adipate terephthalate (PBAT).

**[0043]** According to some embodiments, the polyester yarn comprises continuous filaments. According to some further embodiments, the continuous filaments are bulked continuous filaments.

**[0044]** According to some embodiments, the polyester yarn exhibits increased dyeability compared to a polyester yarn comprising polyester fibers or filaments that have the same degree of crystallinity, but lack the modifier. According to some further embodiments, the increase in dyeability is at least about 1% to at least about 300%. According to some further embodiments, the increase is at least 1% to at least 25%.

**[0045]** According to some embodiments, the polyester fibers or filaments comprise recycled polyester. In an embodiment, the recycled polyester is recycled PET. According to some embodiments, the recycled PET has been recovered from carpet waste or plastic bottles. According to some embodiments, the polyester fibers or filaments comprise recycled PET and virgin PET, and wherein the ratio of recycled PET to virgin PET is from about 99:1 to about 1:99.

**[0046]** According to some embodiments, the rug is beck-dyed. According to some embodiments, the textile face fabric and the backing layer have been dyed simultaneously.

**[0047]** According to some embodiments, the rug further comprises at least one component selected from the group consisting of finishing agents, delusterants, viscosity modifiers, optical brighteners, matting agents, thermal stabilizing agents, anti-oxidative agents, anti-static agents, pigments, and ultra-violet stabilizing agents.

**[0048]** According to a second aspect of the invention, a method of manufacturing a cushioned rug is provided, said method comprising:

**[0049]** providing a greige fabric comprising polyester yarn, said polyester yarn comprising polyester fibers or filaments, said fibers or filaments having a percent crystallinity of less than about 30%, and said fibers or filaments comprising a crystallinity-reducing modifier;

**[0050]** securing a backing layer to the greige fabric, so as to form an intermediate rug;

**[0051]** beck-dyeing the intermediate rug with disperse dye, so as to form a dyed rug; and

**[0052]** scouring the dyed rug with a caustic liquid.

**[0053]** According to some embodiments, the average percent crystallinity is less than about 29%, 28%, 27%, 26%, 25%, 24%, 23%, 22%, 21%, 20%, 19%, 18%, 17%, 16%, 15%, 14%, 13%, 12%, 11%, 10%, 9%, 8%, 7%, 6%, 5%, 4%, 3%, 2% or 1%.

**[0054]** According to some embodiments, the griege fabric is obtained by tufting. According to some embodiments, the yarn is obtained by melt spinning or by extrusion spinning.

**[0055]** According to some embodiments, said caustic liquid comprises a dispersant. According to some further embodiments, said dispersant is naphthalene sulfonate.

**[0056]** According to some embodiments, said polyester fibers or filaments are fibers or filaments comprising polyethylene terephthalate (PET) yarn.

**[0057]** According to some embodiments, said backing layer comprises foam, said foam having a density ranging from about 2 oz per square yard to about 50 oz per square yard. According to some further embodiments, said backing layer comprises a polyurethane foam. According to some embodiments, said backing layer comprises a viscoelastic foam material. According to some embodiments, said backing layer comprises adhesive. According to some further embodiments, said adhesive is a foamed adhesive. According to some embodiments, said adhesive is not a foamed adhesive.

**[0058]** According to some embodiments, the polyester fiber or filament comprises the modifier in an amount from about 0.5% to about 16% by weight. According to some embodiments, the polyester fiber or filament comprises the modifier in an amount of less than, greater than, or equal to about 1%, 2%, 3%, 4%, 5%, 6%, 7%, 8%, 9%, 10%, 11%, 12%, 13%, 14%, 15%, or 16% by weight. According to some embodiments, the polyester fiber or filament comprises the modifier in an amount from about 1% to about 15%, about 3% to about 14%, about 5% to about 12%, or about 8% to about 10% by weight. Preferably, the polyester fiber or filament comprises the modifier in an amount from about 8% to about 10%. According to some embodiments, the modifier is a branched polyester. According to some embodiments, the modifier is polybutylene adipate terephthalate (PBAT).

**[0059]** According to some embodiments, the polyester yarn comprises continuous filaments. According to some further embodiments, the continuous filaments are bulked continuous filaments.

**[0060]** According to some embodiments, the method further comprises the step of providing said polyester yarn, wherein said polyester fibers or filaments are extruded fibers or filaments obtained by melt extrusion of a molten polymer, said polymer comprising said crystallinity-reducing modifier, and drawing said extruded filaments so as to obtain a crystallinity of less than 30%.

**[0061]** According to some embodiments, the polyester yarn exhibits increased dyeability compared to a polyester yarn comprising polyester fibers or filaments that have the same degree of crystallinity, but lack the modifier. According to some further embodiments, the increase in dyeability is at least about 1% to at least about 300%. According to some further embodiments, the increase is at least 1% to at least 25%.

**[0062]** According to some embodiments, the polyester fibers or filaments comprise recycled polyester. According to some embodiments, the recycled polyester is recycled PET. In an embodiment, the recycled PET has been recovered

from carpet waste or plastic bottles. According to some embodiments, the polyester fibers or filaments comprise recycled PET and virgin PET, and wherein the ratio of recycled PET to virgin PET is from about 99:1 to about 1:99.

**[0063]** According to a third aspect of the invention, a cushioned rug is provided, said cushioned rug being prepared by any of the above methods.

**[0064]** FIG. **1** shows a schematic cross-sectional view of a cushioned rug **2** according to one embodiment of the present invention. As shown in FIG. **1**, the cushioned rug **2** is a layered structure comprising a top layer of face fabric **4**, and a backing layer **6**.

**[0065]** In the illustrated embodiment of FIG. **1**, the backing layer **6** comprises a single layer of foam. However, in other embodiments, the backing layer **6** may be a composite of multiple foam layers with an optional fabric layer on the bottom. For example, backings of various densities and/or thicknesses may be secured together to produce various cushioning effects. These foams may also be embossed to create a pattern in the backing. In particular embodiments, the density of the foam may be 2 oz per square yard to 50 oz per square yard. In particular embodiments, the foam may have a thickness of up to 1". In an embodiment, the foam is in the form of a non-skid layer. In particular embodiments, the foam is viscoelastic foam or polyurethane foam. The foam can also be produced out of natural and synthetic latex rubber.

**[0066]** The backing layer **6** may be a foamed adhesive, which is secured to the face fabric **4** by its own adhesive properties. In an alternate embodiment, the foam may be a layer of foam material which has been laminated to the face fabric **4**.

**[0067]** In an embodiment, the cushioned rug has an area from about 0.2-10 $m^2$. In an embodiment, the cushioned rug has an area from about 0.3-2 $m^2$.

**[0068]** FIG. **2** illustrates schematically one potential carpet construction of the face fabric **4**, or carpet, portion of FIG. **1**. It is generally designated by reference numeral **21**. The carpet **21** includes face yarn **22**, which is tufted into a mesh, woven, or spunbonded fabric known as a primary backing **25**. The primary backing **25** has pile yarns **22** tufted therethrough extending outwardly from one face, a primary backcoating or precoat **23** on the opposite face, and at least one secondary backcoating or main coat (frequently called a skip coat) **24**. Other layers may also be associated with the carpet **1**.

**[0069]** The primary backcoating or precoat **23** generally comprises carboxylated latex (e.g., a styrene-butadiene-based latex), PVC (polyvinylchloride), EVA (ethylene-vinyl acetate), or other polymer-based material, and the secondary backcoating **24** may also include these same polymers. This primary and/or secondary backcoating may be foamed polymer. In an embodiment, the primary and/or secondary backcoating is a foam which is not an adhesive. One or both of the primary backcoatings **23** and secondary backcoating(s) **24** can include a filler material. The most common filler is a mineral filler, such as calcium carbonate, although other fillers, such as alumina trihydrate, bauxite, magnesium hydroxide, or the like, may be utilized. In certain situations, calcium carbonate can be used with other common materials such as metal salts. The carpet **1** may be produced with the filler in one or both of the primary backcoating **23** and secondary backcoating(s) **24** comprising waste carpeting as all or part of the filler. As an alternative, only one single backcoating may be provided instead of a primary and secondary backcoating. Like the primary backcoating in the first alternative, this single backcoating will also anchor the pile yarns in the primary backing. This single backcoating may be composed of the same material as set out for the primary and secondary backcoating.

**[0070]** In making the carpet **1**, generally, the fiber tufts are tufted through a woven or non-woven fabric, which is the primary backing **25**. The part of the tufts on the exposed surface of the carpet comprises the face fiber or face yarn **2**. A back-coating **23** is applied to the back of the tufted structure to lock in the tufts. Next, a woven or non-woven secondary backing **24** is laminated to the back of the primary backing **25** to give the carpet added dimensional stability.

**[0071]** The primary backing is a supportive scrim through which the tufts are tufted, and frequently is polyolefin, such as polyethylene or polypropylene; however, other materials such as polyester (including, for example, PET) can be used. For example, slit tapes made from PET may be used. The secondary backing is a fabric that is adhered behind the primary backing, sandwiching therein the back of the tufts with the adhesive material. The secondary backing is frequently made of polypropylene; however other backing types, such as jute, PVC (polyvinyl chloride), polyurethane, and PET, can be used. The secondary backing may be a non-woven fabric, including, but not limited to, spun-bond, wet-laid, melt-blown, and air-entangled.

**[0072]** A filler material, such as calcium carbonate, and an adhesive material are generally applied to the backside of the tufted carpet backing as a slurry in various concentrations. There is almost always more filler than adhesive material. For example, a representative filler-to-adhesive ratio can comprise about 80 percent by weight ("wt %" or "%") calcium carbonate to about 20 wt % adhesive. While calcium carbonate is one of the most commonly employed filler materials, it should be recognized by those skilled in the art to which this disclosure pertains that carpets containing other filler materials can be used in the processes described herein.

**[0073]** The adhesive material functions to bind the tufts with the backing. The adhesive material can include a latex, such as a carboxylic-styrene-butadiene rubber, styrene-butadiene rubber (SBR), natural rubber latex, vinyl acetate ethylene copolymers (VAE or EVA), other natural or synthetic rubbers, urethanes or polymers such as PET. While latex is one of the most commonly employed adhesive materials for holding tufts to the carpet backing, it should be recognized by those skilled in the art to which this disclosure pertains that carpets containing other adhesives can be used in the processes described herein.

**[0074]** A wide variety of different polyesters may be used in the yarn. For example, the polyester can comprise a PET polymer such as LASER-k® PET (available from DAK Americas), NAN YA® PET (Nan Ya Plastics Corporation, America), other PET polymers, or combinations thereof. PET can be produced, for example, by a transesterification reaction of dimethyl terephthalate and ethylene glycol, or by esterification of terephthalic acid and ethylene glycol. PET may be provided from both virgin and recycled resins. In an embodiment, the PET comprises recycled PET that is recovered from soda and water bottles. The PET may be in flake or pellet form in any of the embodiments described herein. Further, a single polyester or a blend of two or more polyesters may be used. Unless otherwise noted, the poly-

ester used in any of the embodiments of the invention may be virgin, recycled, or a blend thereof.

**[0075]** The fibers may be formed from the polymer by any method known in the art to produce fibers from a single polyester or from a blend. The polymer can be extruded to have any shape or dimension suitable to polymeric carpet fibers. Moreover, the carpet fibers can undergo any post-spinning processes generally recognized as useful in the preparation of polymeric carpet fibers. The fibers may be as-spun or heat-set. By "fibers", reference is made to items, recognized in the art as fibers, such as continuous filaments, monofilaments, staple fibers, and the like. The fibers can be round or have other shapes, such as octalobal, delta, sunburst (also known as sol), scalloped oval, trilobal, tetra-channel (also known as quatra-channel), scalloped ribbon, ribbon, starburst, and the like. The fibers may also be solid, hollow, or multi-hollow. The fibers can be used to make yarns, and the fibers or yarns can be used to prepare a number of materials, particularly carpets, rugs, mats, and the like.

**[0076]** The fibers of the present invention may further comprise other components, such as, without limitation, finishing agents, delusterants, viscosity boosters, optical brighteners, matting agents (e.g., titanium oxide), thermal stabilizing agents (e.g., phosphorous compounds), anti-oxidative agents (e.g., hindered phenol), anti-static agents, pigments, ultra-violet blocking agents, and combinations thereof. In an embodiment, the fibers do not comprise at least one component selected from the group consisting of finishing agents, delusterants, viscosity boosters, optical brighteners, matting agents, thermal stabilizing agents, anti-oxidative agents, anti-static agents, pigments, and ultra-violet blocking agents.

**[0077]** The yarns may be prepared according to any method for preparing yarns recognized in the art as being useful therefore. For example, the yarn of the invention could be partially oriented yarn, spun drawn yarn, textured yarn, friction false-twisted yarn, and bulk continuous filament ("BCF") yarn. Preferred steps in preparing BCF yarn includes spinning (e.g., extruding, cooling, and coating filaments), single stage or multi-stage drawing (such as with heated rolls, heated pin or hot fluid assist) at a defined temperature and draw ratio, annealing, bulking, entangling, optionally relaxing, and winding the filaments on a package for subsequent use.

## Discussion and Examples

**[0078]** One improvement for reducing the amount of time and energy required to properly dye polyester fibers is a modifier that is mixed into the polymer of the fiber before the fiber is created, such as during an extrusion process. One such modifier is polybutylene adipate terephthalate (PBAT) (available from BASF SE, Ludwigshafen, Germany, under the Ecoflex® brand). One genus of suitable modifiers are branched polyester modifiers.

**[0079]** The PBAT modifier acts by adding amorphous zones to the structure of the fiber. Generally, a fiber with decreased crystallinity, and therefore with more amorphous zones, will exhibit greater dyeability than a fiber having a greater degree of crystallinity, even if the fiber is otherwise identical. The amorphous zones provide more locations in the fiber for the dye to be taken up. While these amorphous zones decrease crystallinity and thus fiber tenacity, this disadvantage is offset by the increased take up of the dye by the fiber. By using the modifier and increasing the take-up of the dye by the fiber (i.e. increasing the dyeability of the fiber), achieving the desired shade occurs more quickly and less dye is required in the vat, or less time and machine energy are required, to dye the fiber. As a result, the fiber (or a rug containing the fiber) can spend less time in the beck-dyeing vat. In a cushioned rug, this results in less dye being taken up by the backing, and less dye that must be removed from the backing prior to being provided to the consumer.

**[0080]** Advantageously, a scouring process for removing excess dye from a beck-dyed PET washable rug after dyeing has been completed. The scouring process involves submerging the dyed rugs in a vat of caustic chemicals, such as soda ash or sodium hydroxide, which act to remove excess dye from the fibers. This scouring process can be improved by adding dispersant chemicals, such as naphthalene sulfonate, to the vat.

**[0081]** The present inventors have found that by using a modifier in a PET fiber that allows for less dye to be used in the vat, or for faster dyeing, thereby reducing the amount of dye taking up by the backing, in combination with a scouring process using both caustic and dispersant chemicals to remove excess dye, it is possible to beck dye rugs made with PET fibers without the resultant rug having an undesirably stained backing or causing crocking or transfer of dye to the floor. In addition, the rugs are washable by the consumer. The inventors are the first to combine a pre-dyeing fiber modifier with a post-dyeing scouring process using both caustic and dispersant chemicals. By reducing the amount of dye required for the dyeing step, and then removing excess dye after the dyeing step, the inventors have invented a beck-dyed PET rug, and process for making the same, that is colorfast and washable. The following method describes the process of making a cushioned rug using PET yarn and a PBAT modifier; one of skill in the art will readily recognize that the method may be practiced with different polyesters and modifiers.

**[0082]** One method for producing fibers of the current invention using recycled polyester bottles is via a Multiple Rotating Screw (MRS) extruder, as described in U.S. Pat. No. 8,597,553, which is hereby incorporated by reference in its entirety. This process produces bulked continuous filament (BCF).

**[0083]** A BCF (bulked continuous filament) manufacturing process, according to the particular embodiment, may generally be broken down into four steps: (1) preparing flakes of polyester polymer from post-consumer bottles for use in the process; (2) passing the flakes through an extruder that melts the flakes and purifies the resulting polymer; (3) feeding the polyester polymer into a spinning machine, and (4) adding a modifier into the spinning machine, where the spinning machine turns the polyester polymer (and modifier into filament or fiber for use in manufacturing yarns for carpets and rugs.

**[0084]** As may be understood from FIG. **3**, in particular embodiments, the MRS extruder includes a first single-screw extruder section **410** for feeding material into an MRS section **420** and a second single-screw extruder section **440** for transporting material away from the MRS section.

**[0085]** In particular embodiments, after the PET polymer has been extruded and purified by the above-described extrusion process, the molten polymer is cooled into pellets These pellets are then melted and fed into a BCF (or "spinning") machine. PBAT is also added to the spinning

machine, which is configured to turn the molten polymer and PBAT into bulked continuous filament. If using virgin polymer (such as virgin PET), no purification step would be performed, and pellets of the virgin polymer would be added directly to the spinning machine.

**[0086]** In particular embodiments, the modifier is combined with the PET at a loading percentage from 1-16%. In a further embodiment, the modifier is combined with the PET at a loading percentage of 8%.

**[0087]** The spinning machine extrudes molten polymer through small holes in a spinneret in order to produce yarn filaments from the polymer. The molten polymer cools after leaving the spinneret. The yarn is then taken up by rollers and ultimately turned into filaments that are used to produce carpet and rugs. In various embodiments, the yarn produced by the spinning machine may have a tenacity between about 2 gram-force per unit denier (gf/den) and about 9 gf/den. In particular embodiments, the resulting yarn has a tenacity of at least about 2 gf/den. In particular embodiments, the spinning is performed at a temperature within the range of 220° C.-350° C. In a further embodiment, the spinning is performed at 280° C.

**[0088]** Step 5: Preparing Cushioned Rug

**[0089]** The yarn is tufted to a primary backing to form a "face fabric." The tufted carpet is taken to a coater where liquid foam or adhesive material is pumped directly onto the back of the carpet. As the carpet moves under the applicator roller, the backing material is scraped or gauged to the desired thickness. The carpet may pass through a preheat oven to allow a pattern to be embossed into the backing material. The material is then taken through a heated oven or alternate energy source to cure the foam or adhesive to form a cushioned rug.

**[0090]** Step 6: Beck-Dyeing

**[0091]** The cushioned rug is then cut and sewn and put into a batch size suitable to be beck-dyed in a vat of disperse dye. The size of the batch is dependent on the capacity of the beck machine. The rugs are loaded into the beck and desired ambient water level is added. Water content is at a range of a 3/1 ratio up to a 20/1 ratio to the weight of the rugs. Disperse dye is then added to the beck. The beck water is then heated at a controlled rate up to 212F causing the dye to adhere to the fiber. The rugs are circulated in the beck until the dye is evenly distributed on the fiber. The dye water is drained and the beck is refilled with water for a rinse cycle. The rinse water is then drained. The rinse cycle can be repeated as necessary. If the rugs require scouring, the beck will fill with water again to begin the scouring cycle. If the rugs do not require scouring, the rugs will move to the drying process.

**[0092]** Step 7: Scouring

**[0093]** Following beck-dyeing, if necessary, the cushioned rug is scoured so as to remove excess dye. After the dyeing and rinsing process, the beck is filled with water again. Caustic liquid, such as a liquid comprising soda ash or sodium hydroxide is added to the beck. The caustic liquid may include a dispersant. In an embodiment, the dispersant is naphthalene sulfonate. In an embodiment, the caustic liquid is at a pH from 7.5-11. The rugs are circulated in the beck in a water temperature ranging from ambient up to 212° F. The scouring water is then drained and the beck goes back into rinsing mode before the rugs are moved to the drying process.

**[0094]** It is known that trace levels of dye may cause staining when the rug is in use, particularly in humid environments. Scouring with caustic liquid and a dispersant may allow removal of this excess residual trace level of dye to a further extent, even completely, which scouring step itself constitutes a separate, independent aspect of the present invention.

**[0095]** In alternate embodiments, the caustic liquid is at a pH of about 7.5, 8, 8.5, 9, 9.5, 10, 10.5, or 11. In alternate embodiments, the caustic liquid is at a pH of greater than or less than about 7.5, 8, 8.5, 9, 9.5, 10, 10.5, or 11.

## Alternate Embodiments

**[0096]** Non-MRS Extrusion System

**[0097]** In particular embodiments, the process may utilize a polymer flow extrusion system other than the MRS extruder described above. The alternative extrusion system may include for example, a twin screw extruder, a multiple screw extruder, a planetary extruder, or any other suitable extrusion system. The process may include a plurality of any combination of any suitable conical screw extruders (e.g., four twin screw extruders, three multiple screw extruders, etc.).

**[0098]** Variations on Mixing Polyester Polymer and Modifier

**[0099]** In some alternate embodiments, there is no step of cooling the purified, melted PET into pellets. In this alternate embodiment, the melted components can be fed directly into a suitable spinning machine to be combined with the modifier and turned into fiber. Recycled PET flake is fed into the extruder from one feeder and the modifier is fed into the extruder from another feeder.

**[0100]** In an alternate embodiment, recycled PET pellets are fed into the extruder from one feeder and the modifier is fed into the extruder from another feeder.

**[0101]** In an alternate embodiment, virgin PET pellets are fed into the extruder from one feeder and the modifier is fed into the extruder from another feeder.

**[0102]** In an alternate embodiment, recycled PET pellets and modifier are mixed together in one feeder before melting, and the pellet mixture is fed into the extruder.

**[0103]** In an alternate embodiment, virgin PET pellets and modifier are mixed together in one feeder before melting and the pellet mixture is fed into the extruder.

**[0104]** In an alternate embodiment, recycled PET pellets are mixed with virgin PET pellets and fed into the extruder from one feeder and the modifier is fed into the extruder from another feeder.

**[0105]** In an alternate embodiment, recycled PET pellets, virgin PET pellets, and the modifier are mixed together in one feeder before melting and the pellet mixture is fed into the extruder.

**[0106]** In all of these variations, other additives may be used, such as delusterants, colorants, stabilizers, etc., as discussed previously.

## CONCLUSION

**[0107]** Many modifications and other embodiments of the inventions set forth herein will come to mind to one skilled in the art to which these inventions pertain having the benefit of the teachings presented in the foregoing descriptions. Therefore, it is to be understood that the inventions are not to be limited to the specific embodiments disclosed and that

modifications and other embodiments are intended to be included within the scope of this disclosure. Although specific terms are employed herein, they are used in a generic and descriptive sense only and not for purposes of limitation.

**1**. A rug, comprising

a) a textile face fabric comprising a primary backing and a polyester yarn tufted therethrough, said polyester yarn comprising polyester fibers or filaments, said fibers or filaments having an average percent crystallinity of less than about 30%, and said fibers or filaments comprising a crystallinity-reducing modifier; and

b) a backing layer secured to the textile face fabric,

wherein the part of the tufted polyester yarn located on the exposed surface of the rug comprises dyed face yarn.

**2**. The rug of claim **1**, wherein the part of the tufted polyester yarn located on the side opposite the exposed surface of the rug comprises at least partly undyed yarn.

**3**. The rug of claim **1**, wherein said polyester fibers or filaments comprise polyethylene terephthalate (PET).

**4**. The rug of claim **1**, wherein said backing layer comprises foam, said foam having a density ranging from about 2 oz per square yard to about 50 oz per square yard.

**5**. The rug of claim **1**, wherein the polyester fiber or filament comprises the modifier in an amount from about 0.5% to about 16% by weight.

**6**. The rug of claim **1**, wherein the modifier is polybutylene adipate terephthalate (PBAT).

**7**. The rug of claim **1**, wherein the polyester yarn comprises bulked continuous filaments.

**8**. The rug of claim **1**, wherein the polyester yarn exhibits increased dyeability compared to a polyester yarn comprising polyester fibers or filaments that have the same degree of crystallinity but lack the modifier.

**9**. The rug of claim **1**, wherein the polyester fibers or filaments comprise recycled PET and virgin PET, and wherein the ratio of recycled PET to virgin PET is from about 99:1 to about 1:99.

**10**. The rug of claim **1**, wherein the rug is beck-dyed.

**11**. The rug of claim **9**, wherein the textile face fabric and the backing layer have been dyed simultaneously.

**12**. A method of manufacturing a cushioned rug, said method comprising:

(a) providing a greige fabric comprising a primary backing and a polyester yarn tufted therethrough, said polyester yarn comprising polyester fibers or filaments, said fibers or filaments having a percent crystallinity of less than about 30%, and said fibers or filaments comprising a crystallinity-reducing modifier;

(b) securing a backing layer to the greige fabric, so as to form an intermediate rug;

(c) beck-dyeing the intermediate rug with disperse dye, so as to form a dyed rug; and

(d) scouring the dyed rug with a caustic liquid wherein step c comprises evenly distributing the disperse dye on the part of the tufted polyester yarn located on the exposed surface of the rug.

**13**. The method of claim **12**, wherein said polyester fibers or filaments are fibers or filaments comprising polyethylene terephthalate (PET) yarn.

**14**. The method of claim **12**, wherein said backing layer comprises foam, said foam having a density ranging from about 2 oz per square yard to about 50 oz per square yard.

**15**. The method of claim **12**, wherein the polyester fibers or filaments comprise the modifier in an amount from about 1% to about 16% by weight.

**16**. The method of any one of claim **12**, wherein the modifier is polybutylene adipate terephthalate (PBAT).

**17**. The method of claim **12**, wherein the polyester yarn comprises bulked continuous filaments.

**18**. The method of claim **12**, further comprising the step of providing said polyester yarn, wherein said polyester fibers or filaments are extruded fibers or filaments obtained by melt extrusion of a molten polymer, said polymer comprising said crystallinity-reducing modifier, and drawing said extruded filaments so as to obtain a crystallinity of less than 30%.

**19**. The method of claim **12**, wherein the polyester yarn exhibits increased dyeability compared to a polyester yarn comprising polyester fibers or filaments that have the same degree of crystallinity, but lack a modifier.

**20**. The method of claim **12**, wherein the polyester fibers or filaments comprise the modifier in an amount from about 1% to about 16% by weight.

**21**. A rug, comprising

a) a textile face fabric comprising a primary backing and a polyester yarn tufted therethrough, said polyester yarn comprising polyester fibers or filaments, said fibers or filaments having an average percent crystallinity of less than about 30%, and said fibers or filaments comprising a crystallinity-reducing modifier; and

b) a secondary backing layer secured to the textile face fabric, wherein the polyester fibers or filaments comprise recycled PET recovered from carpet waste or plastic bottles, wherein the polyester yarn comprises bulked continuous filaments, wherein the modifier is polybutylene adipate terephthalate (PBAT) in an amount from about 0.5% to about 16% by weight, and wherein the rug is beck-dyed,

wherein the part of the tufted polyester yarn located on the exposed surface of the rug comprises dyed face yarn.

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