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(54) **IRIDESCENT FABRICS FROM POLYAMIDE YARNS**

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(57) **ABSTRACT**

An iridescent fabric comprises a cationic-dyeable nylon polymer yarn and an acid-dyeable nylon polymer yarn. The acid dyeable yarn has greater than 35 amine end group (AEG_{acid}) gram equivalents per 1000 kilograms polymer.

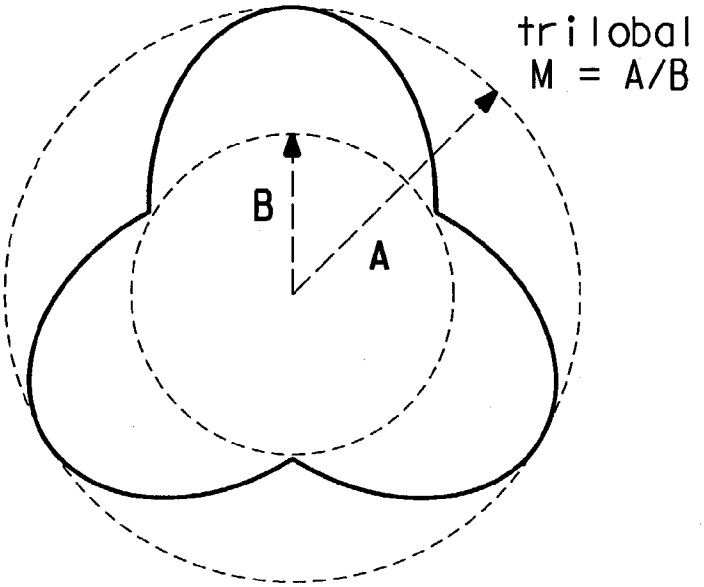

FIG. 1a

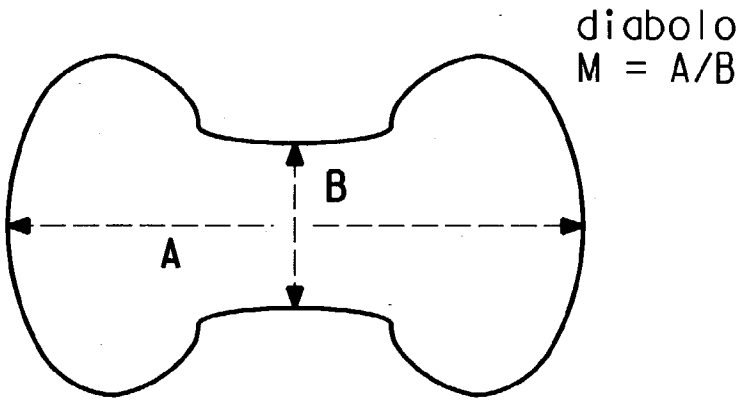

FIG. 1b

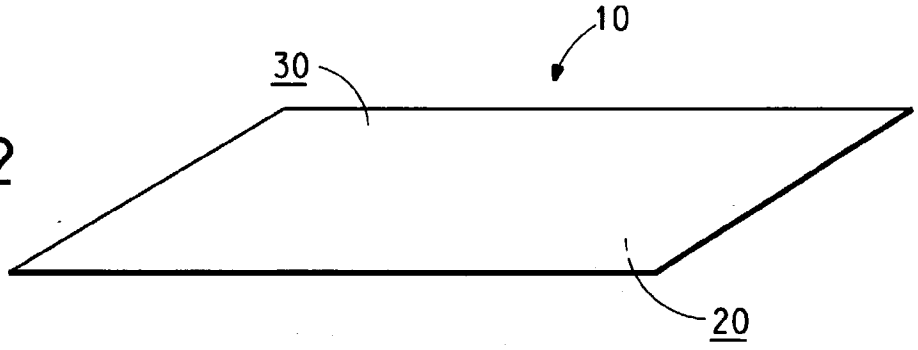

FIG. 2

IRIDESCENT FABRICS FROM POLYAMIDE YARNS

CROSS REFERENCE(S) TO RELATED APPLICATION(S)

[0001] This application claims benefit of priority from Provisional Application No. 60/351,023 filed Jan. 23, 2002.

TECHNICAL FIELD

[0002] The present invention relates to a fabric which exhibits an iridescent appearance. The fabric comprises a cationic-dyeable polyamide yarn and an acid dyeable polyamide yarn.

BACKGROUND ART

[0003] Iridescent fabrics are known. These fabrics exhibit an appearance ranging from a two color effect to a rainbow of colors. In general the color of iridescent fabrics is detemined by the viewing angle. Iridescent fabrics used in apparel applications are viewed from a plurality of angles as the garment conforms to the body of the wearer. As a result, more than one apparent color predominates for the viewer of the garment.

[0004] U.S. Pat. No. 5,741,590 to Kobsa et al. discloses an iridescent fabric. The Kobsa fabric includes a single bicomponent multifilament yarn which is of circular cross-section with a concentric sheath (mantle) and core. The sheath and core portions of the Kobsa bicomponent filaments are of acid-dyeable nylon 66 and basic-dyeable nylon 66. Alternatively, the sheath and core portions of the Kobsa bicomponent filaments are respectively, acid-dyeable nylon 66 and basic-dyeable polyester (a polyethylene terephthalate polymer containing 2 weight percent of dimethyl ester of 5-sulfoisophthalic acid). In either case of the Kobsa filament, the sheath and the core portion are dyed together in the same dye bath but separately receptive to different dyestuffs. Moreover, Kobsa depends upon bicomponent filament spinning which involves complex and expensive bicomponent spin packs. These packs are needed for feeding two molten polymer streams and combining the streams accordingly into the appropriate geometry.

[0005] U.S. Pat. No. 6,279,356 B1 to Takahashi et al. discloses the warp knitting of yarns to obtain fabric color tone by interference and the effects of "improved luster and iridescence". The Takahashi fabrics are warp knits and all are preferably comprised of a black colored base weave yarn or a base weave yarn of a color complementary to the color of the insertion weave yarns. The yarns may be either natural fibers, synthetic fibers such as polyester or nylon, or semi-synthetic fibers such as rayon or acetate. Takahashi's methods to achieve these color effects entail multiple steps of coloration of the polymer prior to spinning as well as conventional dyeing steps for the fabric. Examples of dyeing include use of a cationic dye for the polyester filaments for the base weave, and use of a basic dye and disperse dye used together for separate dyeing of polyester filaments for the insertion weave. In either case, cationic dyes are used. However, cationic dyes are rarely used in nylon yarn apparel applications, because of the limited range of the cationic dye color palette available and the lack of inherent cationic dyeability of standard nylon.

[0006] Other known means to achieve iridescence in textile materials are disclosed by U.S. Pat. No. 6,326,094 B1 to Asano et al. Asano discloses a complex alternating laminated filament structure made from laminated layers of different organic polymers having a different refractive index and which provide for reflection and interference of visible light or reflection of ultraviolet and infrared radiation. These effects can be used in textiles to create colors which vary in hue and intensity depending upon the angle of viewing. The methods of Asano et al. require expensive and precision plural component spinning packs and multiple polymer streams to prepare the alternate laminations of layers of different organic polymers to make laminated synthetic filaments of this type.

[0007] Known iridescent fabrics are made from acid dyeable and cationically dyeable synthetic polymer fibers. In general, the iridescence in such known fabrics is achieved with multifilament yarns comprised of circular cross section filaments of acid dyeable nylon and cationically dyeable polyester, for example. In addition, acid dyeable nylon with cationically dyeable nylon could be used in the same manner, where one of the yarns has an extra bright luster plated to the fabric face. However, such prior art iridescent fabrics of substantially all nylon fabric employ standard acid dye nylon yarns. Such standard acid dye nylon yarns do not retain the acid dye particularly well, which allows more of the acid dye to stain the cationic-dyeable yarn. Thus, dyeing these prior art fabrics in a single dye bath requires dyeing auxiliary chemicals to prevent reaction between the two classes of dyes.

SUMMARY OF THE INVENTION

[0008] The iridescent fabrics of the invention comprise a deeply acid dyeing nylon yarn wherein the deeply dyeing property is obtained using an enhanced level of amine end groups. This enables the fabric to be dyed in a single dye bath without using dyeing auxiliary chemicals to prevent reaction of the acid and the cationic dyes. The deeply acid dyeing nylon polymer yarns used herein react rapidly and completely with acid dyes in the dye bath making the acid dyes unavailable for reaction with any other dyestuff present. As a result, cross staining with the cationic dyeing yarn minimized and the need to use dye auxiliary chemicals is reduced, if not eliminated.

[0009] Thus, the present invention allows for the use of cationic dyes with nylon, which, as noted above, is rarely done. Consequently, the iridescent fabrics of the invention are substantially all nylon, with optionally a portion of spandex elastomer fibers. The fabrics of the present invention are very well suited to textile applications demanding a substantially all nylon fabric, e.g., pantyhose and many new seamless garments.

[0010] Moreover, since the use of deeply acid dyeing nylon polymer yarns minimzes cross staining with cationic dyeing yarns, the iridescent fabrics of the invention may be dyed in a single bath using an acid dye and a cationic dye. Thus, the present invention allows for the fabric to be dyed in a single step, without reliance upon multiple step yarn dyeing.

[0011] In addition, the method for making an iridescent fabric of the present invention is based on conventional

nylon melt spinning technology and does not rely upon complex multi-component spin packs or mass colored polymers.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] **FIG. 1A** is a cross-sectional view of a trilobal shaped fiber, taken normal to the long axis of a single polyamide fiber in a yarn, used to make the fabric according to the invention.

[0013] **FIG. 1B** is a cross-sectional view of a diablo shaped fiber, taken normal to the long axis of a single polyamide fiber in a yarn, used to make the fabric according to the invention.

[0014] **FIG. 2** is a perspective view of a portion of a fabric according to the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0015] The instant invention is an iridescent textile fabric. Preferred fabrics are knit hosiery and seamless knit fabrics. The fabric of the present invention is shown generally at **10** in **FIG. 2**. The fabric comprises two polyamide, multifilament yarns. The yarns are combined after fabric construction. The iridescent fabrics of the invention are two-sided; that is, a single component yarn predominates on one face of the fabric. Thus, the iridescent fabric is constructed such that one yarn is substantially predominate on a first face **20** of the fabric and the second yarn is substantially predominate on a second face **30** of the fabric, represented in **FIG. 2**. The iridescent appearance exhibited by the fabric of the invention may be one of contrasting colors or complementary colors.

[0016] The multifilament, polyamide yarns are a cationic-dyeable (also referred to as base-dyeable) nylon polymer yarn and an acid-dyeable nylon polymer yarn. The yarns are different in dyeability and receptivity for different classes of dyes normally used for nylon. Nylon or aliphatic polyamide yarns, wherein at least about 85% of the polymer chain linkages between repeating amide groups are aliphatic groups, are known to be strongly dyed by the so-called acid dyestuffs, herein normal nylon polymers are referred to as acid-dyeable. Nylon can be rendered resistant to acid dyestuffs by the incorporation of sulfonate groups within the polymer, as described in U.S. Pat. No. 5,164,261. In U.S. Pat. No. 5,164,261, copolymerizing polyamides with a small amount, ca. 1 to 4% by weight, of a sodium salt of 5-sulfoisophthalic acid is taught. Nylon polymers so modified with sulfonate bearing dicarboxylic acids are used to prepare the yarns herein referred to as base-dyeable, cationic-dyeable, or simply cat-dye yarns. This name is due to the chemical group responsible for acid-dye resistance conferring cationic dyeable properties on the yarn. Cationic dyes are known for their application in certain apparel nylon yarns but are more rarely used compared with acid dyes.

[0017] Suitable synthetic polymer fibers which can be processed into acid-dyeable and base-dyeable polyamides and are also melt spinnable with a variety of cross sectional filament shapes according to the invention include: nylon 66 (polyhexamethylene adipamide), nylon 6 (polycaproamide), nylon 7 (polyenanthamide), nylon 612 (polyhexamethylene dodecamide), nylon 11, nylon 12 and copolyamides of nylon 66 and nylon 6, such as polymers from hexamethylene diamine, ε-caprolactam and adipic acid, and polymers prepared from adipic acid, hexamethylene diamine and isophthalic acid, or from adipic acid, hexamethylene diamine and 2-methyl-pentamethylene diamine or 2-ethyl-tetramethylene diamine; copolyamides of nylon 66 containing up to 15% by weight, such as 0.5 to 15% by weight, of polyhexamethylene isophthalamide or poly-(2-methyl)pentamethylene adipamide or poly-(2-ethyl)tetramethylene adipamide and copolyamides of nylon 6 containing up to 15% by weight, such as 0.5 to 15% by weight, of nylon 66.

[0018] Typically, the nylon polymers and copolyamides described in the foregoing paragraph are inherently acid-dyeable. The number of free amine end groups (AEG) in these polymers is at least 25 gram equivalents per 1000 kilograms of nylon polymer. In order to make the polymers more deeply acid dyeing an enhanced level of free amine end groups is desired. A preferred and enhanced AEG level for the acid-dyeable yarn is greater than 35 gram equivalents per 1000 kilograms of nylon polymer. 60 to 130 gram equivalents per 1000 kilograms of nylon polymer is preferred. An amine end group concentration of up to about 130 gram equivalents per 1000 kilograms polymer may be used for the acid-dyeable polymer component to achieve the fabric appearance properties. More particularly, an AEG level of about 70 gram equivalents per 1000 kilograms of nylon polymer for the acid dyeable yarn polymer is most preferred.

[0019] The base-dyeing yarn polymer is prepared with a cationic dye modifier copolymerized in the polymer. U.S. Pat. No. 5,164,261 to Windley, describes the preparation of such cationic dye modified polyamides. In the instant invention it is preferred to modify the polymer during polymerization with from 0.5 to 4 percent of the preferred cationic dye modifier the dimethyl ester of 5-sulfoisophthalic acid. Typically, a weighed quantity of the sodium salt of dimethyl ester of 5-sulfoisophthalic acid is combined with a known amount of the polyamide precursor salt in an autoclave using standard polymerization procedures known in the art. A more preferred amount of cationic dye modified present in the polymer is from about 0.75 to about 3 weight percent as determined by total sulfur analysis of the polymer. This amount of cationic dye modifier is reported as equivalent sulfonate groups. The preferred sulfonate groups concentration is at least 15 gram equivalents per 1000 kilograms polymer up to about 150 gram equivalents per 1000 kilograms polymer, with preferably greater than 30 gram equivalents per 1000 kilograms of polymer. The cationic-dyeable nylon yarn of the preferred iridescent fabric has an amine end group concentration of no greater than 40 gram equivalents per 1000 kilograms polymer. It is preferred to have a difference (ρ) in concentration between sulfonate end groups (S_{cat}) and amine end groups (AEG_{cat}) greater than or equal to zero.

$$\rho = S_{cat} - AEG_{cat} \geq 0 \qquad \text{Equation 1.}$$

[0020] Each yarn comprises filaments having either a circular, noncircular, trilobal or diablo cross sectional shape. A trilobal shape is shown in **FIG. 1A**, and a diablo shape is shown in **FIG. 1B**. The trilobal shape may be further characterized by its modification ratio M in the range from 1.5 to 4. The M ratio is defined as the radius A of the largest escribed circle touching the extremes of the cross section divided by the radius B of the smallest inscribed circle, as

indicated in **FIG. 1A**. An M ratio for the diabolo cross section is in the range from 1.5 to 6 and is defined as the longest length A for the cross section divided by the smallest dimension B, as indicated in **FIG. 1B**.

[**0021**] According to a preferred embodiment of the invention, either of the cationic-dyeable or the acid-dyeable nylon yarns has an extra bright luster, achieved with a polymer delusterant level of no more than 0.1 percent by weight. This bright, more lustrous yarn is predominate on the first face of the fabric. It is preferred to have the bright, high-luster nylon polymer yarn comprise filaments having a non-circular cross sectional shape. The trilobal and diabolo cross sectional shapes are more preferred. The other, duller yarn may have any cross sectional shape. A polyamide yarn having a dull luster is a useful but not essential modification to achieve the iridescent fabric effects of the invention. Dull polymer yarns have a delusterant level of equal or greater than about 0.8 percent by weight; about 1.5% being preferred. Titanium dioxide is a more preferred delustering agent for any of the polyamide polymers disclosed herein. Other delustering agents for polyamide polymers, such as zinc sulfide are also suitable.

[**0022**] The two-sided or layered effect of the fabric is achieved by the ability to plate multiple yarns as is known in the art. Commercially available seamless knitting machines which provide the ability to plate multiple yarns are made by Lonati S.p.a. (Italy) who produce the SANTONI single and double-knit versions of the seamless knitting machine. Seamless knitting machines are also available from San Giacomo and Monarch as is known by the skilled person. In addition to two-sided seamless knit constructions, conventional two-sided hosiery knit construction techniques may used or any other two-sided fabric weaving, warp knitting, circular knitting or flatbed knitting processes are useful ways to make the fabric of the invention.

[**0023**] The yarns of the invention may be prepared by known methods to make FDY (Fully Drawn Yarn), POY (Partially Oriented Yarn), and LOY (Low Oriented Yarn). In the case of FDY (Fully Drawn Yarn), the in-line processing on the spinning machine consists of making several turns round a set of godet rolls (feed rolls), the number of turns being sufficient to prevent slippage over these rolls, then passing the yarn over another set of rolls (draw rolls) rotating at sufficient speed to stretch the yarn by a predetermined amount (the draw ratio), and finally heat setting and relaxing the yarn with a steam-box, before winding up at a speed of 4800 m/min. Optionally, an alternative heat setting method could be used, such as heated rolls, and an additional set of godet rolls may be incorporated between draw rolls and winder to control the tension while the yarn is set or relaxed. Optionally also a second application of spin finish, and/or additional interlacing may be applied before the final winding step

[**0024**] In the case of POY, the additional in-line processing consists only of making a S-wrap over two Godet rolls rotating at the same speed, and then passing the yarn to a high speed winder, in this case running at 4800 m/min. Use of the S-wrap is beneficial to control tension, but not essential. Such a POY may be used directly as a flat yarn for weaving or knitting, or as a feedstock for texturing.

[**0025**] In the case of LOY, the spinning procedure is very similar to POY except that a windup speed of 1000 m/min or below is used. These yarns require further processing via a second stage, e.g. on a conventional draw-twister or draw-wind machine.

[**0026**] The production of yarns of the invention of either polymer type, acid-dyeable and base-dyeable, may follow the same spinning procedures using the known methods as described above. First, a suitable type of polyamide granules may be fed to a melting device, and the molten polymer may be forwarded by a metering pump to a filter pack, and extruded through a spinneret plate containing capillary orifices of a chosen shape to yield the desired filament cross-section at the spinning temperature. These cross-sectional shapes may include circular, non-circular, trilobal and diabolo. Spinning temperatures may be in the range of 270° to 300° C. The bundle of filaments emerging from the spinneret plate may be cooled by conditioned quench air, treated with spin finish (an oil/water emulsion), optionally interlaced, forwarded in an "S-wrap" tension control configuration over two Godet rolls rotating at the same speed and then to a yarn high speed winder, winding on at 4800 meters per minute. The POY so prepared may be optionally used directly as a flat yarn for weaving or knitting or as a feedstock for draw texturing.

[**0027**] Further in accordance with the present invention, there is provided a process for making an iridescent textile fabric. The process comprises dyeing a fabric comprising a cationic-dyeable nylon polymer yarn and an acid-dyeable nylon polymer yarn in a single dye bath. At least one acid dyestuff and at least one cationic dyestuff are present in the dye bath. As noted above for the fabric, a preferred and enhanced AEG level for acid-dyeing polymers used to make the filaments of this invention is greater than 35 gram equivalents per 1000 kilograms of nylon polymer. 60 to 130 gram equivalents per 1000 kilograms of nylon polymer is preferred. An amine end group concentration of up to about 130 gram equivalents per 1000 kilograms polymer may be used for the acid-dyeable polymer component to achieve the fabric appearance properties. More particularly, an AEG level of about 70 gram equivalents per 1000 kilograms of nylon polymer for the acid dyeable yarn polymer is most preferred. This enhanced level of amine end groups enables a fabric to be dyed in a single dye bath without using dyeing auxiliary chemicals to prevent reaction of the acid and the cationic dyes.

TEST METHODS

[**0028**] Nylon polymer relative viscosity (RV) can be measured according to ASTM D789-86 and is the ratio of the viscosity of the solution of 8.4 percent by weight polymer in a solution of 90 percent formic acid and 10 percent water at 25° C. to the viscosity of the formic acid water solution, per se, measured in the same viscosity units and at 25° C.

[**0029**] The nylon polymer amine end group (AEG) concentration and the polymer carboxyl end group concentration were measured by titration methods as described on pages 293-294 of Volume 17 of the "Encyclopedia of Industrial Chemical Analysis" (John Wiley & Sons Inc., 1973). Generally, the method to determine the AEG concentration involves taking a weighed sample of polymer, yarn or fabric; 1 to 2 grams depending upon the level of amine end groups expected and dissolving this sample in 50 ml of phenol and methanol mixture (8:2 volume ratio). This

solution is filtered to remove delusterant and insolubles. This supernatant is made up to 100 ml total volume and titrated with perchloric acid which was standarized against a primary standard alkali. The amount of standarized perchloric acid consumed in the titration is recorded versus a potentiometric or acid indicator end point, as is known in the art. This volume of perchloric acid is related to the amine end group concentration by the weight of sample taken. The AEG level is reported in gram equivalents per 10^6 grams of polyamide.

[0030] Along lines similar to the AEG determination, free carboxylic acid groups is determined by titration with standardized alkali hydroxide. The amount of standardized alkali hydroxide consumed is related, along with the polyamide sample weight, to the number of carboxyl end groups in the polymer. The carboxyl group ends are reported as gram equivalents per 10^6 grams of polyamide.

[0031] The concentration of sulfonate groups in the basic dyeable polymers used in this invention is found via analytical methods known to those in the art. Generally, a weighed sample is taken and dissolved in a suitable solvent system for polyamides. Total sulfur content is determined from total sulfate concentration after oxidation by methods known in the art. Alternatively, x-ray fluorescence methods using calibrated standards are suitable for total sulfur analysis. Total sulfur is assumed to due entirely to the added sulfonate groups during polymerization.

EXAMPLES

Example 1—Part A

[0032] A first nylon multifilament flat (untextured) yarn was prepared with a bright luster, trilobal in cross sectional shape and from polymer modified to provide cationic dyeability. The total yarn decitex was 22 and there were 9 filaments per yarn. This yarn was spun from a nylon 66 polymer (poly-hexamethylene adipamide) containing 1.5% by weight of 5-sulfo-isophthalic acid as the cationic dye modifier. This polymer had a formic acid RV of 31.5, a titanium dioxide delusterant content of 0.02% by weight, the amine end group concentration was 42 gram equivalents per 1000 kg of polymer, and the sulfonate group concentration was 55 gram equivalents per 1000 kg of polymer. Here the difference between sulfonate group ends and amine groups ends for the cationic dyeable yam was given by Equation 1 and was equal to the following:

$$\rho = S_{cat} - AEG_{cat} = 55 - 42 = 13.$$

[0033] This polymer was melted and extruded through a spinneret plate with multiple trilobal capillaries maintained at 279.5° Celsius. The extruded filaments were cooled in a stream of air, converged into a yarn and finished with an oil/water emulsion applied in the known manner. This yarn was first contacted by a feed roll and then to a draw roll assembly. The yarn was drawn 1.5 times. The drawn yarn was wound up at a speed of 4800 meters per minute. This nylon yarn prepared in this manner is dyed easily by cationic dyes. The same yarn is substantially unaffected by normal acid dyes. The tenacity of this yarn was 48 cN/tex, the extension to break was 36.5%, and the boiling water shrinkage was 7.1%. The modification ratio (M) of the trilobal cross section was 1.56 and measured as the ratio of the diameter of the escribed and inscribed circles as in **FIG. 1A**.

[0034] A second yarn was a nylon covered DuPont LYCRA® brand of spandex. This 22 decitex LYCRA® spandex was single-covered at 1600 turns per meter in a standard commercial process. The nylon component was a 26 decitex 14 filament deeply acid dyeing POY which was drawn in a separate step to give a 22 decitex flat (untextured) yarn. The individual filament cross section was circular. This deep acid dye POY was from nylon 66 polymer of 40 RV (formic acid). The amine end group concentration (AEG_{acid}) was enhanced to 70 gram equivalents per 1000 kilograms of polymer by known polymerization methods and the titanium dioxide delusterant content was 1.5% by weight. The covered yarn had stretch properties imparted by the LYCRA® spandex and an appearance determined by the nylon component visible on the surface. This nylon yarn was dyed readily by standard acid dyes and remained unstained by cationic dyes.

[0035] The first nylon yarn and the second (covered) yarn of were knitted together in an alternate course construction, 1×1 selection, on a 400 needle LANATI 404 hosiery machine to form a pantyhose. The structure was alternate course one, with the 22f14 covered flat yarn on one feed and the bright 22f9 flat cationically dyeable yarn on the other. The design was a 1×1 knit tuck selection on the LYCRA® spandex covered yarn. In this construction, the bright 22f9 yarn plates to the front of the garment.

[0036] The garment was then dyed in a single dyebath using two separate dyes, an acid dye, and the other a cationic dye, chosen for their contrasting colors. The cationic dye was a bright red, Maxilon Red 3GLN from CIBA, at 0.4% weight on the cationically dyeable nylon component yarn in the knit garment. The acid dye was a bright turqouise blue acid dye, Acidol br. Blue M-5G from BASF, at 0.4% weight on the acid dyeable nylon component yarn in the knit garment. The dyeing machine was a Roaches Pyrotec 2002 (Roaches International LTD) using 1 liter stainless steel enclosed beakers. At the start, the dye bath and fabric was at 30° C. and the cationic dyes were added along with 5.0% sodium sulfate (Glaubers salt) on total weight of fabric and 0.1% Tinegal MR (a cationic dye retardant for basic dyes from CIBA). The aqueous bath was adjusted to pH 6.0 at a dye liquor to fabric goods ratio of 28:1. The temperature was raised at 1.0° C. per minute to 60° C. and held for 10 minutes. The cooling ramp back to 35° C. was set at 2.5° C. per minute. This was to prevent the cationic dyes from being exhausted onto the cationic dyeable yarn. To this same dyebath the anionic dye was added mixed with 1.0% on total weight of goods of Sandogen NH (a dye retardant for anionic dyes from Clariant). The dye bath temperature was ramped at 1.0° C. per minute to 98° C. and held at this temperature for 45 minutes. Cooling the dye bath to 50° C. was done at 7.0° C. per minute. The knit fabric samples were removed and rinsed in cold water and dried without tumbling.

[0037] This dyed garment was inspected by a panel of dyeing and finishing fabric experts. It was agreed that this garment exhibited a very unusual and attractive iridescent appearance seen on the front side where the high luster yarn was predominant. The fabric color was a basic subdued mauve color which varied strongly with viewing angle, and particularly within the folds of the fabric. The depths of the fabric folds showed a grey-blue color, while the raised portions had a bright pink-hued luster. The component dye

colors, bright red and strident turquoise, did not appear in this garment. The back side of the garment showed some blue shading without the iridescent effect.

Example 1—Part B

[0038] In Part B the yarns, garment construction and the dyeing method were identical to those in Part A with the exception dyestuffs used. The dyestuffs consisted of a bright yellow cationic dye, Maxilon Yellow GL 200% from CIBA, applied at 0.1% weight on weight of the cationic dyeable nylon in the sample and an intense violet acid dye, NYLOSAN Violet F-BL 180% applied at 0.9% weight on weight of the acid-dyable nylon component. The dye procedure was identical to Part A.

[0039] The method of visual assessment in this example was identical to Part A. The finished dyed garment had an overall lilac color, accompanied by fleeting iridescent areas ranging from purple to warm silver. The original bright yellow was not observed and the back of the garment did not show an iridescence.

Example 1—Part C

[0040] The yarns, garment, dyeing method and visual assessment method of Part C were identical to those of Part A. Different dyestuffs were used in Part C and consisted of a sage green cationic dye, a mixture of Sevron Yellow 3RL and Sevron Blue CAN both from YORKSHIRE CHEMICALS. These dyes were applied at 0.2% weight on weight of the cationic dyeable nylon component in the sample. The same intense violet acid dye, NYLOSAN Violet F-BL 180% as used in Part B was applied at a lower concentration 0.2% weight on weight of the acid-dyable nylon component.

[0041] The finished dyed garment had an overall subdued grey color accompanied by lively iridescent areas ranging from mauve to silver. The original sage green color was not observed and the back of the garment did not show any iridescence.

Example 1—Part D

[0042] The yarns, garment, dyeing method and visual assessment method of Part D were identical to those of Part A. Different dyestuffs were used in Part D and consisted of a bright yellow cationic dye, Maxilon Yellow GL 200% from CIBA, applied at 0.2% weight on weight of the cationic-dyeable nylon component in the sample and a bright blue dye, NYLOSAN Blue F-2RFL 160%, applied at a concentration of 1.4% weight on weight of the acid-dyable nylon component.

[0043] The finished dyed garment had an overall lilac color, accompanied by intense, fleeting iridescent areas ranging from purple to warm silver. The original bright yellow was not observable, and the back of the garment did not show an iridescence.

Example 1—Part E

[0044] The yarns, garment, dyeing method and visual assessment method of this example were identical to those of Part A. Different dyestuffs were used in Part E and consisted of a bright yellow cationic dye, Maxilon Yellow GL 200% from CIBA, applied at 0.2% weight on weight of the cationic-dyeable nylon component in the sample and an intense violet acid dye, NYLOSAN Violet F-BL 180%, applied at 0.9% weight on weight of the acid-dyable nylon component.

[0045] The finished garment had a much more speckled appearance rather than an overall basic color of the other garments in Parts A-D. This observation was believed to be due to the strong contrast between the lighter yellow and dark blue components used in Part E. The Part E garment exhibited a strong iridescence and almost metallic sheen. The back of the garment did not show any iridescence.

Example 1—Part F

[0046] Comparative

[0047] In this comparative example, a flat (untextured) POY component substantially the same as that used to make the second yarn of Part A was prepared. The polymer from which this yam was prepared contained 35 gram equivalents of amine end groups per 1000 kilograms (AEG_{acid}) of polymer. All other experimental details, including the dyeing and visual assessment methods, were the same as invention Part E. This comparative example illustrates the effect of using standard acid dye nylon yarns in place of high amine end group concentration deeper dyeing yarns. This lower amine end concentration acid-dyeable yarn does not retain the acid dye so strongly as does a deep-dye yarn, allowing more of the acid dye available to stain the cationic-dyeable yarn.

[0048] After dyeing this garment, considerably more staining of the cationic-dyeable yarn by the blue acid dyestuff resulted in a greyish green color and substantial loss of the iridescent effect.

Example 2

[0049] In this example of the invention a 'seamless' circular knit fabric garment was prepared and dyed according to the dyeing procedure of Example 1, Part A. The prepared garment was comprised of a first yarn, a flat (untextured) POY having a bright luster and comprised of multifilaments with a trilobal cross sectional shape. This flat POY was of 56 decitex total weight and contained 20 filaments. This yarn was spun from a cationic dyeable nylon 66 polymer with an RV (formic acid) of 31.5, a titanium dioxide content of 0.02% by weight, an amine end groups concentration of 42 gram equivalents per 1000 kilograms of polymer and a sulfonate group concentration of 55 gram equivalents per 1000 kilograms of polymer. This yarn was spun through a spinneret plate with a plurality of shaped capillaries in the known manner to give a POY with 20 trilobal cross section filaments per yarn.

[0050] A second yarn was a commercially available sample of deeply acid-dyeing, fully dull luster, circular cross section nylon 66 air-jet textured yarn, of 42 decitex and 46 filaments, covering a 17 decitex DuPont LYCRA® spandex T175. As in Parts A through F of Example 1, the LYCRA® spandex was not necessary to achieve the iridescent visual aesthetic of the invention since it is covered by the dyed nylon yarn. A deep-dye nylon polymer from which this yarn was prepared was identical to that used to prepare the second yarn of Example 1, Part A. The polymer was 40 RV, the amine end group concentration was 70 gram equivalents per 1000 kilograms of polymer and the TiO_2 content was of 1.5

weight percent. This yarn was spun by the conventional POY route and textured via the known means of friction false-twist texturing and then used to cover the LYCRA® spandex in a known manner.

[0051] The first yarn and the second yarn were knitted together on a SANTONI SM8-83 TOP seamless machine, 13 inch 28 gauge, using a single jersey construction, plating to the back. The resulting seamless circular knit garment was dyed by the method of Example 1 using as the cationic dyestuff Maxilon Blue TL at 0.15% weight on weight of cationic-dyeable nylon component and the acid dyes NYLOSAN Bordeaux NBL and NYLOSAN Yellow N7GI at 0.2% and 0.4% respectively by weight on the acid-dyeable nylon component yarn.

[0052] The appearance of the garment was assessed subjectively by a panel of experts. The front of the garment fabric was a fairly uniform reddish brown color. The back face of the garment fabric, to which the bright lustrous yam was plated, had an overall plum-color, with pink shadows, and lustrous flashes of iridescent blue.

[0053] In a variant of this example, the first yarn (50f20 trilobal, cationic dye) was replaced by a POY yarn of 56 decitex, with 26 filaments of diabolo cross-section, the polymer being the same as that of the first yarn. The fabric was made and assessed as above, and also showed the desirable iridescent effect, though this was rated as slightly less intense than that seen with the fabric made using the trilobal yarn.

What is claimed is:

1. An iridescent textile fabric comprising a cationic-dyeable nylon polymer yarn, and an acid-dyeable nylon polymer yarn, wherein said acid-dyeable yarn has greater than 35 amine end group (AEG_{acid}) gram equivalents per 1000 kilograms polymer.

2. An iridescent fabric according to claim 1 wherein said cationic-dyeable nylon polymer yarn has a sulfonate group (S_{cat}) concentration of at least 15 gram equivalents per 1000 kilograms polymer and an amine end group (AEG_{cat}) concentration of no greater than 40 equivalents per 1000 kilograms polymer.

3. An iridescent fabric according to claim 1 wherein said cationic-dyeable nylon polymer yarn comprises a plurality of sulfonate end groups (S_{cat}) and a plurality of amine end groups (AEG_{cat}) wherein the difference (rho) in concentration between sulfonate end groups (S_{cat}) and amine end groups (AEG_{cat}) is according to the following equation: $rho=S_{cat}-AEG_{cat}=0$.

4. An iridescent fabric according to claim 1, wherein either of the cationic-dyeable or the acid-dyeable nylon yarn comprises from 0 to about less than or equal to about 0.1 weight percent titanium dioxide.

5. An iridescent fabric according to claim 4, wherein said cationic-dyeable or the acid-dyeable nylon yarn which comprises from 0 to about less than or equal to about 0.1 weight percent titanium dioxide comprises a plurality of profiled cross section filaments having a trilobal cross-sectional shape.

6. An iridescent fabric according to claim 4, wherein said cationic-dyeable or the acid-dyeable nylon yarn which comprises from 0 to about less than or equal to about 0.1 weight percent titanium dioxide comprises a plurality of filaments having a diablo cross-sectional shape.

7. An iridescent fabric according to claim 5, wherein the nylon yarn which comprises from 0 to about less than or equal to about 0.1 weight percent titanium dioxide comprises a cationic-dyeable yarn.

8. An iridescent fabric according to claim 7, wherein the acid-dyeable nylon comprises a plurality of filaments having a circular cross-sectional shape.

9. A process for making an iridescent fabric comprising: dyeing a fabric comprising a cationic-dyeable nylon polymer yarn and an acid-dyeable nylon polymer yarn in a single dye bath with at least one acid dyestuff and at least one cationic dyestuff present in the dye bath, wherein said acid-dyeable yarn has greater than 35 amine end group (AEG_{acid}) gram equivalents per 1000 kilograms polymer.

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