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(54) **SPUN DYEING CHROMATOGRAPHIC FIBER AND THE PREPARATION METHOD THEREOF**

(57) The present invention discloses a spin-dyed gradient-color fiber and a method for fabricating the same, wherein at least one component of the fiber is spin-dyed. The present invention obtains gradient color via controlling at least one of the following spinning condi-

tions: (1) colorant quantity: continuously varying quantity of at least one colorant metered by colorant meters; (2) output ratio: continuously varying the output ratio of at least one melt extruder; (3) fineness: varying fineness of the fiber in a stretching way, a false-twisting way or another way.

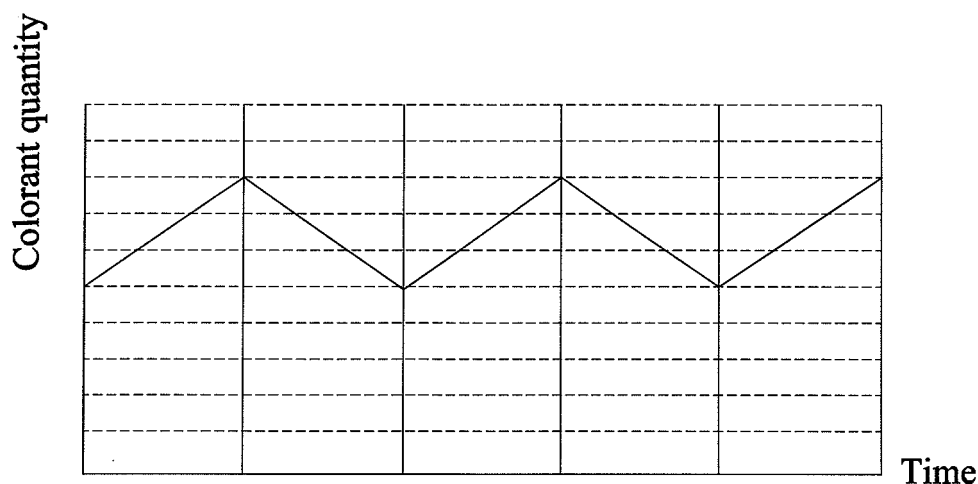


FIG.1

Description

BACKGROUND OF THE INVENTION

5 Field of the Invention

[0001] The present invention relates to a gradient-color fiber and a method for fabricating the same, particularly to a spin-dyed gradient-color thermoplastic fiber and a method for fabricating the same.

10 Description of the Related Art

[0002] Gradient-color fiber and fabric is usually fabricated with a pigment-printing or bath-dyeing method. However, pigment printing and bath dyeing generates a great amount of waste water and causes environmental protection problems.

[0003] A China patent No.CN2564602Y disclosed a fiber gradient-coloring device, which adopts a spray-dyeing method to obtain gradient-color fiber. However, the prior art has lower productivity and poor color fastness.

[0004] A France patent No.FR2682130 disclosed a fiber gradient-coloring technology, wherein fiber are disposed on a supporter and slowly immersed into a dye bath, whereby different parts of fiber are dyed for different lengths of time to have gradient variation of color. However, the prior art is realized with bath dyeing, which generates a great amount of waste water and damages the environment.

[0005] A Canada patent disclosed a fabric gradient-coloring technology, wherein different portions of a fabric are respectively disposed at different altitudes and dyed for different lengths of time via gradually releasing the dye solution to obtain gradient variation of color. However, the prior art is realized with bath dyeing and generates a great amount of waste water.

[0006] Thus, how to fabricate gradient-color fiber without generating massive waste water has been an important subject in the field concerned.

SUMMARY OF THE INVENTION

[0007] One objective of the present invention is to provide a spin-dyed gradient-color fiber and a method for fabricating the same to solve the abovementioned problems, wherein at least one component of fiber is spin-dyed to attain gradient color via controlling at least one spinning condition, whereby a gradient-color fiber can be efficiently produced without generating massive waste water.

[0008] To achieve the abovementioned objective, the present invention proposes a spin-dyed gradient-color fiber and a method for fabricating the same, which are **characterized in that** at least one component of a thermoplastic fiber is spin-dyed with the dye quantity being gradually varied to attain gradient variation of color. The present invention is applied to spin-dyed thermoplastic fiber and realized via controlling at least one of the following spinning conditions:

- (1) Colorant quantity: continuously varying quantity of at least one colorant metered by colorant meters when a monocomponent or a conjugate fiber containing at least two components is spin-dyed in at least one melt extruder;
- (2) Drawing rate: continuously varying the drawing rate of at least one component of a monocomponent or a conjugate fiber containing at least two components when the monocomponent or conjugate fiber is spin-dyed in at least one melt extruder; and
- (3) Output Ratio: continuously varying the output ratio of at least one component of a monocomponent or a conjugate fiber containing at least two components when the monocomponent or conjugate fiber is spin-dyed in at least one melt extruder.

[0009] The thermoplastic fiber used in the present invention is made of a thermoplastic resin selected from a group consisting of polyester resins, polyester copolymers, polyamide resins, polyamide copolymers, polypropylene resins, polypropylene copolymers, polyethylene resins, polyethylene copolymers, and combinations thereof.

[0010] When a thermoplastic fiber is colored with a pigment or dye, the color tint varies with the quantity of the pigment or dye. Via continuously varying the quantity of the pigment or dye, the fiber will have gradient color. The quantity of a pigment or dye is controlled via the following methods:

- (1) Continuously and periodically varying colorant quantities metered by colorant meters;
- (2) Continuously and periodically varying the output ratio of at least one melt extruder when the component is spin-dyed in the melt extruder; and
- (3) A combination of the abovementioned methods.

[0011] Gradient color of a thermoplastic fiber can be alternatively obtained via continuously varying the fineness of the thermoplastic fiber when the thermoplastic fiber is spin-dyed with at least one pigment or dye. The fineness of a thermoplastic fiber can be varied via the following methods:

- (1) Continuously and periodically varying the total output ratio of the melt extruders via continuously and periodically varying the output ratio of at least one of the melt extruders;
- (2) Continuously and periodically varying the drawing rate of the thermoplastic fiber with a stretching method, a false-twisting method or another method; and
- (3) A combination of the abovementioned methods.

[0012] In summary, when at least one component of a thermoplastic fiber is spin-dyed, gradient color of the thermoplastic fiber and the fabric made thereof can be obtained via controlling at least one of the following spinning conditions:

- (1) Colorant quantity: continuously and periodically varying at least one colorant quantity metered by colorant meters;
- (2) Output ratio: continuously and periodically varying the output ratio of at least one melt extruder with the total output ratio remaining constant or varying continuously; and
- (3) Fineness: continuously and periodically varying the fineness of the thermoplastic fiber via a stretching method, a false-twisting method or another method.

[0013] Different methods mentioned above generate different gradient effects. Some methods do not generate obvious variation of hue but only result in variation of color strength. Some methods generate obvious gradient variation of hue. The details thereof are further demonstrated below.

(1) If there is only a single colorant metered by a colorant meter, continuously varying the quantity of the single colorant results in only gradient variation of color strength. If at least two colorants are respectively metered by colorant meters, continuously varying the quantity of at least one of the colorants obtains obvious gradient variation of hue.

(2) Suppose that only a component of a thermoplastic fiber is spin-dyed with at least one pigment or dye. The greater the output ratio of the melt extruder of the spin-dyed component, the deeper the color. The smaller the output ratio of the melt extruder of the spin-dyed component, the lighter the color. Continuously varying the output ratio generates gradient variation of color strength.

[0014] Suppose that at least two components of a thermoplastic conjugate fiber are spin-dyed with an identical colorant (such as a pigment or a dye) and that the concentrations of the pigment or dye are different for the at least two components. The greater the output ratio of the melt extruder of a component spin-dyed with a higher concentration, the deeper the color. The smaller the output ratio of the melt extruder of a component spin-dyed with a higher concentration, the lighter the color. Although the method can generate gradient variation of color strength, the range of color strength variation is limited.

[0015] Suppose that at least two components of a thermoplastic fiber are respectively spin-dyed with different colorants (such as pigments or dyes). The greater the output ratio of the melt extruder of one of the at least two spin-dyed components, the closer the hue of the thermoplastic fiber to that of the component. The smaller the output ratio of the melt extruder of one of the at least two spin-dyed components, the closer the hue of the thermoplastic fiber to that of another component. When the proportion of the components is varied continuously, the hue of the thermoplastic fiber is also varied continuously. Via continuously varying the output ratios of the components, a gradient-color conjugate fiber having hue variation is obtained.

(3) Suppose that at least one component of a thermoplastic fiber is spin-dyed with at least one colorant (such as a pigment or dye). The smaller the drawing rate in stretching or false-twisting, the greater the fineness (the Denier count) of the fiber, and the higher the color strength. The greater the drawing rate in stretching or false-twisting, the smaller the fineness (the Denier count) of the fiber, and the lower the color strength. Via continuously varying the drawing rate, a fiber with gradient variation of color strength is obtained.

[0016] In the present invention, when a component of a fiber is spin-dyed, the total amount of all the colorants used in the component is 0.01-10 wt % of the component.

[0017] The present invention is characterized in obtaining gradient variation of color strength of a fiber via continuously and periodically varying at least one colorant quantity metered by colorant meters, continuously and periodically varying the output ratio of at least one melt extruder, or continuously and periodically varying the fineness of a fiber with a stretching method, a false-twisting method or another method. The present invention applies to any thermoplastic fiber.

Via controlling at least one spinning condition of a spin-dyed component of a fiber, the present invention can mass-fabricate a gradient-color fiber and a fabric thereof without generating massive waste water.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018]

Fig. 1 shows a linear relationship of spinning time and a colorant quantity metered by a colorant meter;
 Fig.2 shows a nonlinear relationship of spinning time and a colorant quantity metered by a colorant meter;
 Fig.3 shows a linear relationship of spinning time and fiber fineness;
 Fig.4 shows a nonlinear relationship of spinning time and fiber fineness;
 Fig.5 shows a linear relationship of spinning time and an output ratio of a melt extruder; and
 Fig.6 shows a nonlinear relationship of spinning time and an output ratio of a melt extruder.

DETAILED DESCRIPTION OF THE INVENTION

[0019] Below, embodiments are used to demonstrate the technical contents of the present invention in detail. However, it should be understood that the embodiments are only to exemplify the present invention but not to limit the scope of the present invention.

[0020] The present invention is **characterized in that** a thermoplastic fiber having at least one component spin-dyed in a melt extruder with at least one pigment or dye obtains gradient variation of color appearance via at least one of the following methods:

- (1) Gradually varying at least one colorant quantity metered by at least one colorant meter according to a linear relationship (as shown in Fig.1) or a nonlinear relationship (as shown in Fig.2), wherein in Fig.1 and Fig.2, the horizontal axis denotes the spinning time, and the vertical axis denotes the colorant quantity metered by the colorant meter (the effect thereof is further described in Embodiment I);
- (2) Continuously varying the drawing rate of a fiber in stretching or false twisting to gradually vary the fineness of the fiber and obtain gradient variation of the color strength of the fiber, wherein the fineness can be varied according to a linear relationship (as shown in Fig.3) or a nonlinear relationship (as shown in Fig.4), and wherein in Fig.3 and Fig.4, the horizontal axis denotes the spinning time, and the vertical axis denotes the fineness of the fiber;
- (3) Gradually varying the output rate of a melt extruder of a monocomponent fiber according to a linear relationship (as shown in Fig.5) or a nonlinear relationship (as shown in Fig.6), wherein in Fig.5 and Fig.6, the horizontal axis denotes the spinning time, and the vertical axis denotes the output rate;
- (4) Gradually varying the output ratio of at least one melt extruder of a component of a conjugate fiber according to a linear relationship (as shown in Fig.5) or a nonlinear relationship (as shown in Fig.6) (the effect thereof is further described in from Embodiment II to Embodiment VI);
- (5) A combination of at least two of the abovementioned methods.

[0021] Via continuously varying the colorant quantity metered by at least one colorant meter, continuously varying the output ratio of at least one melt extruder, or continuously varying the fineness of a fiber with a stretching method, a false-twisting method or another method, the present invention can obtain a gradient-color fiber.

[0022] In the present invention, when a component of a fiber is spin-dyed, the total amount of all the colorants used in the component is 0.01-10wt % of the component. In the present invention, a fiber can be fabricated with various spinning methods, including a melt spray spinning method and methods to fabricate a staple fiber, a monocomponent filament yarn, a multicomponent filament yarn, and BCF (Bulked Continuous Filament). The fiber can be further processed with a stretching method or a false-twisting method.

[0023] In the present invention, the spin-dyed fiber is made of thermoplastic polymeric materials. Each of the components of a fiber is made of a material selected from a group consisting of polyester resins, polyester copolymers, polyamide resins, polyamide copolymers, polypropylene resins, polypropylene copolymers, polyethylene resins, polyethylene copolymers, and combinations thereof. A heat stabilizer, an antifire agent or an antiseptic agent may be added to any single component according to requirement.

[0024] In the present invention, a conjugate fiber can be fabricated with various conjugate methods, including a side-by-side compositing method, a sheath-core compositing method, a sea-island compositing method, a deformed sheath-core compositing method, and a partially-protruding sheath-core compositing method.

[0025] Below, embodiments are used to exemplify the effects of the present invention. In the embodiments, comparison of hue (L , a , b) or color intensity is realized via sampling a fiber fabricated in a specified time interval, winding the fiber sample around a white cardboard, obtaining hue or color intensity with a Datacolor SF600 spectrometer under a D65

light source having wavelengths of 400-700nm, wherein L denotes the lightness in a CIE model, a the chroma from green to red, b the chroma from blue to yellow.

Embodiment I

[0026] In Embodiment I, a spin-dyed gradient-color monocomponent polyester fiber is used to exemplify the effect of the present invention. The abovementioned fiber contains 0.3 wt % of a semi-dull PET resin and is spin-dyed by two colorant meters.

[0027] In this embodiment, Colorant Meter A meters a colorant Solvent Blue 45 by a concentration of 0.4wt% of the fiber in the initial 480 seconds. Then, the concentration of the colorant Solvent Blue 45 is gradually increased to 0.56wt% of the fiber. Colorant Meter B meters a colorant Carbon Black by a concentration of 0.6wt% of the fiber in the initial 480 seconds. Then, the concentration of the colorant Carbon Black is gradually decreased to 0.36wt% of the fiber.

[0028] The spinning conditions include a fusion temperature of 285°C, a spinning speed of 3200m/min, POY (Partially Oriented Yarn), and 3.3 Denier per PET fiber.

[0029] The following table shows the comparison of hue (L , a , b) and color intensity of the initial fiber and the fiber sampled at a section 25600m away from the beginning (at the 480th second from the beginning). The table shows that a gradient-color fiber is obtained via continuously varying the concentrations of colorants metered by colorant meters.

Hue (L , a , b), Color strength	L	a	b	Color intensity
Sample taken at the beginning	25.60	-0.41	-3.77	As Standard
Sample taken at a section 25600m away from the beginning	27.55	-0.38	-6.53	83.7%

Embodiment II

[0030] In Embodiment II, a full-stretched spin-dyed gradient-color conjugate polyester fiber is used to exemplify the effect of the present invention. Component A of the conjugate fiber is made of a polyester resin and spin-dyed with a colorant Pigment Red 214 by a concentration of 0.6wt% of Component A. Component B of the conjugate fiber is made of a polyester resin without spin-dyeing.

[0031] At the beginning, the output ratio of Component A from Melt Extruder A is 60% of the total output of the conjugate fiber. The output ratio of Component A is gradually increased to 70% of the total output of the conjugate fiber within 90 seconds. At the beginning, the output ratio of Component B from Melt Extruder B is 40% of the total output of the conjugate fiber. The output ratio of Component B is gradually decreased to 30% of the total output of the conjugate fiber within 90 seconds.

[0032] The spinning conditions include a fusion temperature of 285°C, a spinning speed of 4500m/min, a drawing rate of 290%, and 3.0 Denier per PET conjugate fiber at the beginning.

[0033] The following table shows the comparison of hue (L , a , b) and color intensity of the initial fiber and the fiber sampled at a section 6750m away from the beginning (at the 90th second from the beginning). The table shows that a gradient-color conjugate fiber is obtained via continuously varying the output ratio of the components.

Hue (L , a , b), Color strength	L	a	b	Color intensity
Sample taken at the beginning	50.58	42.21	17.81	As Standard
Sample taken at a section 6750m away from the beginning	49.48	43.30	19.44	114.3%

Embodiment III

[0034] In Embodiment III, a spin-dyed gradient-color conjugate polyester fiber is used to exemplify the effect of the present invention.

[0035] Component A of the conjugate fiber is made of a polyester resin and spin-dyed with a colorant titanium dioxide by a concentration of 1.7wt% of Component A. Component B of the conjugate fiber is made of a polyester resin and spin-dyed with a colorant Solvent Red 135 by a concentration of 0.8wt% of Component B.

[0036] At the beginning, the output ratio of Component A from Melt Extruder A is 30% of the total output of the conjugate fiber. The output ratio of Component A is gradually increased to 50% of the total output of the conjugate fiber within 120 seconds. At the beginning, the output ratio of Component B from Melt Extruder B is 70% of the total output of the conjugate fiber. The output ratio of Component B is gradually decreased to 50% of the total output of the conjugate fiber

within 120 seconds.

[0037] The spinning conditions include a fusion temperature of 285°C, a spinning speed of 3200m/min, POY (Partially Oriented Yarn), and 4.5 Denier per PET conjugate fiber at the beginning.

[0038] The following table shows the comparison of hue (L , a , b) and color intensity of the initial fiber and the fibers respectively sampled at sections 3200m and 6400m away from the beginning (at the 60th second and 120th second from the beginning). The table shows that a gradient-color conjugate fiber is obtained via continuously varying the output ratios of the components.

Hue (L , a , b), Color strength	L	a	b	Color intensity
Sample taken at the beginning	53.95	43.69	28.61	As Standard
Sample taken at a section 3200m away from the beginning	57.16	41.97	24.77	72.0%
Sample taken at a section 6400m away from the beginning	60.61	38.79	20.85	49.9%

Embodiment IV

[0039] In Embodiment IV, a spin-dyed gradient-color conjugate polyester fiber is used to exemplify the effect of the present invention.

[0040] Component A of the conjugate fiber is made of a polyester resin and spin-dyed with a colorant Pigment Blue 15:3 by a concentration of 0.48wt% of Component A and a colorant titanium dioxide by a concentration of 0.3wt% of Component A. Component B of the conjugate fiber is made of a polyester resin and spin-dyed with a colorant Carbon Black by a concentration of 0.96wt% of Component B.

[0041] At the beginning, the output ratio of Component A from Melt Extruder A is 50% of the total output of the conjugate fiber. The output ratio of Component A is gradually increased to 80% of the total Output of the conjugate fiber within 180 seconds. At the beginning, the output ratio of Component B from Melt Extruder B is 50% of the total output of the conjugate fiber. The output ratio of Component B is gradually decreased to 20% of the total output of the conjugate fiber within 180 seconds.

[0042] The spinning conditions include a fusion temperature of 285°C, a spinning speed of 3200m/min, POY (Partially Oriented Yarn), and 5.0 Denier per PET conjugate fiber at the beginning.

[0043] The following table shows the comparison of hue (L , a , b) and color intensity of the initial fiber and the fibers respectively sampled at sections 3200m, 6400m and 9600m away from the beginning (at the 60th second, the 120th second and the 180th second from the beginning). The table shows that a gradient-color conjugate fiber is obtained via continuously varying the output ratios of the components.

Hue (L , a , b), Color strength	L	a	b	Color intensity
Sample taken at the beginning	25.76	-0.89	-1.8	As Standard
Sample taken at a section 3200m away from the beginning	26.21	-1.44	-3.18	94.8%
Sample taken at a section 6400m away from the beginning	29.51	-2.95	-6.39	71.6%
Sample taken at a section 9600m away from the beginning	31.27	-4.1	-9.74	61.5%

Embodiment V

[0044] In Embodiment V, a spin-dyed gradient-color conjugate polyester fiber is used to exemplify the effect of the present invention.

[0045] Component A of the conjugate fiber is made of a polyester resin and spin-dyed with a colorant Pigment Red 214 by a concentration of 0.51wt% of Component A and a colorant titanium dioxide by a concentration of 0.3wt% of Component A. Component B of the conjugate fiber is made of a polyester resin and spin-dyed with a colorant Disperse Violet 57 by a concentration of 0.17wt% of Component B and a colorant titanium dioxide by a concentration of 0.3wt% of Component B.

[0046] At the beginning, the output ratio of Component A from Melt Extruder A is 50% of the total output of the conjugate fiber. The output ratio of Component A is gradually increased to 80% of the total output of the conjugate fiber within 180 seconds. At the beginning, the output ratio of Component B from Melt Extruder B is 50% of the total output of the conjugate fiber. The output ratio of Component B is gradually decreased to 20% of the total output of the conjugate fiber within 180 seconds.

[0047] The spinning conditions include a fusion temperature of 285°C, a spinning speed of 3200m/min, POY (Partially Oriented Yarn), and 4.5 Denier per PET conjugate fiber at the beginning.

[0048] The following table shows the comparison of hue (L , a , b) and color intensity of the initial fiber and the fibers respectively sampled at sections 3200m, 6400m and 9600m away from the beginning (at the 60th second, the 120th second and the 180th second from the beginning). The table shows that a gradient-color conjugate fiber is obtained via continuously varying the output ratios of the components.

Hue (L , a , b), Color strength	L	a	b	Color intensity
Sample taken at the beginning	39.78	19.22	-7.85	As Standard
Sample taken at a section 3200m away from the beginning	40.92	23.94	-0.42	109.5%
Sample taken at a section 6400m away from the beginning	41.31	26.72	5.40	122.6%
Sample taken at a section 9600m away from the beginning	43.38	30.36	10.26	123.1%

Embodiment VI

[0049] In Embodiment VI, a spin-dyed gradient-color conjugate polyamide (Nylon) fiber is used to exemplify the effect of the present invention.

[0050] Component A of the conjugate fiber is made of a polyamide resin and spin-dyed with a colorant Pigment Blue 15:3 by a concentration of 0.5wt% of Component A. Component B of the conjugate fiber is made of a polyamide resin and spin-dyed with a colorant Pigment Green 7 by a concentration of 0.5wt% of Component B.

[0051] At the beginning, the output ratio of Component A from Melt Extruder A is 50% of the total output of the conjugate fiber. The output ratio of Component A is gradually increased to 80% of the total output of the conjugate fiber within 180 seconds. At the beginning, the output ratio of Component B from Melt Extruder B is 50% of the total output of the conjugate fiber. The output ratio of Component B is gradually decreased to 20% of the total output of the conjugate fiber within 180 seconds.

[0052] The spinning conditions include a fusion temperature of 2805°C, a spinning speed of 4300m/min, an drawing rate of 250%, and 4.5 Denier per polyamide conjugate fiber at the beginning.

[0053] The following table shows the comparison of hue (L , a , b) and color intensity of the initial fiber and the fibers respectively sampled at sections 4300m, 8600m and 12900m away from the beginning (at the 60th second, the 120th second and the 180th second from the beginning). The table shows that a gradient-color conjugate fiber is obtained via continuously varying the output ratios of the components.

Hue (L , a , b), Color strength	L	a	b	Color intensity
Sample taken at the beginning	45.91	-29.22	-18.28	As Standard
Sample taken at a section 4300m away from the beginning	46.29	-26.63	-24.27	93.0%
Sample taken at a section 8600m away from the beginning	45.53	-24.77	-26.88	95.1%
Sample taken at a section 12900m away from the beginning	47.51	-24.05	-30.54	83.4%

[0054] The embodiments described above are only to exemplify the present invention but not to limit the scope of the present invention. Any equivalent modification or variation according to the claims and specification of the present invention is to be also included within the scope of the present invention.

Claims

1. A spin-dyed gradient-color fiber **characterized in**
that said spin-dyed gradient-color fiber is a thermoplastic fiber containing more than one component, and
that at least one of said more than one component is spin-dyed, and
that said spin-dyed gradient-color fiber has gradient variation of color strength, and
that said gradient variation of color strength is realized via continuously and periodically varying concentrations of colorants of said spin-dyed gradient-color fiber.

2. The spin-dyed gradient-color fiber according to claim 1, wherein each of said more than one component of said thermoplastic fiber is made of a material selected from a group consisting of polyester resins, polyester copolymers, polyamide resins, polyamide copolymers, polypropylene resins, polypropylene copolymers, polyethylene resins, polyethylene copolymers, and combinations thereof.
3. A fabric made of said spin-dyed gradient-color fiber claimed in claim 1.
4. A method for fabricating a spin-dyed gradient-color fiber, **characterized in** using a colorant meter to spin-dye a monocomponent thermoplastic fiber or a multicomponent conjugate thermoplastic fiber containing at least two components, and controlling said colorant meter to continuously and periodically varying concentration of a colorant to provide gradient color for said thermoplastic fiber.
5. The method for fabricating a spin-dyed gradient-color fiber according to claim 4, wherein said monocomponent thermoplastic fiber or each of said components of said thermoplastic fiber is made of a material selected from a group consisting of polyester resins, polyester copolymers, polyamide resins, polyamide copolymers, polypropylene resins, polypropylene copolymers, polyethylene resins, polyethylene copolymers, and combinations thereof.
6. A method for fabricating a spin-dyed gradient-color fiber, **characterized in** using at least two colorant meters to spin-dye a monocomponent thermoplastic fiber or a multicomponent conjugate thermoplastic fiber containing at least two components, and controlling at least one of said colorant meters to continuously and periodically varying concentration of at least one colorant to provide gradient color for said thermoplastic fiber.
7. The method for fabricating a spin-dyed gradient-color fiber according to claim 6, wherein said monocomponent thermoplastic fiber or each of said components of said thermoplastic fiber is made of a material selected from a group consisting of polyester resins, polyester copolymers, polyamide resins, polyamide copolymers, polypropylene resins, polypropylene copolymers, polyethylene resins, polyethylene copolymers, and combinations thereof.
8. A method for fabricating a spin-dyed gradient-color fiber, **characterized in** performing spin-dyeing in at least one melt extruder to spin-dye a monocomponent thermoplastic fiber or a multicomponent conjugate thermoplastic fiber containing at least two components, and continuously and periodically varying an drawing rate in stretching or false twisting said thermoplastic fiber to provide gradient color for said thermoplastic fiber.
9. The method for fabricating a spin-dyed gradient-color fiber according to claim 8, wherein said monocomponent thermoplastic fiber or each of said components of said thermoplastic fiber is made of a material selected from a group consisting of polyester resins, polyester copolymers, polyamide resins, polyamide copolymers, polypropylene resins, polypropylene copolymers, polyethylene resins, polyethylene copolymers, and combinations thereof.
10. A method for fabricating a spin-dyed gradient-color fiber, **characterized in** performing spin-dyeing in a melt extruder to spin-dye a monocomponent thermoplastic fiber or a multicomponent conjugate thermoplastic fiber containing at least two components, and continuously and periodically varying a output ratio of said melt extruder to provide gradient color for said thermoplastic fiber.
11. The method for fabricating a spin-dyed gradient-color fiber according to claim 10, wherein said monocomponent thermoplastic fiber or each of said components of said thermoplastic fiber is made of a material selected from a group consisting of polyester resins, polyester copolymers, polyamide resins, polyamide copolymers, polypropylene resins, polypropylene copolymers, polyethylene resins, polyethylene copolymers, and combinations thereof.
12. A method for fabricating a spin-dyed gradient-color fiber, **characterized in** respectively performing spin-dyeing in at least two melt extruders with identical colorants wherein at least one said extruder has a colorant concentration different to colorant concentrations of other said extruders to spin-dye a monocomponent thermoplastic fiber or a multicomponent conjugate thermoplastic fiber containing at least two components, and continuously and periodically varying a output ratio of at least one of said melt extruders to provide gradient color for said thermoplastic fiber.
13. The method for fabricating a spin-dyed gradient-color fiber according to claim 12, wherein said monocomponent thermoplastic fiber or each of said components of said thermoplastic fiber is made of a material selected from a group consisting of polyester resins, polyester copolymers, polyamide resins, polyamide copolymers, polypropylene resins, polypropylene copolymers, polyethylene resins, polyethylene copolymers, and combinations thereof.

14. A method for fabricating a spin-dyed gradient-color fiber, **characterized in** respectively performing spin-dyeing in at least two melt extruders with different colorants to spin-dye a monocomponent thermoplastic fiber or a multicomponent conjugate thermoplastic fiber containing at least two components, and continuously and periodically varying a output ratio of at least one of said melt extruders to provide gradient color for said thermoplastic fiber.

15. The method for fabricating a spin-dyed gradient-color fiber according to claim 14, wherein said monocomponent thermoplastic fiber or each of said components of said thermoplastic fiber is made of a material selected from a group consisting of polyester resins, polyester copolymers, polyamide resins, polyamide copolymers, polypropylene resins, polypropylene copolymers, polyethylene resins, polyethylene copolymers, and combinations thereof.

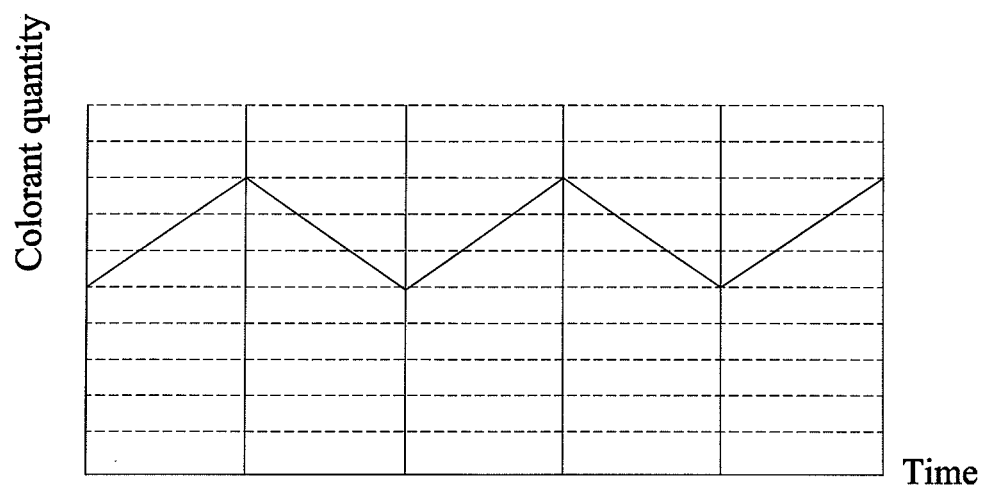


FIG.1

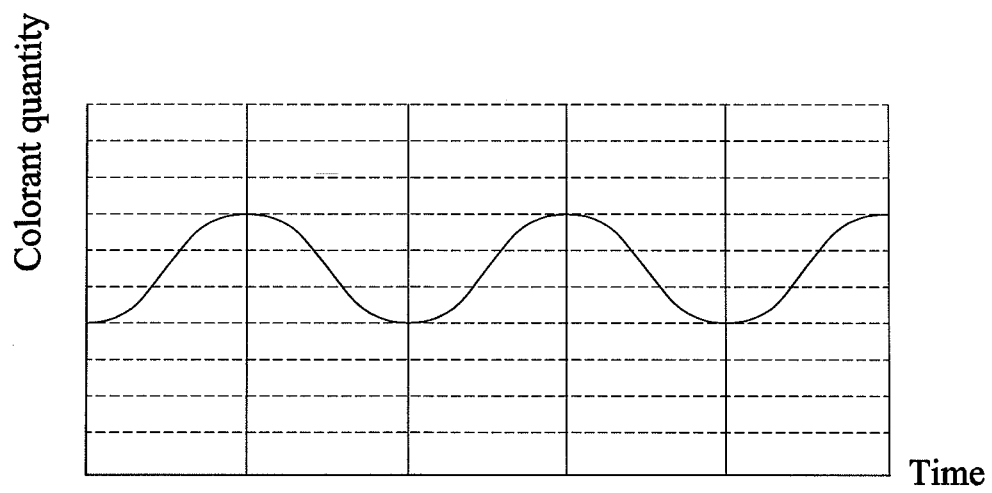


FIG.2

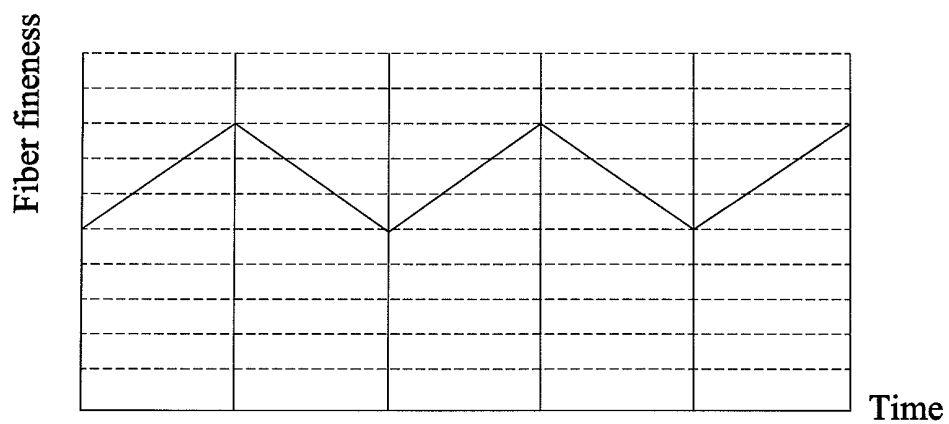


FIG.3

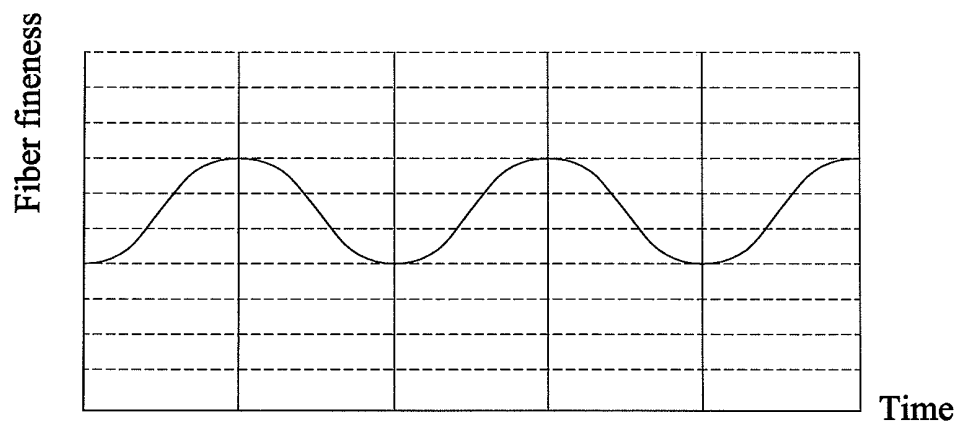


FIG.4

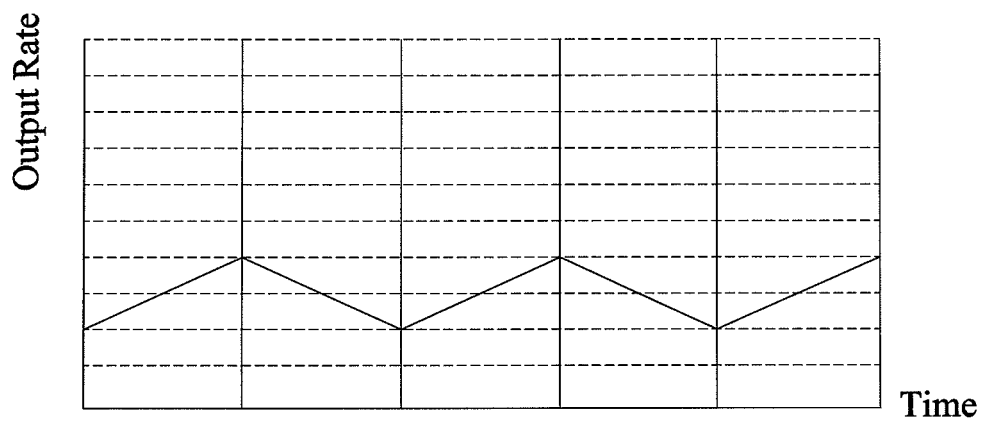


FIG.5

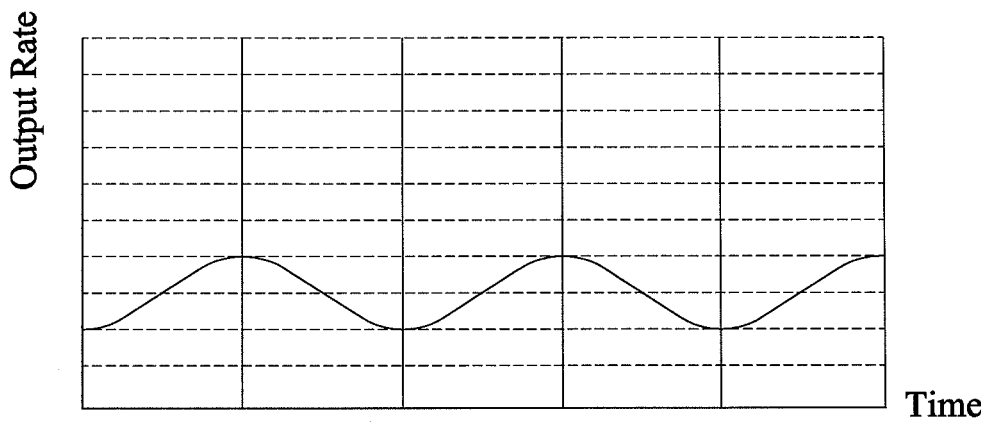


FIG.6

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2008/001402

A. CLASSIFICATION OF SUBJECT MATTER		
See extra sheet		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols)		
IPC: D01F, D01D		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
CNKI, CPRS, WPI, EPODOC, PAJ: mass w colo?ration, sp?n+ w dyeing, sp?ndyeing, mass w colo?red w dyeing, internal w dyeing, dope? w spin+, dope? w spun, colo?r+, dye+, pigment?, chang+, variat+, alter+, melt+, multiple w colo?r+, multicolor?r+, shade?		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US4011192A(IMPERIAL CHEM IND LTD), 08 Mar. 1977(08.03.1977), claims 1, 13, column 1 lines 4-37, column 3 line 51	1-7
A		8-15
X	EP0494432A2(BASF AG et al.), 15 Jul. 1992(15.07.1992), claims 1-6	1-3, 8, 9
A		4-7, 10-15
☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
* Special categories of cited documents: “A” document defining the general state of the art which is not considered to be of particular relevance “E” earlier application or patent but published on or after the international filing date “L” document which may throw doubts on priority claim (S) or which is cited to establish the publication date of another citation or other special reason (as specified) “O” document referring to an oral disclosure, use, exhibition or other means “P” document published prior to the international filing date but later than the priority date claimed “T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention “X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone “Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art “&” document member of the same patent family		
Date of the actual completion of the international search 02 Apr. 2009(02.04.2009)		Date of mailing of the international search report 14 May 2009 (14.05.2009)
Name and mailing address of the ISA/CN The State Intellectual Property Office, the P.R.China 6 Xitucheng Rd., Jimen Bridge, Haidian District, Beijing, China 100088 Facsimile No. 86-10-62019451		Authorized officer SONG Lin Telephone No. (86-10)62084562

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2008/001402

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO0034555A1(DU PONT DE NEMOURS & CO E I), 15 Jun. 2000(15.06.2000), claims 1-7, page 2 line 25-page 3 line 29	1-7
A		8-15
X	CN1170050A(BASF CORP), 14 Jan. 1998(14.01.1998), claims 70-75, page 5 lines 6-13	1-7
A		8-15

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INTERNATIONAL SEARCH REPORT
 Information on patent family members

International application No.

PCT/CN2008/001402

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
US4011192A	08.03.1977	NL7117184A	19.06.1972
		DE2162308A	13.07.1972
		FR2118677A	28.07.1972
		AU3686171A	21.06.1973
		GB1359478A	10.07.1974
		AU450718B	18.07.1974
		CA1004820A	08.02.1977
		JP47014411A	09.08.1972
		CA2058830A	08.07.1992
EP0494432A2	15.07.1992	JP4289217A	14.10.1992
		EP0494432A3	27.01.1993
		None	
WO0034555A1	15.06.2000		
CN1170050A	14.01.1998	EP0794222A2	10.09.1997
		AU1503497A	11.09.1997
		US5800746A	01.09.1998
		US5833893A	10.11.1998
		US5834089A	10.11.1998
		US5869551A	09.02.1999
		US5889089A	30.03.1999
		US5955516A	21.09.1999
		US5973032A	26.10.1999
		AU724515B	21.09.2000
		US6232371B1	15.05.2001
		US6416859B1	09.07.2002
		CN1160489C	04.08.2004
		EP0794222B1	17.05.2006
		DE69735865E	22.06.2006
		DE69735865T2	16.11.2006
		US5964231A	12.10.1999
		US5961734A	05.10.1999

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2008/001402

CLASSIFICATION OF SUBJECT MATTER

D01F 1/04 (2006.01) i
D01F 1/06 (2006.01) i
D01D 5/08 (2006.01) i

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- CN 2564602 Y [0003]
- FR 2682130 [0004]