



US 20080164632A1

(19) **United States**(12) **Patent Application Publication****Wang**(10) **Pub. No.: US 2008/0164632 A1**(43) **Pub. Date: Jul. 10, 2008**(54) **DNA COUNTERFEIT-PROOF FIBER
TOGETHER WITH SPINNING NOZZLE AND
METHOD USED TO PRODUCED THEREOF****Publication Classification**(51) **Int. Cl.**
D01F 1/10 (2006.01)(52) **U.S. Cl.** **264/184; 425/67**(57) **ABSTRACT**

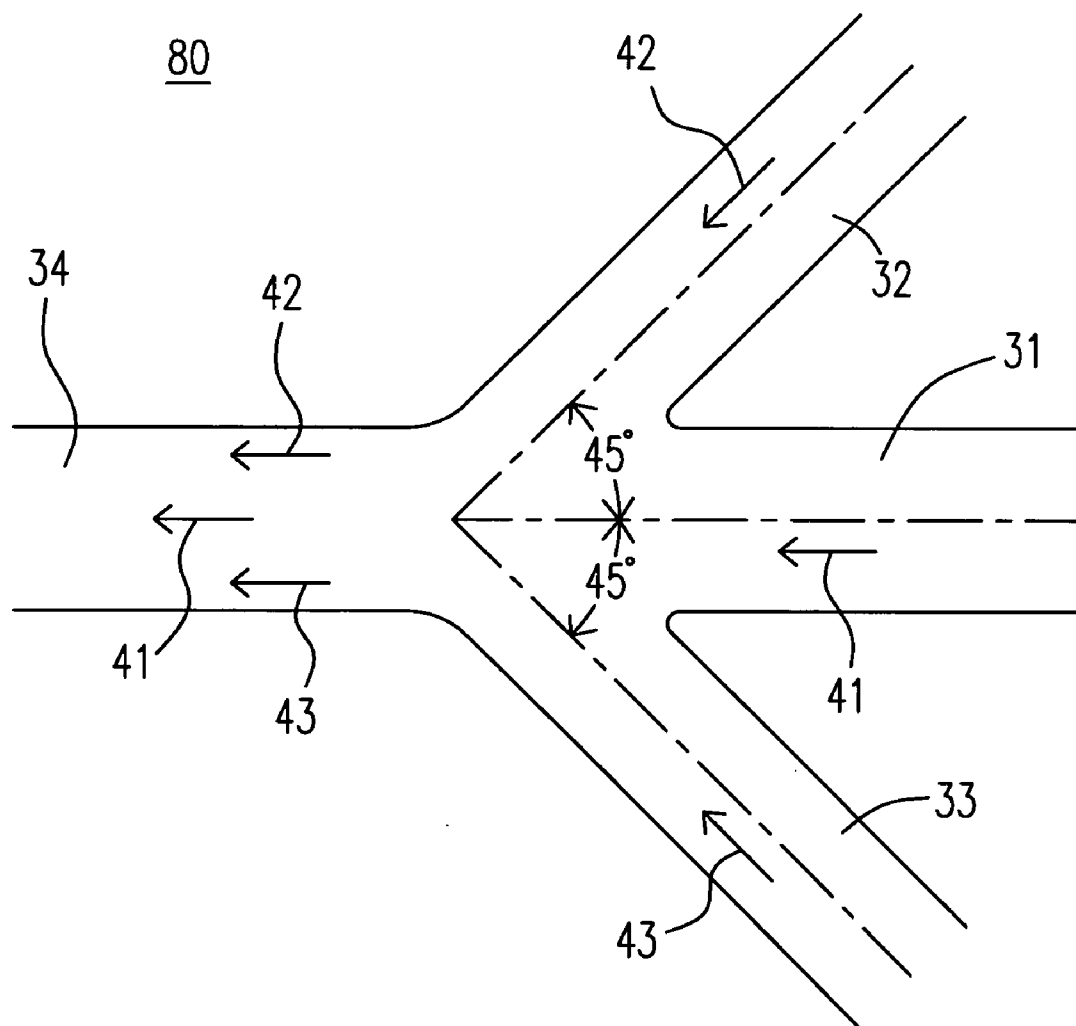
A spinning nozzle for producing the synthetic fibers and a method for producing a DNA counterfeit-proof fiber by the spinning nozzle are provided. The spinning nozzle includes a polymer solution inflow passage and a pair of water inflow passages located at the both sides of the polymer solution inflow passage, wherein the polymer solution inflow passage and the water inflow passages are converged into a mixing outflow passage and a synthetic fibers are produced at the outlet of the mixing outflow passage. A method for producing a DNA counterfeit-proof fiber by the spinning nozzle includes the steps as follows. First, mixing a plurality of the DNA microcapsules with a material solution to produce a polymer solution. Then, to form a converging interface between the polymer solution and the two streams of acid-hydrolysis waters. Afterwards, causing the flowing polymer solution to converge with the two streams of acid-hydrolysis waters for producing the DNA counterfeit-proof fiber.

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Jan. 9, 2007 (TW) 096100855



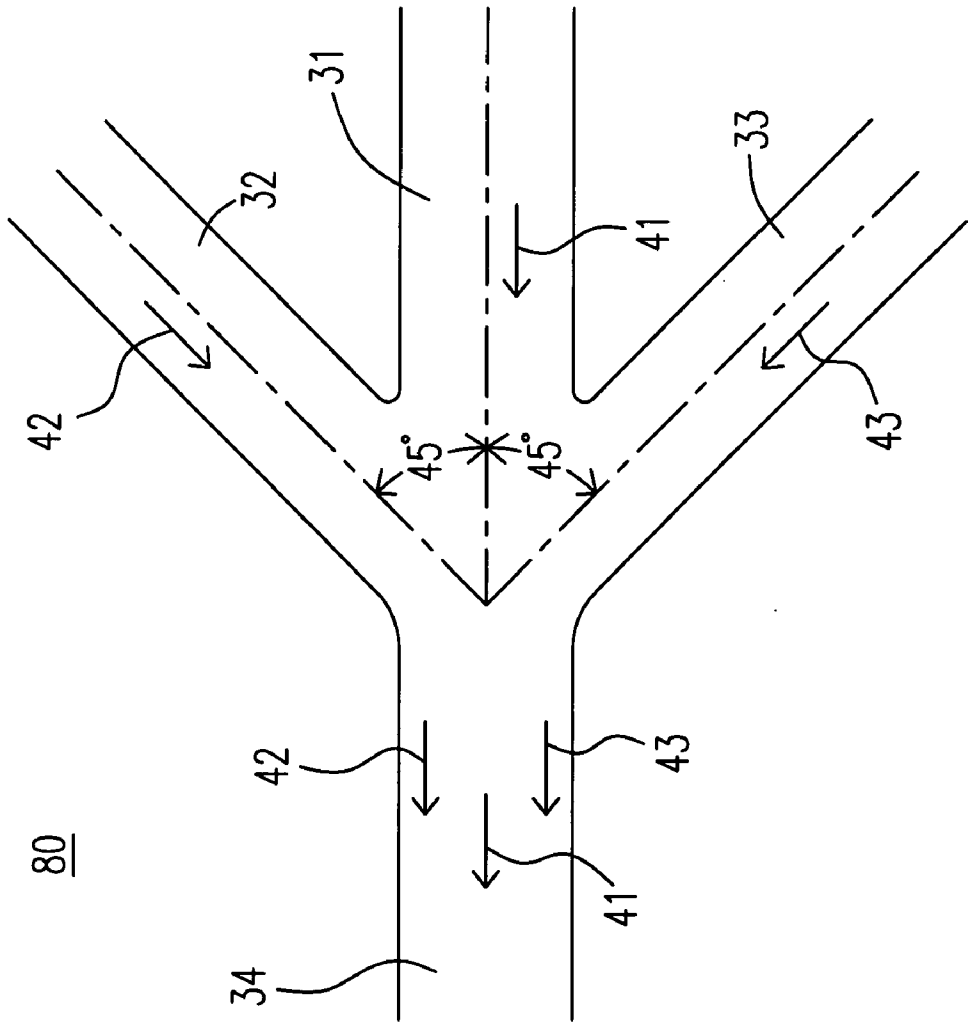


Fig. 1

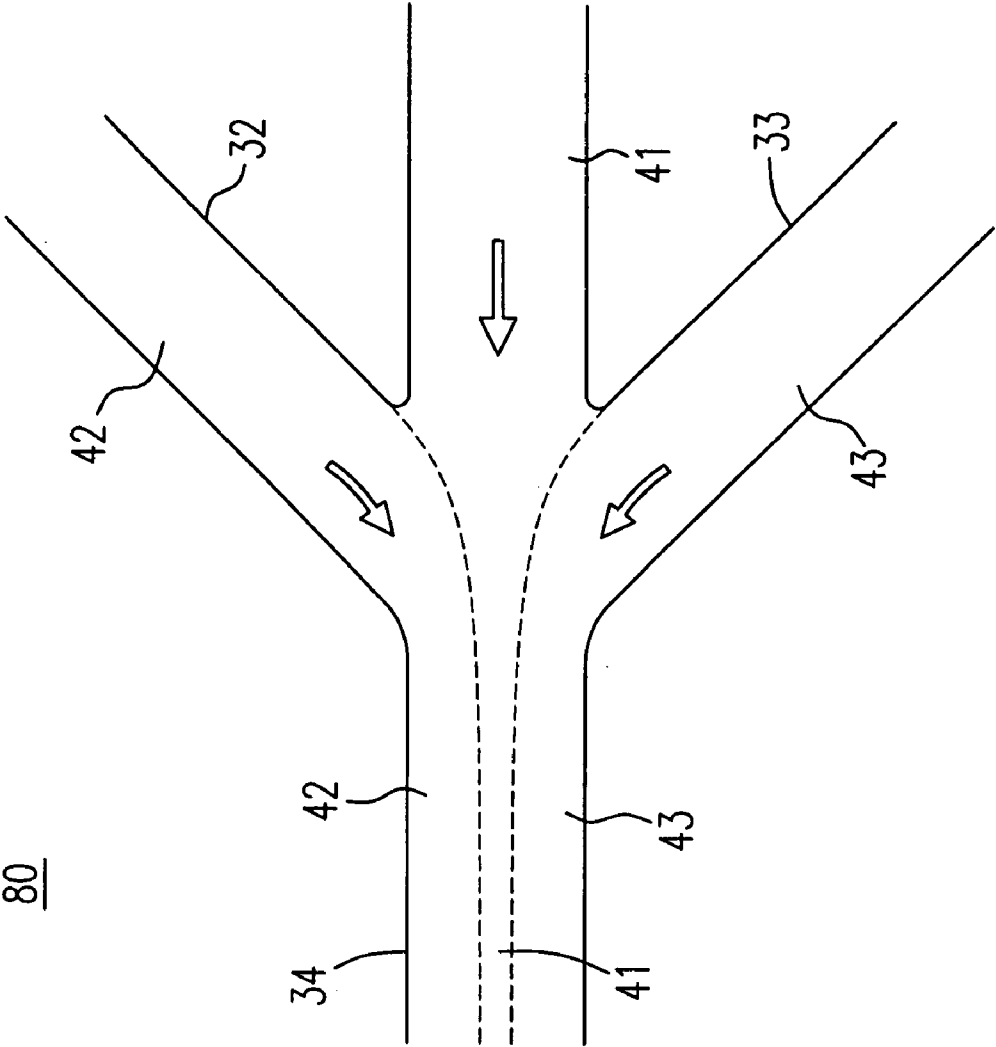


Fig. 2

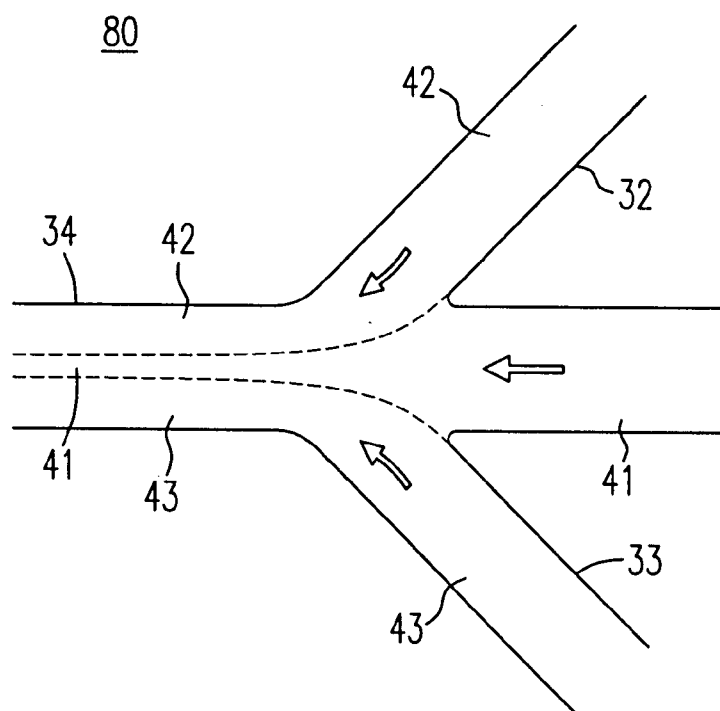


Fig. 3(a)

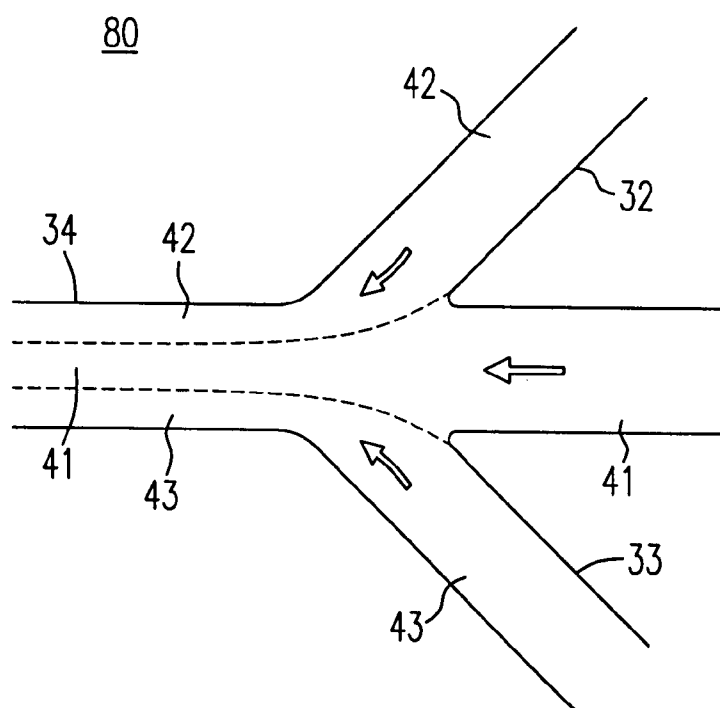


Fig. 3(b)

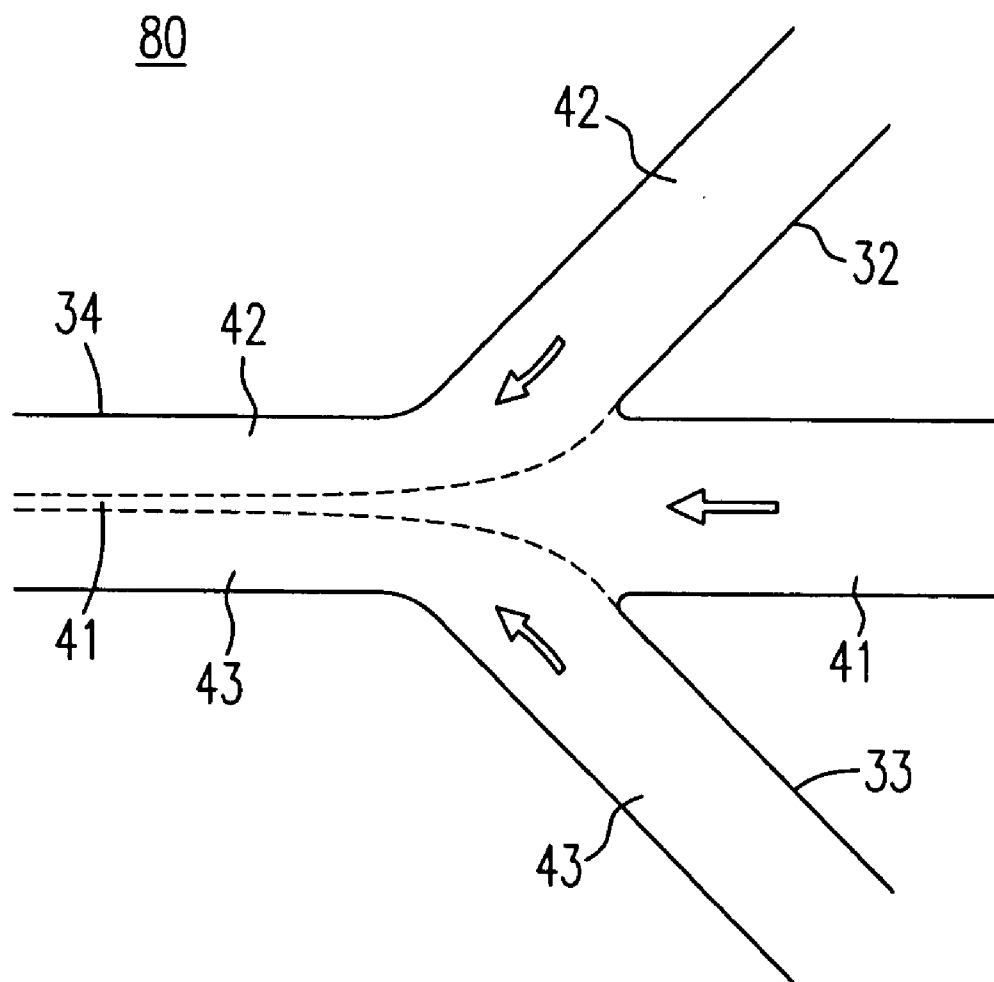


Fig. 3(c)

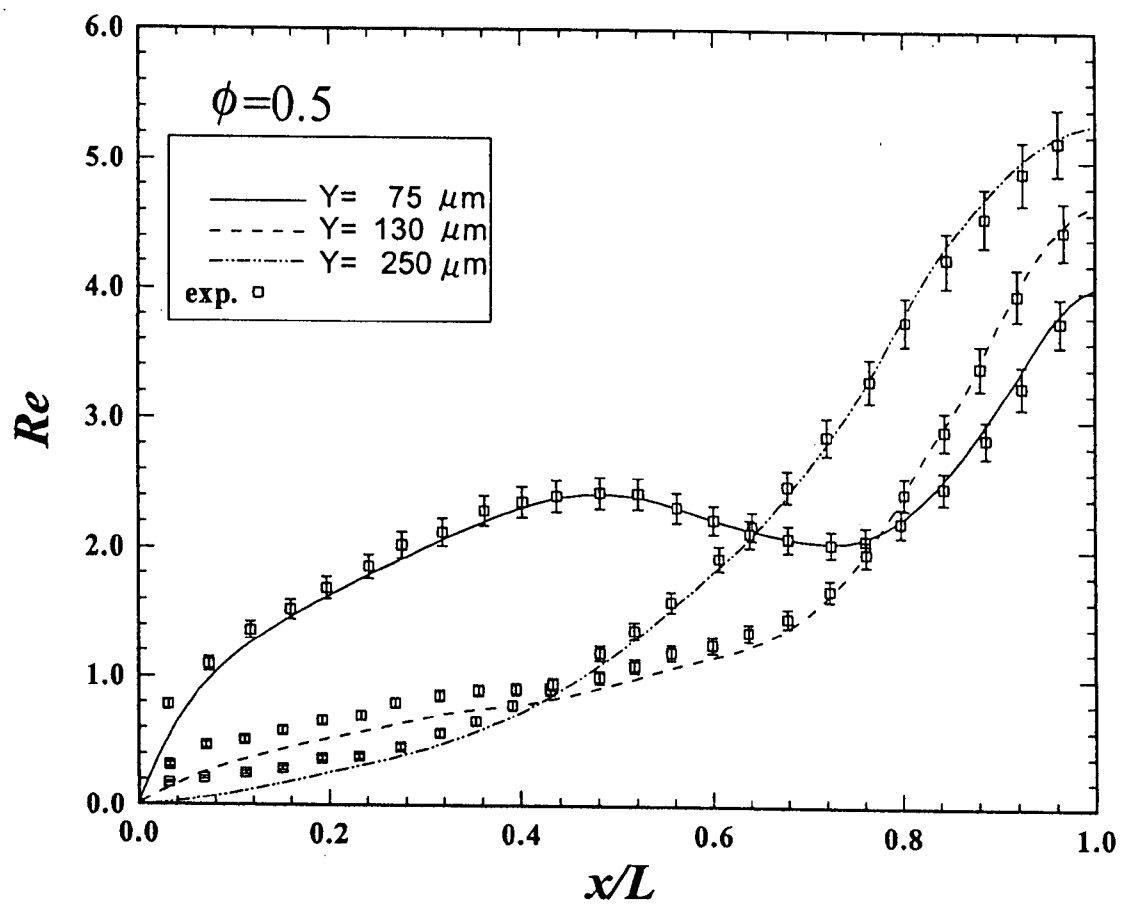


Fig. 4(a)

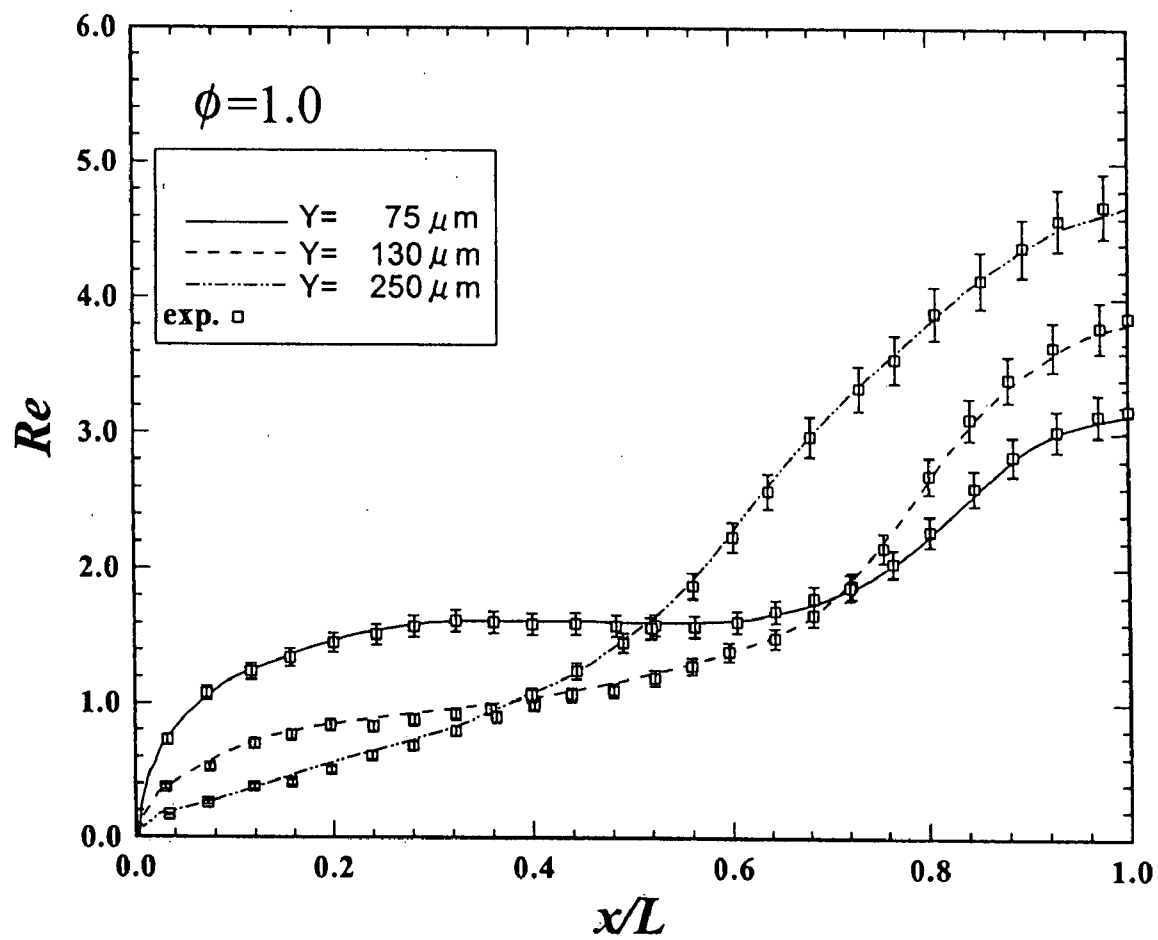


Fig. 4(b)

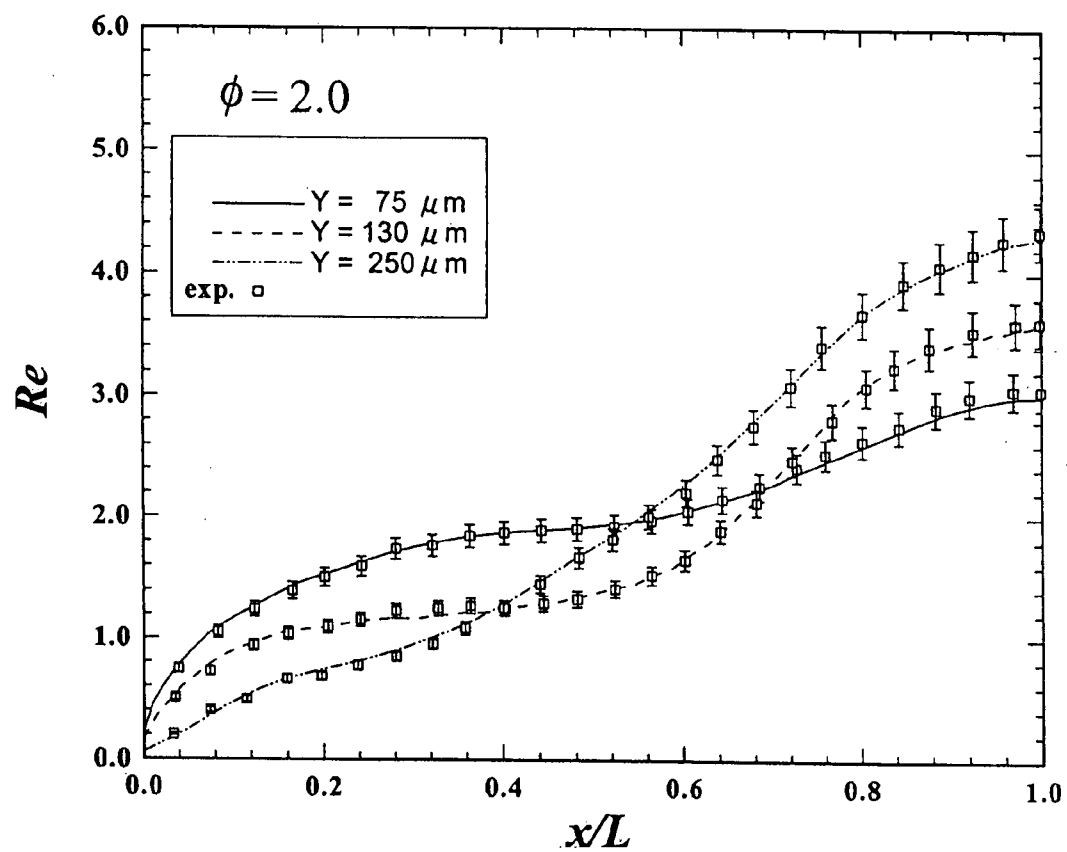


Fig. 4(c)

DNA COUNTERFEIT-PROOF FIBER TOGETHER WITH SPINNING NOZZLE AND METHOD USED TO PRODUCED THEREOF

FIELD OF THE INVENTION

[0001] The present invention relates to a deoxyribonucleic acid (DNA) counterfeit-proof fiber, the method thereof and the spinning nozzle for manufacturing thereof, and more particularly to the manufacture of the counterfeit-proof fibers for preventing the counterfeiting of textiles.

BACKGROUND OF THE INVENTION

[0002] The counterfeit-proof principle of DNA is by means of the characteristics of unique, complex and difficult to copy of DNA to protect the product from counterfeiting via mixing and/or adhering the DNA with some specific mediums (e.g. the colors, the glue, the resin or the printing ink). Anti counterfeiting by DNA will increase the income and protect the goodwill.

[0003] The textiles, adding some specific materials for anti-counterfeiting, have not been sold in the market. At the present day, there are three methods for anti-counterfeiting by adding some specific materials which can be recognized by machines described as follows. The first method is to integrate the vitamin B group into the fiber by plasma surface modification. The second is to graft the fiber and the chitosan by enzyme. The third is to package the specific DNA as the microcapsules and to mix them with the fiber.

[0004] The three above methods seem to achieve the purposes of anti counterfeiting rapidly and effective of the textiles and being detected by machines directly. But, after analyzing carefully with the manufacturing process of textiles, it is found that the purposes of anti counterfeiting rapidly and effective of textiles and being detected by machines directly can be achieved only by the third method. The two reasons are introduced as follows.

[0005] The first reason is regarding to the effects of scouring and bleaching process. Because the natural fibers mostly contain oil and dust, they need to be washed with the alkali and/or the soap. But the chitin (β -poly-N-acetyl-D-glucosamin) and the chitosan (β -poly-D-glucosamin), different from other polysaccharides, are strongly electropositive so that they will bond strongly with some specific chemicals, especially the negatively charged oil. So, if the counterfeit-proof fibers, grafting with the chitosan by enzyme, have been added before washing with the alkali and/or the soap, the chitin and/or the chitosan will fall off during the washing process. In other words, the chitin and/or the chitosan will bond with the oil adhered on the animal or the plant fibers. The chitin and/or the chitosan will solve in the soap-contained washing waste during the scouring and bleaching process and certainly lose the effect for anti counterfeiting of textiles.

[0006] The chitin is the only natural monosaccharide in nature. It widely exists in the shell of insects and crustaceans and the cell wall of bacteria. Therefore, the chitin lacks the characteristic of unique since it is easily obtained. Applying the chitin to produce the functional fiber may get well effects, but the chitin seems not appropriate for being used as the counterfeit-proof materials since it is easily counterfeited. Therefore, that the chitin is applied to produce the counterfeit-proof fibers is very limited.

[0007] The second reason is regarding to the effects of dyeing the fabric blank at high-pressure and high-tempera-

ture. After a textile is produced into a fabric blank, it needs to be processed with a post-manufacturing of dyeing at high-temperature for producing the colorful cloths. Therefore, whatever fabric materials the fabric blank produced therefrom, it needs to be processed with the high-temperature dyeing using several organic and/or inorganic dyes solved in the water. The fabric blank needs to be maintained at the high temperature of 120-200° C. and high pressure surrounding for 20-30 minutes for achieving a better outcome. But, the fibers had anti-counterfeiting and recognized functions by integrating the vitamin B group into the fiber by plasma surface modification, which will be the pyrolysis at the high temperature. Moreover, the water-soluble vitamin B group will be washed out from the fabric blank after being treated with the high pressure and high temperature water. The vitamin B group, similar to the chitin, is easily obtained and lacks the characteristic of unique. Therefore, the vitamin B group applied to produce the counterfeit-proof fibers is very limited.

[0008] The third method for anti counterfeiting is using the microcapsule technique to package the specific DNA into the microcapsules and then to mix therewith fibers. Due to the mechanism for anti counterfeiting of this method causing the DNA microcapsules to be mixed with fibers, the DNA microcapsules are not easily lost and the properties of heat-resistance and acid- and alkali-resistance thereof are outstanding. The fibers mixed with the DNA microcapsules maintain the original properties after heating at 250° C. for 40 minutes. Moreover, because of the properties of private and unique, DNA is appropriately applied for anti counterfeiting rapidly and effectively. But how to integrate the DNA microcapsules into the fibers effectively and uniformly and to increase the stability thereof to further produce the fibers had DNA counterfeit-proof technique are big challenges.

[0009] A microcapsule consists of a capsule core and a capsule membrane. The capsule membrane can be made by various natural or synthetic high-molecular materials. The diameter of the microcapsule is 10-200 μ m and the shape thereof is mostly spherical or polyhedral. The common methods for producing the microcapsule are the separating method and the interfacial polymerization. The technique of the microcapsule had been provided since 1950's, and it was applied to manufacture the printing ink of non-carbon paper originally. Recently, the microcapsule technique has been applied to the fields of printing, medison, biochemistry and liquid crystal.

[0010] Because of the arising of environmental consciousness, the microcapsule technique is also applied to prevent the environmental pollution of industrial waste. For example, in the industry of textiles dyeing and finishing, all the disperse dye, the acid dye, the cationic dye, the vat dye, the reactive dye and the oil-soluble dye can be packaged by microcapsules to be good for processing the waste. Moreover, by means of the microcapsule technique, some special materials can be packaged by the microcapsules and further adhered to textiles to produce the functional textiles. So, the microcapsule technique develops vigorously and is majorly applied to the textiles of dyeing, calico printing, UV absorbing, chemical asepticizing, blanching and adhering.

[0011] The processes of wet spinning are making a polymer to become a soluble salt (i.e. the spinning solution) by chemical treatments and spinning the spinning solution to form the silks by a spinning nozzle. The silks are further returned to the solid ones by the coagulation bath. Finally, the silks need to be treated with drafting treatment. Besides, the viscosity of the

spinning solution shall be noticed. If the viscosity of the spinning solution is too low, the spinning solution will easily break to drops during spinning, but if the viscosity thereof is too high, the spinning solution will pass through the spinning nozzle difficultly. Usually, the low-viscosity and high-density spinning solution can be obtained by increasing the temperature thereof. This kind of spinning solution is easily spun and the silks spun therefrom are highly crystallized.

[0012] The above wet spinning spins via a single spinning nozzle locating in the warm acid-hydrolysis solution. But the process of acid hydrolysis is unstable due to the hardly controlled operational environment. The spun silks further need drawing to stabilize the size, and the manufacturing equipments thereof are huge and complex.

[0013] In conclusion, when spinning by wet spinning, due to the special characteristics of DNA counterfeit-proof fiber, the spinning nozzle and the spinning processes need to be adjusted for stabilizing the size of fibers and simplifying the manufacturing equipments. But the known spinning nozzles and spinning processes could not meet the above requirements.

SUMMARY OF THE INVENTION

[0014] In accordance with one aspect of the present invention, a spinning nozzle for producing a synthetic fiber is provided. The spinning nozzle includes a polymer solution inflow passage and a pair of water inflow passages located at the both sides of the polymer solution inflow passage, wherein the polymer solution inflow passage and the pair of water inflow passages are merged into a mixing outflow passage, and the synthetic fibers are produced at an outlet of the mixing outflow passage. The manufacturing equipments of drawing of the traditional spinning processes can be displaced with the spinning nozzle of the present invention, hence the cost will be decreased.

[0015] In accordance with another aspect of the present invention, a method for producing a DNA counterfeit-proof fiber is provided. First, mixing a plurality of DNA microcapsules with a material solution to produce a polymer solution. Then, to form a converging interface between the polymer solution and the two streams of acid-hydrolysis waters. Afterwards, to cause the flowing polymer solution to encounter with the two streams of acid-hydrolysis waters for producing the DNA counterfeit-proof fiber. Different forms of DNA counterfeit-proof fibers can be produced by adjusting the conditions of the convergence between the polymer solution and the two streams of acid-hydrolysis waters.

[0016] In accordance with another aspect of the present invention, a DNA counterfeit-proof fiber produced by the above method is provided.

[0017] In a preferable embodiment, a spinning nozzle includes a polymer solution inflow passage and a pair of water inflow passages, wherein the polymer solution inflow passage providing a polymer solution for producing a synthetic fiber and the pair of water inflow passages located at the sides of the polymer solution inflow passage and supplying two streams of acid-hydrolysis waters. The polymer solution inflow passage and the water inflow passages are merged into a mixing outflow passage and a synthetic fiber is produced at an outlet of the mixing outflow passage.

[0018] Preferably, the polymer solution includes a plurality of DNA microcapsules and the synthetic fiber is a DNA counterfeit-proof fiber.

[0019] Preferably, the polymer solution is formed by solving Nylon 6 in a formic acid first and then mixing therewith a plurality of DNA microcapsules.

[0020] Preferably, the two streams of acid-hydrolysis waters are deionized waters and have a temperature of 60° C.

[0021] Preferably, the pair of water inflow passages have respective central lines symmetrical to what the polymer solution inflow passage has, and the central lines of the pair of water inflow passages form an included angle of 90°.

[0022] Preferably, the polymer solution is encountered in flanks by the two streams of acid-hydrolysis waters in the mixing outflow passage for processing an acid-hydrolysis reaction.

[0023] Preferably, the polymer solution is convergently attacked by the two streams of acid-hydrolysis waters in the mixing outflow passage for processing an acid-hydrolysis reaction.

[0024] In a preferable embodiment, a method for producing a DNA counterfeit-proof fiber includes following steps. First, to prepare a polymer solution having a plurality of DNA microcapsules. Then, driving the polymer solution and driving the two streams of the acid-hydrolysis water to approach the both sides of the polymer solution. Afterwards, causing the flowing polymer solution to encounter with the two streams of acid-hydrolysis waters for producing the DNA counterfeit-proof fiber.

[0025] Preferably, the method for producing the DNA counterfeit-proof fiber includes following pre-processing steps of purifying the acid-hydrolysis waters to deionized waters and preheating the acid-hydrolysis waters to 60° C.

[0026] Preferably, the steps of the method for producing a polymer solution are forming a Nylon 6 formic acid solution by solving Nylon 6 with a formic acid and then mixing therewith a plurality of the DNA microcapsules the Nylon 6 formic acid solution.

[0027] Preferably, the polymer solution encountering with the two streams of acid-hydrolysis waters is caused by a converging attack of the two streams of acid-hydrolysis waters.

[0028] Preferably, the encountering between the flowing polymer solution and the two streams of acid-hydrolysis waters further includes the following steps of convergently attacking the polymer solution by the two streams of acid-hydrolysis waters to generate an acid hydrolysis, and to adjust the flowing speed of the two streams of acid-hydrolysis waters for controlling the diameter and the quality of DNA counterfeit-proof fiber.

BRIEF DESCRIPTION OF THE DRAWINGS

[0029] FIG. 1 is a schematic diagram showing the passages of spinning nozzle for producing the synthetic fibers of present invention.

[0030] FIG. 2 is a photo showing the spinning and the acid hydrolysis of polymer solution in the spinning nozzle, wherein the spinning nozzle is included in a preferable embodiment of the method for producing the DNA counterfeit-proof fiber of present invention.

[0031] FIG. 3(a) is a photo showing the forming of the DNA counterfeit-proof fibers produced by the method of FIG. 2, where $\Phi=1.0$.

[0032] FIG. 3(b) is a photo showing the forming of the DNA counterfeit-proof fibers produced by the method of FIG. 2, where $\Phi=2.0$.

[0033] FIG. 3(c) is a photo showing the forming of the DNA counterfeit-proof fibers produced by the method of FIG. 2, where $\Phi=0.5$.

[0034] FIG. 4(a) is the diagram of the change of Reynolds Number (Re) of flow in the mixing outflow passage of DNA counterfeit-proof fiber, where $\Phi=1.1$.

[0035] FIG. 4(b) is the diagram of the change of Reynolds Number (Re) of flow in the mixing outflow passage of DNA counterfeit-proof fiber, where $\Phi=2.0$.

[0036] FIG. 4(c) is the diagram of the change of Reynolds Number (Re) of flow in the mixing outflow passage of DNA counterfeit-proof fiber, where $\Phi=0.5$.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0037] In order to further illustrate the techniques, methods and efficiencies used to procure the aims of this invention, please see the following detailed description. It is believable that the features and characteristics of this invention can be deeply and specifically understood by the descriptions. It is to be noted that the following descriptions of preferred embodiments of this invention are presented herein for the purposes of illustration and description only; it is not intended to be exhaustive or to be limited to the precise form disclosed.

[0038] Please refer to FIG. 1, which is a schematic diagram showing the passages of a spinning nozzle for producing the synthetic fibers of the present invention. In FIG. 1, the spinning nozzle 80 for producing the synthetic fiber includes a polymer solution inflow passage 31 and a pair of water inflow passages 32, 33, wherein the polymer solution inflow passage 31 is used to provide a polymer solution 41 for producing a synthetic fiber. The pair of water inflow passages 32, 33 locate at both sides of the polymer solution inflow passage 31. The polymer solution inflow passage 31 and the water inflow passages 32, 33 are merged into a mixing outflow passage 34 and the synthetic fibers are produced at the outlet of the mixing outflow passage 34.

[0039] In a preferable embodiment, the polymer solution 41 merging with the two streams of acid-hydrolysis waters 42, 43 is caused by a converging attack of the two streams of acid-hydrolysis waters 42, 43.

[0040] The polymer solution inflow passage 31, flowed through by the polymer solution 41 for producing the synthetic fibers, locates at the middle of the spinning nozzle 80 for producing the synthetic fibers. The synthetic fibers produced in the present embodiment is a DNA counterfeit-proof fiber, but the spinning nozzle 80 for producing the synthetic fibers also can be used to produce various kinds of synthetic fibers. The polymer solution 41 includes a plurality of DNA microcapsules when the synthetic fiber sought to produce is a DNA counterfeit-proof fiber.

[0041] The polymer solution of the DNA counterfeit-proof fiber is produced by solving Nylon 6 with a formic acid first and mixing therewith a plurality of the DNA microcapsules. But, it is shall not be limited that applying to the fiber materials of Nylon 6 and the solvent of formic acid.

[0042] A pair of the water inflow passages 32, 33 locate at both sides of the polymer solution inflow passage 31, wherein the pair of water inflow passages 32, 33 have respective central lines symmetrical to what the polymer solution inflow passage 31 has, and the central lines of the pair of water inflow passages 32, 33 form an included angle lower than 180° . In the present embodiment, the central lines of the pair of water inflow passages 32, 33 form an included angle of 90° .

[0043] Each of the water inflow passages 32, 33 is flowed through by a stream of acid-hydrolysis waters 42, 43, wherein the acid-hydrolysis waters are deionized waters. The effect of the acid hydrolysis is better when the acid-hydrolysis waters 42, 43 are hot. In the present embodiment, the acid-hydrolysis waters 42, 43 have a temperature of 60°C .

[0044] Because the acid-hydrolysis waters 42, 43 approach the mixing outflow passage 34 slopingly, therefore, when the polymer solution 41 and the two streams of acid-hydrolysis waters 42, 43 flow into the mixing outflow passage 34, polymer solution 41 is encountered in flanks by the two streams of acid-hydrolysis waters 42, 43 for processing an acid hydrolysis reaction.

[0045] Preferably, an acid hydrolysis reaction of the polymer solution 41 is generated by a converging attack of two streams of acid-hydrolysis waters 42, 43.

[0046] A method for produced a DNA counterfeit-proof fiber is introduced as follows. Because the DNA microcapsule is heat-unstable, the spinning system for producing the DNA counterfeit-proof fiber must not use the traditional method of the hot melt spinning but shall use the wet spinning with chemical solutions. Thus, the hot effects of producing can be ignored completely. It only shall be noticed on the radio between the DNA microcapsules and the chemical solutions to decrease the variation of processes and the possibility of failure and to simplify the producing of products.

[0047] The formula of polymer solution 41 including a plurality of DNA microcapsules is introduced as follows. The formula of the polymer solution 41 is (formic acid+Nylon 6) \rightarrow (heating) \rightarrow (mixing the DNA microcapsules (PS thin-film)) \rightarrow (cooling).

[0048] The formula of polymer solution 41 for the wet spinning is (formic acid+Nylon 6+DNA microcapsules) $_L\rightarrow$ (driving the polymer solution into the spinning nozzle) \rightarrow (mixing the deionized waters) \rightarrow (controlling the pH by acid hydrolysis) \rightarrow (Nylon 6+DNA microcapsules) $_S\rightarrow$ (hot-air drying) \rightarrow (spinning), wherein $_L$ means liquid and $_S$ means solid.

[0049] The above wet spinning includes the following steps. To drive the polymer solution 41 and to drive the two streams of acid-hydrolysis waters 42, 43 approaching the both sides of polymer solution 41. To converge the polymer solution 41 and the two streams of acid-hydrolysis waters 42, 43 to produce a DNA counterfeit-proof fiber.

[0050] Please refer to FIG. 2, which is a photo showing the spinning and the acid hydrolysis of polymer solution 41 in the spinning nozzle 80. In FIG. 2, the sectional size of polymer solution 41 of Nylon 6 is going to narrowing because of the converging attacking by the two streams of hot acid-hydrolysis waters 42, 43. In the meanwhile, the acid hydrolysis occurs and causes the polymer solution solidifying because of the acid solutions releasing therefrom. Thus, a Nylon 6 fiber containing the DNA microcapsules is formed.

[0051] As shown in FIG. 2, after the acid solutions, mixing with the DNA microcapsules and Nylon 6 and flowing out from the polymer solution inflow passage 31, flow into the mixing outflow passage 34, the size of the fiber will be determined by the flow rate of polymer solution 41 and the two streams of acid-hydrolysis waters 42, 43 because of the limitation of spinning speed at the outlet of spinning nozzle 80. The two streams of acid-hydrolysis waters 42, 43 (hot waters having a temperature of 60°C .), locates at the both sides of the polymer solution 41 respectively, are provided to generate the acid hydrolysis in the spinning process. The more acid-

hydrolysis waters **42**, **43** are added, the better effect of the acid hydrolysis is preformed, and the increasing acid-hydrolysis waters **42**, **43** will narrow the fiber size because the flowing speed at the outlet of mixing outflow passage **34** is fixed. On the contrary, the less acid-hydrolysis waters **42**, **43** are added, the larger fiber size is formed, but the physical properties of the fiber will be influenced because of the insufficient degree of acid hydrolysis.

[0052] Based on the above reasons, it can be known that the spinning process convergently attacking with a higher flow rate of hot waters seems better. But, actually, the fiber will not meet the following examining requirements because it is too thin to contain enough DNA microcapsules. The optimum fiber size, figured out from the effective examining concentration of the simple, is larger than 50 μm .

[0053] In order to characterize the fluid properties of spinning nozzle at the micro-scale, the ratio of quantitative flow rates is defined as $\Phi = m_{\text{inner}}/m_{\text{outer}}$, wherein the m_{inner} refers to the quantitative flow rate of polymer solution **41** and the m_{outer} refers to the totally quantitative flow rate of the two streams of acid-hydrolysis waters.

[0054] Please refer to FIGS. **3(a)**, **3(b)** and **3(c)**, wherein FIG. **3(a)** is photo showing the forming of the DNA counterfeit-proof fibers produced by the method of FIG. **2**, where $\Phi=1.0$. FIG. **3(b)** is a photo showing the forming of the DNA counterfeit-proof fibers produced by the method of FIG. **2**, where $\Phi=2.0$. FIG. **3(c)** is a photo showing the forming of the DNA counterfeit-proof fibers produced by the method of FIG. **2**, where $\Phi=0.5$. In FIGS. **3(a)**, **3(b)** and **3(c)**, under the situation of stable outlet pressure and total flow rate, the size of fibers can be controlled by adjusting the flow rates of the two streams of acid-hydrolysis waters. By adjusting the quantitative flow rate from $\Phi=2.0$ to $\Phi=0.5$, the size of fibers are correspondingly changed from 100 μm to 25 μm .

[0055] The distribution of the speed of flow is introduced as follows. Please refer to FIGS. **4(a)**, **4(b)** and **4(c)**. FIG. **4(a)** is the diagram showing the change of Reynolds Number (Re) of flow in the mixing outflow passage of DNA counterfeit-proof fiber, where $\Phi=1.0$. FIG. **4(b)** is the diagram showing the change of Reynolds Number (Re) of flow in the mixing outflow passage of DNA counterfeit-proof fiber, where $\Phi=2.0$. FIG. **4(c)** is the diagram showing the change of Reynolds Number (Re) of flow in the mixing outflow passage of DNA counterfeit-proof fiber, where $\Phi=0.5$. The Reynolds Numbers of FIGS. **4(a)**, **4(b)** and **4(c)** are measured by a micro-particle image velocimetry (Micro-PIV).

[0056] In FIGS. **4(a)**, **4(b)** and **4(c)**, the acid-hydrolysis waters **42**, **43** in the mixing outflow passage **34** of spinning nozzle **80** and the polymer solution **32** are added to react therewith simultaneously, wherein the acid-hydrolysis waters **42**, **43** are the greater part thereof. Moreover, because of the converging attacking of acid-hydrolysis waters, the flowing range of polymer solution **41** will be narrowed and hence flow in high speed. Therefore, there is a greatly difference of flowing speed at the part which is near the interface between the inner flow of polymer solution **41** and the outer flows of two streams of acid-hydrolysis waters **42**, **43**. But in a very short distance, the inner flow and the outer flows with different speed therebetween will couple rapidly and form a typically parabolic complete expanded flow.

[0057] All of the diagrams of FIGS. **4(a)**, **4(b)** and **4(c)** have three curves therein respectively. The curves refer to the distribution curves of flow speed of passage sections at the flowing directions of $Y=75 \mu\text{m}$, $Y=130 \mu\text{m}$ and $Y=250 \mu\text{m}$

respectively, which is recorded at the start of inner flow and outer flows approaching therewith. In FIGS. **4(a)**, **4(b)** and **4(c)**, wherein the x refers to the distance from a flow to the wall of mixing outflow passage **34** of spinning nozzle **80**, the dimensionless performance parameter of Reynolds Number is VL/ν , the ν is the Kinematic viscosity and the L is the distance from the core of inner flow to the wall of mixing outflow passage **34** of spinning nozzle **80**.

[0058] In FIGS. **4(a)**, **4(b)** and **4(c)**, it is found when the quantitative flow rates between the inner flow and outer flows are more different, the inner fluids will flow faster caused by the outer fluids and the size of fiber is smaller. But if the forming speed is too fast, the amount of DNA microcapsules of a unit length will be decreased. Therefore, when $\Phi=1.0$, the dimensionless performance parameter Re is 3.5 approximately (i.e. 250 $\mu\text{m}/\text{sec}$ of the average of flowing speed) and the diameter of fiber is 50 μm , which is known from the measured results of speed. Thus, under the condition that the volume of fibers is approximately 0.02 C.C. per inch and the DNA microcapsules concentration of fibers is 1 mg/C.C., one inch of the fiber contains 0.02 mg of the DNA microcapsules. Under the same condition, it is enough for following PCR analysis by sampling 100 inch of fibers.

[0059] The feature of the present invention is a spinning nozzle for producing the synthetic fibers includes a polymer solution inflow passage and a pair of water inflow passages, wherein a polymer solution inflow passage providing a polymer solution for producing a synthetic fiber and the pair of water inflow passages at the both sides of the polymer solution inflow passage and supplying two streams of acid-hydrolysis waters, and the polymer solution inflow passage and the water inflow passages are merged into a mixing outflow passage and the synthetic fiber are produced at an outlet of the mixing outflow passage.

[0060] The steps of the method using the mentioned spinning nozzle to produce a DNA counterfeit-proof fiber are described as follows. First, preparing a polymer solution having a plurality of the DNA microcapsules. Then, driving the polymer solution and driving two streams of acid-hydrolysis waters to approach the both sides of the polymer solution. Afterwards, causing the flowing polymer solution to converge with the two streams of acid-hydrolysis waters for producing the DNA counterfeit-proof fiber.

[0061] While the invention has been described in terms of what are presently considered to be the most practical and preferred embodiments, it is to be understood that the invention need not be limited to the disclosed embodiment. On the contrary, it is intended to cover various modifications and similar arrangements included within the spirit and scope of the appended claims, which are to be accorded with the broadest interpretation so as to encompass all such modifications and similar structures. Therefore, the above description and illustration should not be taken as limiting the scope of the present invention which is defined by the appended claims.

What is claimed is:

1. A spinning nozzle producing a synthetic fiber, comprising:

- a polymer solution inflow passage providing a polymer solution for producing the synthetic fiber; and
- a pair of water inflow passages located at both sides of the polymer solution inflow passage and supplying two streams of acid-hydrolysis waters, wherein

the polymer solution inflow passage and the water inflow passages are merged into a mixing outflow passage and the synthetic fiber are produced at an outlet of the mixing outflow passage.

2. A spinning nozzle according to claim 1, wherein the polymer solution includes a plurality of DNA microcapsules and the synthetic fiber is a DNA counterfeit-proof fiber.

3. A spinning nozzle according to claim 2, wherein the polymer solution is formed by solving Nylon 6 in a formic acid first and then mixing therewith the plurality of DNA microcapsules.

4. A spinning nozzle according to claim 1, wherein the two streams of acid-hydrolysis waters are deionized waters.

5. A spinning nozzle according to claim 1, wherein the two streams of acid-hydrolysis waters have a temperature of 60° C.

6. A spinning nozzle according to claim 1, wherein the pair of water inflow passages have respective central lines symmetrical to what the polymer solution inflow passage has, and the central lines of the pair of water inflow passages form an included angle of 90°.

7. A spinning nozzle according to claim 1, wherein the polymer solution is encountered in flanks by the two streams of acid-hydrolysis waters for processing an acid hydrolysis reaction.

8. A spinning nozzle according to claim 7, wherein the polymer solution is convergently attacked by the two streams of acid-hydrolysis waters.

9. A method for producing a DNA counterfeit-proof fiber, comprising steps of:

- (a) preparing a polymer solution having a plurality of the DNA microcapsules;
- (b) driving the polymer solution and driving two streams of acid-hydrolysis waters approaching to the both sides of the polymer solution; and

(c) causing the flowing polymer solution to encounter with the two streams of acid-hydrolysis waters for producing the DNA counterfeit-proof fiber.

10. A method according to claim 9, comprising before Step (a) a step of:

(p) pre-purifying the two streams of the acid-hydrolysis waters to be deionized waters.

11. A method according to claim 9, comprising before Step (a) a step of:

(q) preheating the two streams of the acid-hydrolysis waters to have a temperature of 60° C.

12. A method according to claim 9, wherein Step (a) further comprises steps of:

(a1) solving Nylon 6 with a formic acid to generate a Nylon 6 formic acid solution; and

(a2) mixing the plurality of the DNA microcapsules with the Nylon 6 formic acid solution to generate the polymer solution.

13. A method according to claim 9, wherein Step (c) further comprises a step of:

(c2) adjusting flowing speeds of the two streams of acid-hydrolysis waters to control a diameter and a quality of the DNA counterfeit-proof fibers.

14. A method according to claim 9, wherein the flowing polymer solution encountering with the two streams of acid-hydrolysis waters is caused by a converging attack of the two streams of acid-hydrolysis waters.

15. A method for producing a DNA counterfeit-proof fibers, comprising steps of:

- (a) preparing a polymer solution having a plurality of the DNA microcapsules; and
- (b) encountering the polymer solution with the two streams of acid-hydrolysis waters for processing an acid hydrolysis reaction and producing a DNA counterfeit-proof fiber.

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