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(71) Applicant: **UHT Unitech Co., Ltd**
Taoyuan City (TW)

(72) Inventor: **Wang, Chih-Yung**
Taoyuan City (TW)

(74) Representative: **Zeitler Volpert Kandlbinder**
Patent- und Rechtsanwälte Partnerschaft mbB
Herrnstrasse 44
80539 München (DE)

(54) CARBON FIBER SURFACE OILING AGENT CHANGING METHOD AND CARBON FIBER SURFACE OILING AGENT CHANGING APPARATUS

(57) A carbon fiber surface oiling agent changing method and a carbon fiber surface oiling agent changing apparatus are provided. The carbon fiber surface oiling agent changing method includes providing a raw material step; performing a desizing step; performing a plasma surface treatment step; and performing a sizing step. In the plasma surface treatment step, the impurities that originally adhere to the surface of the carbon fiber (71) can be broken to form small molecules and blown away through the physical and chemical reaction of the plasma gas flow, enabling the surface of the carbon fiber (71) to be roughened and provided with functional groups, which is beneficial to achieve high-quality interface bonding of the carbon fiber (71) and the matrix resin in the subsequent sizing step, thereby enhancing the characteristics of carbon fiber composite materials.

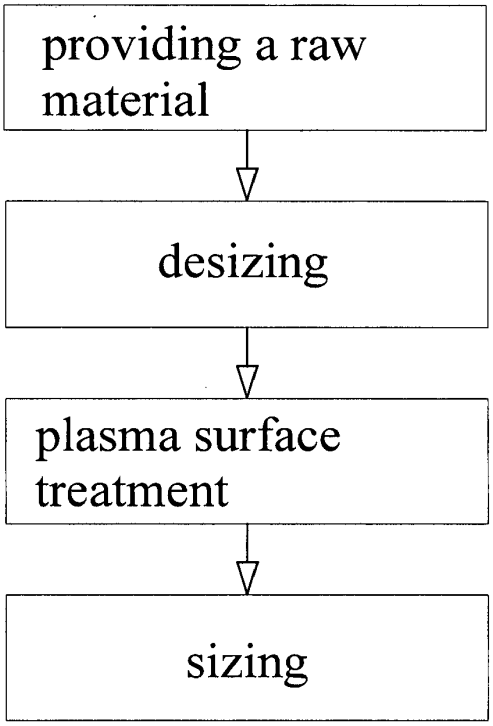

FIG.1

EP 3 348 685 A1

Description

SURFACE OILING AGENT CHANGING APPARATUS

FIELD OF THE INVENTION

[0001] The present invention relates to a carbon fiber surface treatment technique, and more particularly to a carbon fiber surface oiling agent changing method and a carbon fiber surface oiling agent changing apparatus which are capable of effectively changing the oiling agent on the surface of a carbon fiber.

BACKGROUND OF THE INVENTION

[0002] Carbon fibers have excellent mechanical properties and electrical properties and can be widely used in various applications. A conventional carbon fiber is achieved by bundling precursor fibers, such as polyacrylonitrile fibers, to form a carbon fiber precursor fiber bundle, and then the carbon fiber precursor fiber bundle is calcined (high-temperature carbonization) to form the carbon fiber.

[0003] The surfaces of untreated carbon fibers don't have sufficient adhesion, which have poor transverse properties, such as separation strength and shear strength. Therefore, they are less directly utilized. They are usually combined with a matrix resin to form carbon fiber composite materials in accordance with their applications. On the other hand, because carbon fibers and graphite fibers are hard and brittle, they lack adhesion, bending and wear resistance. The surface of the carbon fiber or graphite fiber is always coated with a layer of oiling agent (a sizing agent) before it leaves the factory so as to protect the fiber from breakage due to friction.

[0004] In general, for using the excellent mechanical properties of carbon fibers, the matrix resin of the carbon fiber composite material is a thermosetting resin material to form the so-called thermosetting carbon fiber composite material. The main difference between the thermosetting carbon fiber composite material and the thermoplastic carbon fiber composite material is that the forming time of the traditional thermosetting carbon fiber composite material is long, resulting in lower utilization of the mold, so its production capacity is relatively low.

[0005] However, at present, most of the oiling agents on the surfaces of commercially available carbon fiber raw materials are thermosetting resin oiling agents designed according to the wettability of the thermosetting resin oiling agents. In case such carbon fiber raw materials are manufactured to form thermoplastic carbon fiber composite materials, the carbon fiber raw materials and the resin don't match with each to form a complete interface bonding. As a result, it cannot be applied to various kinds of electrical and electronic parts, mechanical parts and automobile parts which are formed by injection molding.

[0006] Accordingly, the inventor of the present invention has devoted himself based on his many years of practical experiences to solve these problems.

SUMMARY OF THE INVENTION

[0007] In view of the problems of the prior art, the primary object of the present invention is to provide a carbon fiber surface oiling agent changing method and a carbon fiber surface oiling agent changing apparatus to effectively change the oiling agent on the surface of a carbon fiber.

[0008] In order to achieve the forgoing object, the carbon fiber surface oiling agent changing method of the present invention comprises: providing a raw material step, providing a carbon fiber, the carbon fiber being coated with a first oiling agent; performing a desizing step, the first oiling agent being removed; performing a plasma surface treatment step, providing a plasma gas flow to act on the carbon fiber; and performing a sizing step, a second oiling agent being coated on the carbon fiber.

[0009] Thereby, through the carbon fiber surface oiling agent changing method of the present invention, the oiling agent on the surface of the carbon fiber can be replaced with a desired oiling agent in a relatively more active and reliable manner. Particularly, through the plasma surface treatment, the surface of the carbon fiber is roughened and provided with functional groups, which is beneficial to achieve high-quality interface bonding of the carbon fiber and the desired oiling agent in the subsequent sizing step, thereby enhancing the characteristics of carbon fiber composite materials.

[0010] Preferably, in the plasma surface treatment step, the plasma gas flow with a power of 100-10000 watts acts on the carbon fiber for 10-1000 milliseconds.

[0011] Alternatively, in the plasma surface treatment step, an atmospheric plasma gas flow with a power of 100-10000 watts acts on the carbon fiber for 10-1000 milliseconds.

[0012] Alternatively, in the plasma surface treatment step, a low-pressure plasma gas flow with a power of 100-10000 watts acts on the carbon fiber for 10-1000 milliseconds.

[0013] Alternatively, in the plasma surface treatment step, a microwave plasma gas flow with a power of 100-10000 watts acts on the carbon fiber for 10-1000 milliseconds.

[0014] Alternatively, in the plasma surface treatment step, a glow plasma gas flow with a power of 100-10000 watts acts on the carbon fiber for 10-1000 milliseconds.

[0015] Preferably, the desizing step is performed at a temperature of 250-650°C for 1-60 seconds.

[0016] Alternatively, the desizing step is performed by providing an organic solvent to remove the first oiling agent.

[0017] Preferably, the organic solvent is acetone or chloroform.

[0018] Preferably, in the sizing step, the second oiling agent is coated on the carbon fiber by soaking.

[0019] Alternatively, in the sizing step, the second oiling agent is coated on the carbon fiber by immersing.

[0020] Preferably, the first oiling agent is a thermosetting resin oiling agent.

[0021] Preferably, the second oiling agent is a thermosetting resin oiling agent.

[0022] Alternatively, the second oiling agent is a thermoplastic resin oiling agent.

[0023] Preferably, the second oiling agent is one of polyurethane (PU), polyethene (PE), polypropylene (PP), and acrylic.

[0024] Preferably, the carbon fiber surface oiling agent changing method further comprises a drying step after the sizing step, enabling the second oiling agent to be firmly adhered to the carbon fiber.

[0025] In order to achieve the forgoing object, the carbon fiber surface oiling agent changing apparatus of the present invention comprises a feeding module, a receiving module, a desizing module, a plasma surface treatment module, and a sizing module. The feeding module is capable of providing a carbon fiber. The carbon fiber is coated with a first oiling agent. The receiving module is disposed in the vicinity of the feeding module and corresponds to the feeding module to constitute a carbon fiber drag route. The receiving module includes at least one yarn winding assembly to receive the carbon fiber released from the feeding module and to perform a drag action on the carbon fiber. The desizing module is disposed at the carbon fiber drag route between the feeding module and the receiving module for removing the first oiling agent. The plasma surface treatment module is disposed at the carbon fiber drag route between the desizing module and the receiving module for providing a plasma gas flow to act on the carbon fiber. The sizing module is disposed at the carbon fiber drag route between the plasma surface treatment module and the receiving module for coating a second oiling agent on the carbon fiber.

[0026] Thereby, the carbon fiber surface oiling agent changing apparatus of the present invention can be operated in the integrated operation of the feeding module, the desizing module, the plasma surface treatment module, the sizing module, and the receiving module. The carbon fiber released from the feeding module is sequentially processed at a predetermined speed to perform the steps of desizing, plasma surface treatment, sizing, and so on, in a relatively more active and reliable manner. The oiling agent on the surface of the carbon fiber can be replaced with a desired oiling agent. Particularly, the surface of the carbon fiber is roughened and provided with functional groups, which is beneficial to achieve high-quality interface bonding of the carbon fiber and the matrix resin in the subsequent sizing step, thereby enhancing the characteristics of carbon fiber composite materials.

[0027] Preferably, the plasma surface treatment module is provided with at least one plasma generator.

[0028] Alternatively, the plasma surface treatment module is provided with at least one plasma generator located at upper and lower positions of the carbon fiber drag route, respectively.

[0029] Preferably, the plasma generator is able to generate the plasma gas flow having a power in the range of 100-10000 Watts.

[0030] Alternatively, the plasma generator is able to generate an atmospheric plasma gas flow having a power in a range of 100-10000 Watts.

[0031] Alternatively, the plasma generator is able to generate a low-pressure plasma gas flow having a power in the range of 100-10000 Watts.

[0032] Alternatively, the plasma generator is able to generate a microwave plasma gas flow having a power in the range of 100-10000 Watts.

[0033] Alternatively, the plasma generator is able to generate a glow plasma gas flow having a power in the range of 100-10000 Watts.

[0034] Preferably, the desizing module is provided with at least one desizing furnace capable of generating a heat source having a temperature of 250-650°C .

[0035] Preferably, the sizing module is provided with at least one reservoir for storing the second oiling agent.

[0036] Preferably, the carbon fiber surface oiling agent changing apparatus further comprises a drying module. The drying module is disposed at the carbon fiber drag route between the sizing module and the receiving module, enabling the second oiling agent to be firmly adhered to the surface of the carbon fiber.

[0037] The carbon fiber surface oiling agent changing method and the carbon fiber surface oiling agent changing apparatus of the present invention are suitable for replacing a thermosetting resin oiling agent on the surface of the existing carbon fiber raw material with a thermoplastic resin oiling agent so that it can be applied to various kinds of electrical and electronic parts, mechanical parts and automobile parts which are formed by injection molding. Particularly, the surface of the carbon fiber is roughened and is provided with functional groups, which is beneficial to achieve high-quality interface bonding of the carbon fiber and the thermoplastic resin oiling agent in the subsequent sizing step, thereby enhancing the characteristics of carbon fiber composite materials.

BRIEF DESCRIPTION OF THE DRAWINGS

[0038]

FIG. 1 is a flow diagram of a carbon fiber surface oiling agent changing method in accordance with a first embodiment of the present invention;

FIG. 2 is a sectional schematic view of a carbon fiber raw material in the step of providing a raw material of the present invention;

FIG. 3 is a sectional schematic view of a carbon fiber after finishing a desizing step of the present inven-

tion;

FIG. 4 is a sectional schematic view of a carbon fiber after finishing a plasma surface treatment step of the present invention;

FIG. 5 is a sectional schematic view of a carbon fiber after finishing a sizing step of the present invention;

FIG. 6 is a flow diagram of a carbon fiber surface oiling agent changing method in accordance with a second embodiment of the present invention.

FIG. 7 is a structural schematic view of a carbon fiber surface oiling agent changing apparatus in accordance with a first embodiment of the present invention; and

FIG. 8 is a structural schematic view of a carbon fiber surface oiling agent changing apparatus in accordance with a second embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0039] Embodiments of the present invention will now be described, by way of example only, with reference to the accompanying drawings.

[0040] The present invention discloses a carbon fiber surface oiling agent changing method which is capable of effectively changing the oiling agent on the surface of a carbon fiber. As shown in FIG. 1, the carbon fiber surface oiling agent changing method of the present invention comprises providing a raw material step, performing a desizing step, perfoming a plasma surface treatment step, and performing a sizing step.

[0041] As shown in FIG. 1 to FIG. 5, the step of providing the raw material is to provide a carbon fiber raw material 70 formed of a carbon fiber 71 whose surface is coated with a first oiling agent 81. The carbon fiber 71 may be made of a carbon fiber precursor fiber bundle formed by bundling precursor fibers, such as rayon, poly vinyl alcohol, vinylidene chloride, polyacrylonitrile (PAN), pitch, and the like, obtained by calcination. In practice, the first oiling agent 81 may be a thermosetting resin oiling agent.

[0042] In the desizing step, the first oiling agent 81 is removed from the surface of the carbon fiber raw material 70, as shown in FIG. 2. In practice, the desizing step may be performed at a temperature of 250-650°C for 1-60 seconds, or by washing the surface of the carbon fiber raw material 70 with an organic solvent. In the embodiment by using the organic solvent to wash the surface of the carbon fiber raw material 70, the organic solvent may be acetone or chloroform.

[0043] In the plasma surface treatment step, a plasma gas flow with a predetermined power is provided to act on the carbon fiber 71 without the first oiling agent, such that the surface of the carbon fiber 71 is formed with a plasma-modified configuration 711 (shown in FIG. 4) which is relatively rougher.

[0044] In the sizing step, the plasma-modified configuration 711 on the surface of the carbon fiber 71 is coated with a second oiling agent 82 to obtain the carbon fiber raw material 70 having the second oiling agent 82 thereon (as shown in FIG. 5). In practice, the second oiling agent 82 is coated on the surface of the carbon fiber 71 by soaking or immersing. The second oiling agent 82 may be a thermosetting resin oiling agent or a thermoplastic resin oiling agent. In an embodiment that the second oiling agent 82 is a thermoplastic resin oiling agent, the second oiling agent 82 may be one of polyurethane (PU), polyethene (PE), polypropylene (PP), and acrylic.

[0045] Thereby, through the carbon fiber surface oiling agent changing method of the present invention, the oiling agent on the surface of the carbon fiber can be replaced with a desired oiling agent in a relatively more active and reliable manner. Particularly, it is suitable for replacing a thermosetting resin oiling agent on the surface of the existing carbon fiber raw material with a thermoplastic resin oiling agent so that it can be applied to various kinds of electrical and electronic parts, mechanical parts and automobile parts which are formed by injection molding.

[0046] In the plasma surface treatment step, an atmospheric plasma gas flow, a low-pressure plasma gas flow, a microwave plasma gas flow, or a glow plasma gas flow with a power of 100-10000 watts may be used to act on the carbon fiber for 10-1000 milliseconds. Since the plasma gas flow contains particles having energy, the impurities that originally adhere to the surface of the carbon fiber can be broken to form small molecules and blown away through the physical reaction (collision) and chemical reaction of the plasma gas flow, enabling the surface of the carbon fiber to be roughened and provided with functional groups, which is beneficial to achieve high-quality interface bonding of the carbon fiber and the thermoplastic resin oiling agent in the subsequent sizing step, thereby enhancing the characteristics of carbon fiber composite materials.

[0047] Furthermore, the plasma surface treatment of the present invention belongs to a dry-type surface treatment technique. This not only prevents the carbon fiber from generating additional impurities or sediment but also reduces the working time and working procedure of drying after the completion of the plasma surface treatment.

As shown in FIG. 6, after the sizing step, the carbon fiber raw material having the second oiling agent is processed with at least one drying step, so that the second oiling agent is firmly adhered to the surface of the carbon fiber in a drying or wind-drying manner.

[0048] In order to implement the aforesaid carbon fiber surface oiling agent changing method, the present invention discloses a carbon fiber surface oiling agent changing apparatus which is capable of effectively changing

the oiling agent on the surface of a carbon fiber. As shown in FIG. 7, the carbon fiber surface oiling agent changing apparatus of the present invention comprises a feeding module 10, a receiving module 20, a desizing module 30, a plasma surface treatment module 40, and a sizing module 50.

[0049] The feeding module 10 is to perform the step of providing a raw material in the carbon fiber surface oiling agent changing method. The feeding module 10 is used to provide a carbon fiber 71 (shown in FIG. 2) whose surface is coated with a first oiling agent 81.

[0050] The receiving module 20 is disposed in the vicinity of the feeding module 10, and corresponds to the feeding module 10 to constitute a carbon fiber drag route. The receiving module 20 includes at least one yarn winding assembly 21 to receive the carbon fiber 71 released from the feeding module 10. The yarn winding assembly 21 performs a drag action on the carbon fiber 71 to be received.

[0051] The desizing module 30 is to perform the desizing step in the carbon fiber surface oiling agent changing method. The desizing module 30 is disposed at the carbon fiber drag route between the feeding module 10 and the receiving module 20 for removing the first oiling agent 81 from the surface of the carbon fiber 71. The desizing module 30 is provided with at least one desizing furnace 31 capable of generating a heat source having a temperature of 250-650°C, such that the first oiling agent 81 can be removed from the surface of the carbon fiber 71 by the action of the desizing module 30 (as shown in FIG 3).

[0052] The plasma surface treatment module 40 is to perform the plasma surface treatment step in the carbon fiber surface oiling agent changing method. The plasma surface treatment module 40 is disposed at the carbon fiber drag route between the desizing module 30 and the receiving module 20 to provide a plasma gas flow with a predetermined power to act on the carbon fiber 71 without the first oiling agent 81, such that the surface of the carbon fiber 71 is formed with a plasma-modified configuration 711 (shown in FIG. 4) which is relatively rougher or has functional groups.

[0053] The sizing module 50 is to perform the sizing step in the carbon fiber surface oiling agent changing method. The sizing module 50 is disposed at the carbon fiber drag route between the plasma surface treatment module 40 and the receiving module 20 for the plasma-modified configuration 711 on the surface of the carbon fiber 71 to be coated with a second oiling agent 82 (as shown in FIG. 5). The sizing module 50 is provided with at least one reservoir 51 for storing the second oiling agent 82.

[0054] Thereby, the carbon fiber surface oiling agent changing apparatus of the present invention can be operated in the integrated operation of the feeding module 10, the desizing module 30, the plasma surface treatment module 40, the sizing module 50, and the receiving module 20. The carbon fiber 71 released from the feeding module 10 is sequentially processed at a predetermined speed to perform the steps of desizing, plasma surface treatment, sizing, and so on, in a relatively more active and reliable manner. The oiling agent on the surface of the carbon fiber 71 can be replaced with a desired oiling agent.

[0055] The plasma surface treatment module 40 is provided with at least one plasma generator 41 for generating a plasma gas flow. In this embodiment, the plasma surface treatment module 40 is provided with at least one plasma generator 41 disposed at the upper and lower positions of the carbon fiber drag route, respectively. The plasma generator 41 generates the plasma gas flow to act on the surface of the carbon fiber 71.

[0056] The plasma surface treatment module of the present invention provides a dry-type surface treatment for the carbon fiber. This not only prevents the carbon fiber from generating additional impurities or sediment but also reduces the working time and working procedure for drying after the completion of the plasma surface treatment. As shown in FIG. 8, the carbon fiber surface oiling agent changing apparatus of the present invention further comprise a drying module 60. The drying module 60 is to perform the drying step in the carbon fiber surface oiling agent changing method. The drying module 60 is disposed at the carbon fiber drag route between the sizing module 50 and the receiving module 20 for the second oiling agent to be firmly adhered to the surface of the carbon fiber. In practice, the drying module 60 is provided with at least one blast furnace 61 to generate hot blast.

[0057] Specifically, the carbon fiber surface oiling agent changing method and the carbon fiber surface oiling agent changing apparatus of the present invention are suitable for replacing a thermosetting resin oiling agent on the surface of the existing carbon fiber raw material with a thermoplastic resin oiling agent so that it can be applied to various kinds of electrical and electronic parts, mechanical parts and automobile parts which are formed by injection molding. Particularly, the surface of the carbon fiber is roughened and is provided with functional groups, which is beneficial to achieve high-quality interface bonding of the carbon fiber and the thermoplastic resin oiling agent in the subsequent sizing step, thereby enhancing the characteristics of carbon fiber composite materials.

[0058] Although particular embodiments of the present invention have been described in detail for purposes of illustration, various modifications and enhancements may be made without departing from the spirit and scope of the present invention. Accordingly, the present invention is not to be limited except as by the appended claims.

Claims

1. A carbon fiber surface oiling agent changing method, comprising:

providing a raw material step, providing a carbon fiber (71), the carbon fiber (71) being coated with a first oiling agent (81)
performing a desizing step, the first oiling agent (81) being removed;
performing a plasma surface treatment step, providing a plasma gas flow to act on the carbon fiber (71); and
performing a sizing step, a second oiling agent (82) being coated on the carbon fiber (71).

2. The carbon fiber surface oiling agent changing method as claimed in claim 1, wherein in the plasma surface treatment step, the plasma gas flow with a power of 100-10000 watts acts on the carbon fiber (71) for 10-1000 milliseconds.

3. The carbon fiber surface oiling agent changing method as claimed in claim 1, wherein in the plasma surface treatment step, an atmospheric plasma gas flow with a power of 100-10000 watts acts on the carbon fiber for 10-1000 milliseconds.

4. The carbon fiber surface oiling agent changing method as claimed in claim 1, wherein in the plasma surface treatment step, a low-pressure plasma gas flow with a power of 100-10000 watts acts on the carbon fiber for 10-1000 milliseconds.

5. The carbon fiber surface oiling agent changing method as claimed in claim 1, wherein in the plasma surface treatment step, a microwave plasma gas flow with a power of 100-10000 watts acts on the carbon fiber for 10-1000 milliseconds.

6. The carbon fiber surface oiling agent changing method as claimed in claim 1, wherein in the plasma surface treatment step, a glow plasma gas flow with a power of 100-10000 watts acts on the carbon fiber for 10-1000 milliseconds.

7. The carbon fiber surface oiling agent changing method as claimed in claim 1, wherein the desizing step is performed at a temperature of 250-650°C for 1-60 seconds.

8. The carbon fiber surface oiling agent changing method as claimed in claim 1, wherein the desizing step is performed by providing an organic solvent to remove the first oiling agent (81).

9. The carbon fiber surface oiling agent changing method as claimed in claim 8, wherein the organic solvent is acetone or chloroform.

10. The carbon fiber surface oiling agent changing method as claimed in claim 1, wherein in the sizing step, the second oiling agent is coated on the carbon fiber by soaking or by immersing.

11. The carbon fiber surface oiling agent changing method as claimed in claim 1, wherein the first oiling agent (81) is a thermosetting resin oiling agent, and the second oiling agent (82) is a thermosetting resin oiling agent or a thermoplastic resin oiling agent.

12. The carbon fiber surface oiling agent changing method as claimed in claim 1, wherein the second oiling agent (82) is one of polyurethane (PU), polyethene (PE), polypropylene (PP), and acrylic.

13. The carbon fiber surface oiling agent changing method as claimed in claim 1, further comprising a drying step after the sizing step, enabling the second oiling agent (82) to be firmly adhered to the carbon fiber (71).

14. A carbon fiber surface oiling agent changing apparatus, comprising:

a feeding module (10), capable of providing a carbon fiber (71), the carbon fiber (71) being coated with a first oiling agent (81);
a receiving module (20), disposed in the vicinity of the feeding module (10) and corresponding to the feeding module (10) to constitute a carbon fiber drag route, the receiving module (20) including at least one yarn winding assembly (21) to receive the carbon fiber (71) released from the feeding module (10) and to perform a drag action on the carbon fiber (71);
a desizing module (30), disposed at the carbon fiber drag route between the feeding module (10) and the receiving module (20) for removing the first oiling agent (81);
a plasma surface treatment module (40), disposed at the carbon fiber drag route between the desizing module (30) and the receiving module (20) for providing a plasma gas flow to act on the carbon fiber (71) ; and
a sizing module (50), disposed at the carbon fiber drag route between the plasma surface treatment module (40) and the receiving module (20) for coating a second oiling agent (82) on the carbon fiber (71).

15. The carbon fiber surface oiling agent changing apparatus as claimed in claim 14, wherein the plasma surface treatment module (40) is provided with at least one plasma generator (41).

16. The carbon fiber surface oiling agent changing apparatus as claimed in claim 14, wherein the plasma surface treatment module (40) is provided with at least one plasma generator (41) located at upper and lower positions of the carbon fiber drag route,

respectively.

17. The carbon fiber surface oiling agent changing apparatus as claimed in claim 15, wherein the plasma generator (41) is able to generate the plasma gas flow, an atmospheric plasma gas flow, a low-pressure plasma gas flow, a microwave plasma gas flow, or a glow plasma gas flow having a power in the range of 100-10000 Watts.

18. The carbon fiber surface oiling agent changing apparatus as claimed in claim 14, wherein the desizing module (30) is provided with at least one desizing furnace (31) capable of generating a heat source having a temperature of 250-650°C.

19. The carbon fiber surface oiling agent changing apparatus as claimed in claim 14, wherein the sizing module (50) is provided with at least one reservoir (51) for storing the second oiling agent (82).

20. The carbon fiber surface oiling agent changing apparatus as claimed in claim 14, further comprising a drying module (60), the drying module (60) being disposed at the carbon fiber drag route between the sizing module (50) and the receiving module (20), enabling the second oiling agent (82) to be firmly adhered to the surface of the carbon fiber (71).

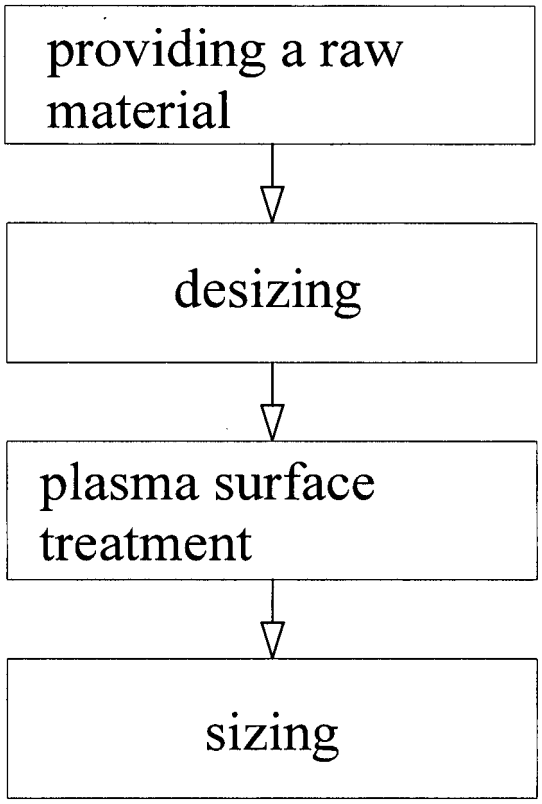
providing a raw material
desizing
plasma surface treatment
sizing

FIG.1

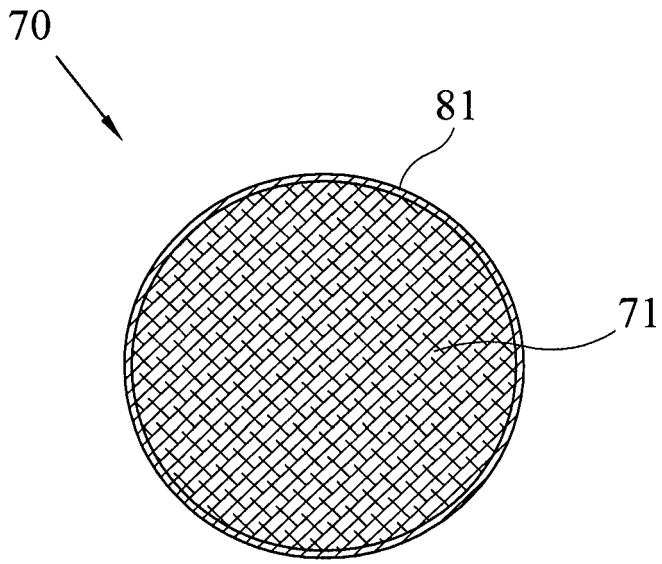

FIG.2

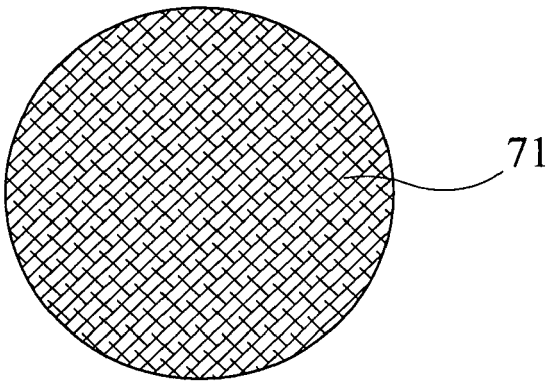

FIG.3

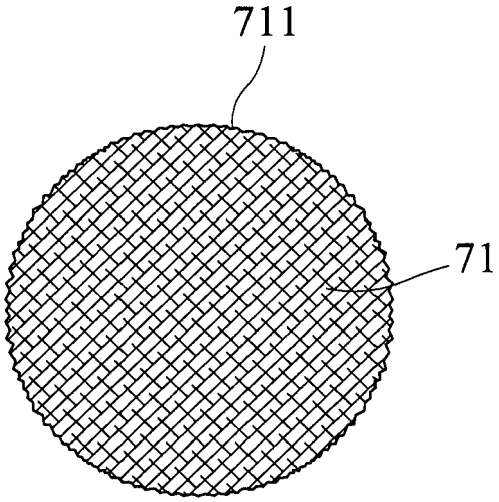

FIG.4

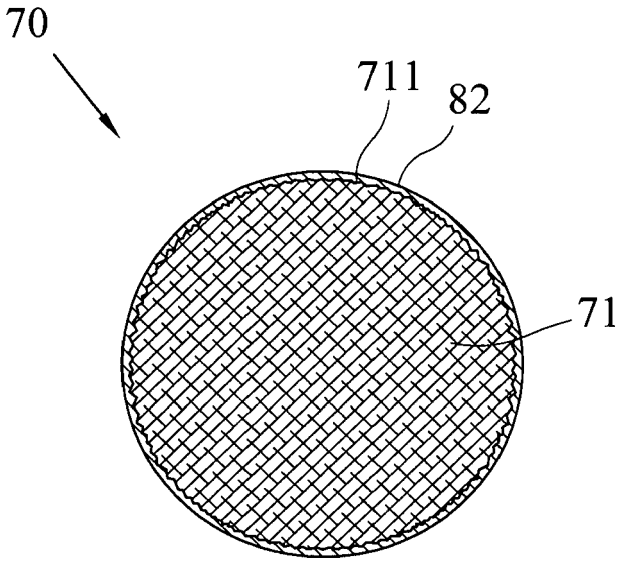

FIG.5

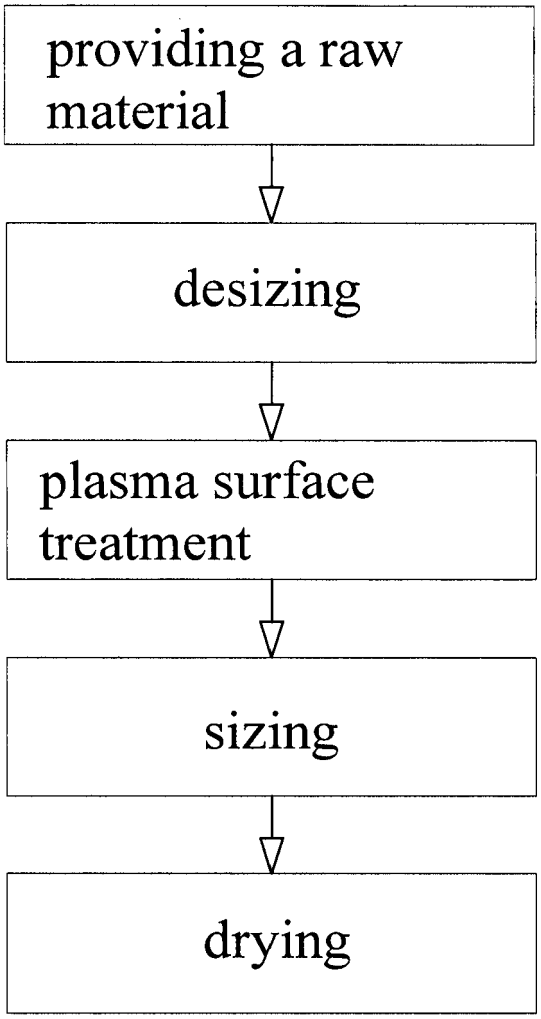
providing a raw material
desizing
plasma surface treatment
sizing
drying

FIG.6

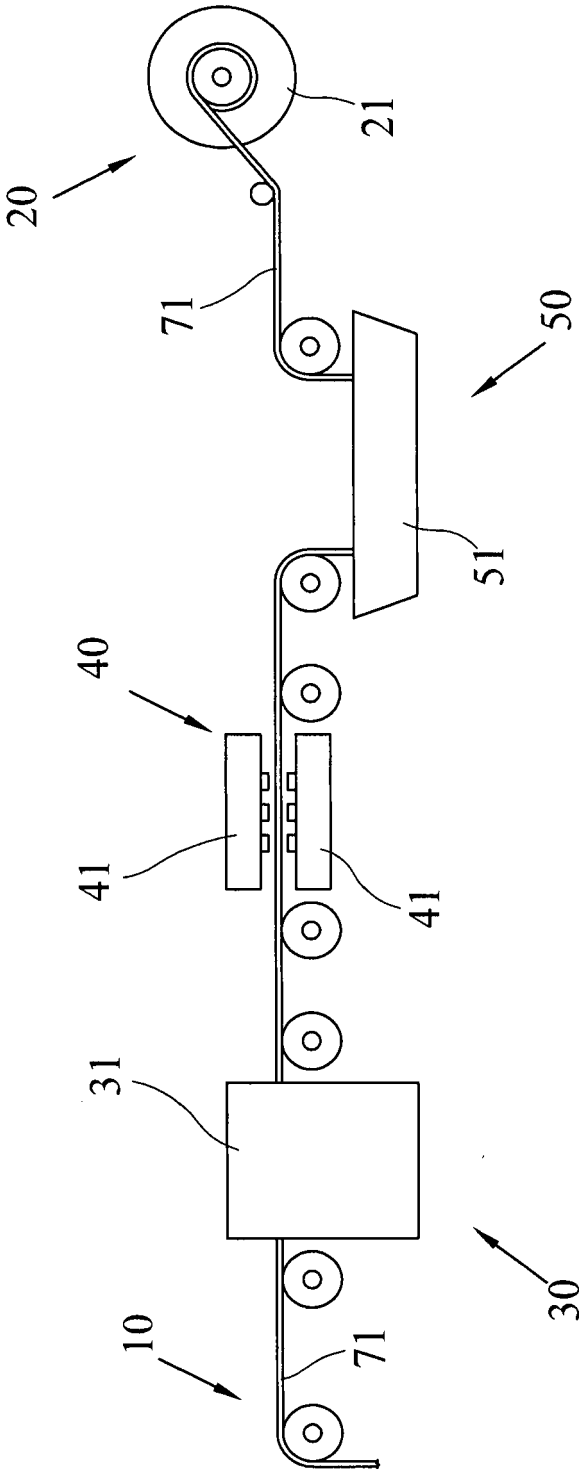

FIG.7

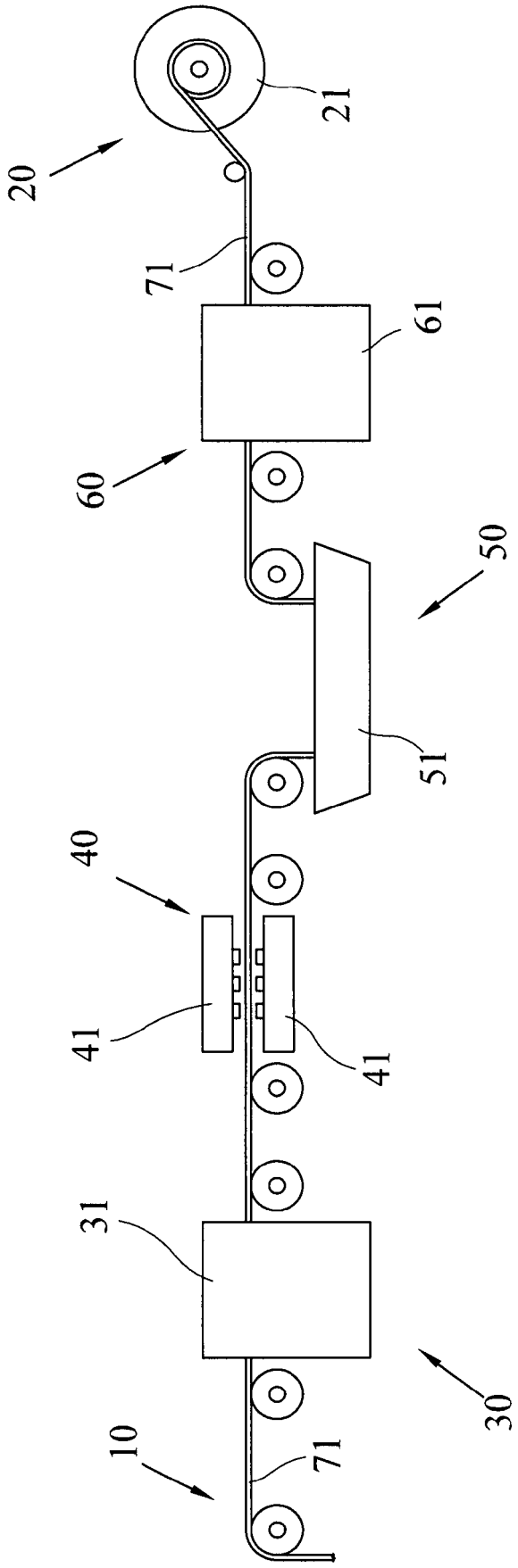

FIG.8

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 17 00 0055

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2010/178825 A1 (SHAH TUSHAR K [US] ET AL) 15 July 2010 (2010-07-15) * figure 8 * * example 1 * * claims 15,20-22,24,30-32 * * paragraphs [0056] - [0060], [0083], [0130] *	1-20	INV. D01F11/14 D01F11/16 ADD. D06M10/02 D06M101/40
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