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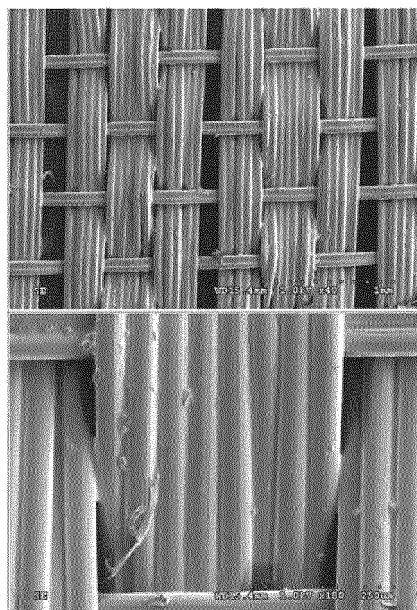
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(54) **MANUFACTURING METHOD OF WOVEN FABRIC FOR WEARABLE SOLAR CELL AND
FABRIC FOR WEARABLE SOLAR CELL THEREBY**

(57) The present invention provides a woven fabric used as an electrode substrate for preparing a wearable solar cell having excellent shape stability and flexibility.

The present invention is characterized in that when weaving the warp tension is individually adjusted, a selvedge yarn portions of the warp located at both edges of a unit fabric cell having a group of warps are formed to have a leno weaving, and the weaving by a metal fiber in a loom can be performed by preventing the yarn cutting and the sagging of the selvedge yarn portion of the warp.

FIG. 2



Description

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims priority to and the benefit of Korean Patent Application No. 10-2016-0035088 filed in the Korean Intellectual Property Office on March 24, 2016, the entire contents of which are incorporated herein by reference.

BACKGROUND OF THE DISCLOSURE

1. Field of the Disclosure

[0002] The present invention relates to a metal fiber weave fabric for flexible wearable solar cell comprising a woven fabric.

2. Description of the Related Art

[0003] A photovoltaic industry leading a renewable energy industry is expected to continuously grow in the future, and in particular, the market demand for thin film solar cells is increasing.

[0004] Meanwhile, recently, the attention has been focused on wearable devices due to the announcement of Google Glass.

[0005] A wearable device certainly requires 24-hour power supply. Accordingly, although a small-sized battery is built in, a development of a more effective power source capable of supplying power required for the wearable device is attracting attention.

[0006] As the global enters the smart era, the technology development of flexible electronic products and wearable devices has been focused on and the development of solar cells requires being light, durable and flexible.

[0007] The wearable solar cell developed as the above is expected to be applied to architectural interior materials, outdoor wear, smart health care and so on.

[0008] The wearable solar cell developed up to now uses an electrode body which consists of metal plates of an upper layer and a lower layer and cloth inserted between the two metal plates. And a flexible solar cell in the form of cloth is known to be manufactured by printing a photo electrode and a dye on the electrode body by screen printing, sealing with a sealing member, charging the inside of the member with an electrolyte and connecting a terminal electrode to a cloth electrode for wiring.

[0009] In addition, Korean Patent Publication No. 2014-0093791 (dye-sensitive solar cell using fiber weaving) discloses a solar cell using woven fabric. The solar cell is manufactured to be equipped with a photoelectrode and a counter electrode woven with wrap of a metal wire and weft of an insulator wire, and formed by charging the inside thereof with an electrolyte, and sealed.

[0010] It is difficult to fabricate a dense woven fabric so as to produce a solar cell, and there are problems that

cutting of fibers are occurs frequently because of the tension and frictional force that the fine metal fibers inevitably suffer during the weaving process, and accordingly that productivity in commercial weaving equipment is remarkably lowered.

SUMMARY OF THE DISCLOSURE

[0011] In order to solve the above problems, it is an object of the present invention to provide a method of preparing a woven fabric for a flexible wearable solar cell by using an electrode body woven with metal fibers.

[0012] To accomplish the object of the present invention, an embodiment of the present disclosure provides a method of preparing woven fabric for wearable solar cell comprising: when weaving metal fabric using metal yarn, warp tension setting step of setting a maximum warp tension at a predetermined set value according to property of the metal yarn before starting weaving; and weaving step of weaving with a warp tension at open shedding being set on the set value when the weaving is started and a rate of warp tension change at closed shedding being adjusted within 30% of the set value by warp tension adjusting device, wherein in a unit fabric cell having a group of warps, a selvage yarn portions of the warp located at both edges of the cell are formed to have a leno weaving, and a tension of a leno doubling warp for forming the leno structure is adjusted by a leno tension adjusting device.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013]

Fig. 1 is a woven fabric for a wearable solar cell according to an embodiment of the present invention. Fig. 2 is a magnified SEM photograph showing a surface of the woven fabric of Fig. 1.

Fig. 3 is a magnified SEM photograph showing a cross section of the woven fabric of Fig. 1.

Fig. 4 is an example of a loom including a warp adjusting device according to an embodiment of the present invention.

Fig. 5 is a fabric woven in a loom according to an embodiment of the present invention.

Fig. 6 is a photograph showing a leno heddle for forming a selvage yarn portion of a unit fabric cell according to an embodiment of the present invention.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0014] The present invention relates to a woven fabric for providing a wearable solar cell having excellent shape stability and flexibility. The present invention relates to a method comprising: using a metal fiber when manufacturing the woven fabric, separately regulating the tension of warp when weaving, and forming a leno weaving by

an outermost selvedge yarn portion of a unit fabric cell having a group of warps, thereby preventing the yarn from being cut and a warp of the selvedge yarn portion from being sagged to decrease the weaving defect rate and improve the weaving productivity.

[0015] A woven fabric according to the present invention is woven with fine metal fiber having the thickness of 35 to 100 μ m as a warp and a weft to have plain weave, dobby weave or satin weave, and in a unit fabric cell having a group of warps, a selvedge yarn portion of the warp located at both edges of the fabric cell is formed to have a leno weaving.

[0016] If the thickness of the metal fiber is less than 35 μ m, the warp can be cut off by the friction of the warp or stretched due to the tension during the weaving process, and it is easy to deviate the warp tension adjustment range by reacting sensitively the warp tension adjusting device of the present invention. If the thickness of the metal fiber exceeds 100 μ m, the open shedding and the closed shedding are not smooth due to the bad stretch characteristics of the metal fiber, so that the weaving speed is remarkably lowered, and the thickness of the weaving fabric is thickened to decrease the flexibility.

[0017] The metal fiber may be a fiber of metal material such as a stainless steel fiber(SUS yarns), a silver fiber, a copper fiber, a nickel fiber, and the like, but is not limited to and the stainless steel fiber is more preferable in terms of strength and cost.

[0018] The woven fabric of the present invention can be prepared by weaving in a conventional rapier loom capable of forming a wide width of 60 inches or more and at this time, while forming a unit fabric cell having a group of warps and the width of the unit fabric cell may be 10 to 300mm.

[0019] In addition, it is preferable that the unit fabric cell has a warp density of 100 to 600 ends/inch and accordingly, even when the electrolyte is injected into the spaces between the SUS yarns in the manufacturing process of the solar cell, the efficiency of the solar cell can be improved by uniform thickness of the intersections and non-intersections between the SUS yarns.

[0020] It is preferable that the woven fabric of the present invention is woven in the form of a combined yarn by passing 2-12 yarns of the warp, and accordingly, the metal fibers having thin thickness and weak strength and bad elongation characteristics can prevent the fiber from being cut due to the warp tension and a predetermined thickness at the intersection portion between SUS yarns can be formed.

[0021] The warp sagging of the both edges of the unit fabric cell occurs because the warp tension acts loosely. As a result, when the weft is inserted at the time of open shedding, the warp is frequently cut and the yarn is displaced from the original position and the weaving density is lowered.

[0022] Accordingly, in the present invention, the edge of the unit fabric cell forms the leno weaving (the fiber having leno weaving is formed by twisting a plurality of

warps positioned on the same line while one among the plurality of the warps is leftward and rightward reciprocating about the other warp and by weaving by the weft interposed therebetween.). Because the doup warp turns around the warp and the weft, the doup warp used for forming the leno weaving has a required length of 4 to 10 times that of the warp. As a result, a separate method is used for the edge warp such as use of a wrap beam for leno weaving or the provision of the warp with wrapping the wrap on a creel as many as the number of the warp for leno weaving.

[0023] At this time, the let-off tension of the warp for leno weaving is let-off by guide tension device using the warp beam or tension washer mounted on the upper and lower sides of the creel using the creel, and the difference in tension along the weaving axis of the warp for leno weaving is adjusted at every warp so that a constant tension is maintained.

[0024] It is preferable that the weaving density at the selvage yarn is 10 to 30% lower by controlling the density of the warp while maintaining the density of the weft. It is possible to prevent the problem that the thickness of the fabric is increased or the both ends of the fabric cell are splashed by making the selvage yarn portion less dense.

[0025] In generally weaving, the tension of the warp synchronizes with the main motion of the loom to changes in pulsation during one rotation of the main axis.

[0026] As a result, when the tension of the warp becomes temporarily high due to open shedding or beating motion, or when a pile is formed at low tension of the pile warp such as a towel loom, a proper tension correction is required in many steps in the weaving process.

[0027] The adjustment of the warp tension for correcting the tension may be performed by adjusting the rotational speed of the warp beam, or by winding the warp around the tension roll and responding the position change of the tension roll and controlling the amount of the let-off warp.

[0028] An easing motion can be used as a method of adjusting the warp tension.

[0029] During one cycle consisting of shedding, picking, and beating of a loom, an easing roll operation device such as a servo motor controlled by position control during a position control period including beating timing, is driven to set the easing roll to a predetermined right position to set the warp tension and is driven to move the easing roll so as to adjust the warp tension within the predetermined tension in the tension control period including the maximum shedding timing.

[0030] As mentioned above, the warp tension in the loom can be adjusted with the rotational speed of the warp beam, but an easing device particularly causing easing motion can be used to weave the high density fabric. In this case, since the easing device is driven by the crank shaft in a power transmitting manner, the capability of quickly grasping and finely controlling the change of the tension is decreased. As a result, it is not

easy to control the warp tension of the sensitive SUS yarns.

[0031] A wearable solar cell of the present invention is used as a material for a photoelectrode substrate by using a woven fabric using metal fibers such as titanium (Ti) or stainless steel. Because the metal fibers are fine and sensitive, when weaving, the deformation and the yarn cutting of metal fibers occur too much so that it is impossible to weave as much as desired. That is, metal fibers lack elasticity so that they are easily broken or stretched when they are subjected to a higher tension than the set tension. Because once they are stretched, they are not reduced to their original state, when weaving, many frictions and collisions incur cutting of yarn by deviating from the original position and the stretched warp is sagged so the weaving itself get impossible by a bad interlace of the warp and the weft. Thus, metal fibers are highly sensitive fibers so it is difficult to weave during the weaving process.

[0032] Accordingly, in the present invention, as shown in Fig. 4, in order to adjust the tension of the metal fiber warp to a predetermined range, the weaving can be performed together with controlling the warp tension within the range of the set tension value by the positive type rapier loom comprising a dobby for driving the individual harness frame; an easing device interlocked with the motion of the dobby; and an easing roller interlocked with the easing device, thereby adjusting warp tension by changing position in front, rear, left or right directions.

[0033] In a conventional loom, when weaving is started, the changed warp tension is measured, and then the warp tension is controlled through the easing device or the easing roller.

[0034] On the other hand, in the present invention, when the weaving is started, the dobby is operated for the open shedding and closed shedding and the warp tension is changed at the open shedding and the closed shedding by harness frame interlocked with the dobby. At this time, the easing device interlocked with the dobby operates simultaneously with the operation of the dobby, and by this operation, the position of the easing roller can be adjusted within the range of the predetermined value of the warp tension by changing the position of the easing roller in advance.

[0035] Generally, when weaving with metal yarns, the warp tension is maximized at the time of the open shedding and the warp tension at the time of the closed shedding is instantaneously decreased to 40 to 50% of the maximum warp tension. In the present invention, the maximum warp tension at the time of open shedding is set by the easing device interlocked with the dobby and the change rate of the warp tension is primarily controlled within 30% based on the set maximum warp tension by simultaneously operating the easing device according to the operation of the dobby at the time of the closed shedding, thus the change rate of the warp tension is minimized and the stability of the warp is improved and the weaving can be easily performed.

[0036] At this time, the set value of the maximum warp tension can be set according to the properties of the warp such as the kind, the number and the elongation of the warp.

5 **[0037]** At this time, the easing device can use an elastic means such as a position changing means by a weight to be applied or a spring or the like, but in the present invention, an easing device having a plurality of link mechanisms that perform joint motion in conjunction with the dobby motion is used.

10 **[0038]** In the construction of the fabric of the present invention, because when weaving with one warp and weft, the weaving cannot withstand the friction and the excessive tension change during weaving process, and the weaving itself becomes impossible, the warp of 2 to 12 yarns is leaded in a heald and a weft of 2 to 6 yarns is picked at a time when one time-picking is performed, thereby strengthening the weak Flexural strength of the warp and weaving densely,

15 **[0039]** At this time, a positive type rapier head can be applied to picking 2 to 6 yarns as described above.

20 **[0040]** Hereinafter, the present invention will be described in detail with reference to examples. It is to be understood, however, that these examples are for illustrative purposes only and are not intended to limit the scope of the present invention. It is to be understood that various changes, substitutions and alterations can be made herein without departing from the scope of the invention. And will be apparent to those skilled in the art to which the present invention pertains.

[Example]

35 **[0041]** The weaving was performed so as to have a unit fabric cell in which the width is 18mm and the length is 10mm, to be the width between each fabric cell of 10mm and the length therebetween of 10mm, by using positive type rapier loom equipped with the warp tension adjusting device comprising: a dobby; an easing device equipped with a plurality of link mechanisms for performing a joint motion by being interlocked with the motion of the dobby; and an easing roller interlocked with the easing device, thereby adjusting directly the warp tension by changing position in front, rear, left or right directions. In order to weave in plain weave so as to form a plurality of unit fabric cells having fiber density wherein the warp density is 576 ends / inch, the weft density in which 2 yarn is picked in 1 pick, is 80T (thread)/inch, stainless steel fibers having a diameter of 50 μ m and a circular cross section was used as a warp and a weft, 4 yarns of the warp were passed through one heald and 12 yarns are led in into one reed to set a maximum warp unit number to 19,200 for preparing the weaving.

40 **[0042]** And then the maximum tension of the warp is set at a predetermined set value (15Kg) before starting the weaving, and when the weaving is started, the dobby is operated to form a cycle of open shedding, picking and closed shedding, and at the same time, while the easing

device and the easing roller, interlocked with the dobby and the easing device, respectively, are operated to weave a fabric shown in Fig. 5, with reducing the warp tension at time of closed shedding so that the change rate of the warp tension is 20% with respect to the predetermined set value.

[0043] At this time, in order to make a selvage yarn portion of the warp located at both edges of the fabric cell having a leno weaving, a leno warp is applied in a predetermined tension by a tension washer mounted on the upper and lower sides of the leno warp creel and is woven to be a length of the leno doubling warp as 6 times that of the non-doubling warp.

[0044] Since in a conventional loom, the metal fiber has bad elasticity and is sensitive to a change in the tension, it is almost impossible to commercially weave because of a large number of yarn cutting. However, the present invention uses a dobby, an easing device which is equipment for easing motion and interlocked with the dobby, and an easing roller interlocked with the easing device to preferentially adjust the warp tension at the same time of change start of the warp tension, thus as a result, the degree of change in the warp tension can be reduced easily and precisely and the occurrence of yarn cutting can be prevented and it is possible to commercially weave metal fibers in a loom.

[0045] Although the present invention has been described in detail with reference to the specific features, it will be apparent to those skilled in the art that this description is only for a preferred embodiment and does not limit the scope of the present invention. Thus, the substantial scope of the present invention will be defined by the appended claims and equivalents thereof.

Claims

1. A method of preparing woven fabric for wearable solar cell comprising:

when weaving metal fabric using metal yarn, warp tension setting step of setting a maximum warp tension at a predetermined set value according to property of the metal yarn before starting weaving; and

weaving step of weaving with a warp tension at open shedding being set on the set value when the weaving is started and a rate of warp tension change at closed shedding being adjusted within 30% of the set value by warp tension adjusting device,

wherein in a unit fabric cell having a group of warps, a selvage yarn portions of the warp located at both edges of the cell are formed to have a leno weaving, and a tension of a leno doubling warp for forming the leno structure is adjusted by a leno tension adjusting device.

2. The method of preparing woven fabric for wearable solar cell of claim 1, wherein the metal yarn is stainless steel yarn and has a diameter of 35 to 100 μ m.

3. The method of preparing woven fabric for wearable solar cell of claim 1, wherein the warp tension adjusting device comprises:

a dobby for operating harness frame for open shedding and closed shedding;
an easing device equipped with a plurality of link mechanisms for performing a joint motion so as to move an easing roller with interlocked with the motion of the dobby; and
an easing roller interposed between warp beam and heald and interlocked with the easing device, thereby adjusting warp tension by changing position in front, rear, left or right directions, wherein the dobby is operated for open and closed shedding, the easing device interlocked with the dobby is operated simultaneously with the operation of the dobby and a position of the easing roller is changed in front, rear, left or right directions accordingly to adjust a warp tension.

4. The method of preparing woven fabric for wearable solar cell of claim 1, wherein a required length of the leno warp is 4 to 10 times that of the warp.

5. The method of preparing woven fabric for wearable solar cell of claim 1, wherein the warp of 2 to 12 yarns is leaded in a heald and a weft of 2 to 6 yarns is picked at a time when one time-picking is performed.

6. The method of preparing woven fabric for wearable solar cell of claim 1, wherein the cell has 100 to 600 ends/inch of a density of the warp.

7. The method of preparing woven fabric for wearable solar cell of claim 1, wherein a maximum warp unit number is 6,400 to 32,000 by leading in 2 to 16 yarns per a reed when weaving.

8. The method of preparing woven fabric for wearable solar cell of claim 1, wherein a plurality of the unit fabric cell is formed when weaving or a fabric cell of the unit having a same width as when weaving is formed.

9. The method of preparing woven fabric for wearable solar cell of claim 1, wherein the metal fabric is any one of plain weave, dobby weave and satin weave.

10. A woven fabric for wearable solar cell prepared by the method of anyone of claim 1 to claim 9, having 100 to 600 ends/inch of a warp density of the metal yarn.

FIG. 1

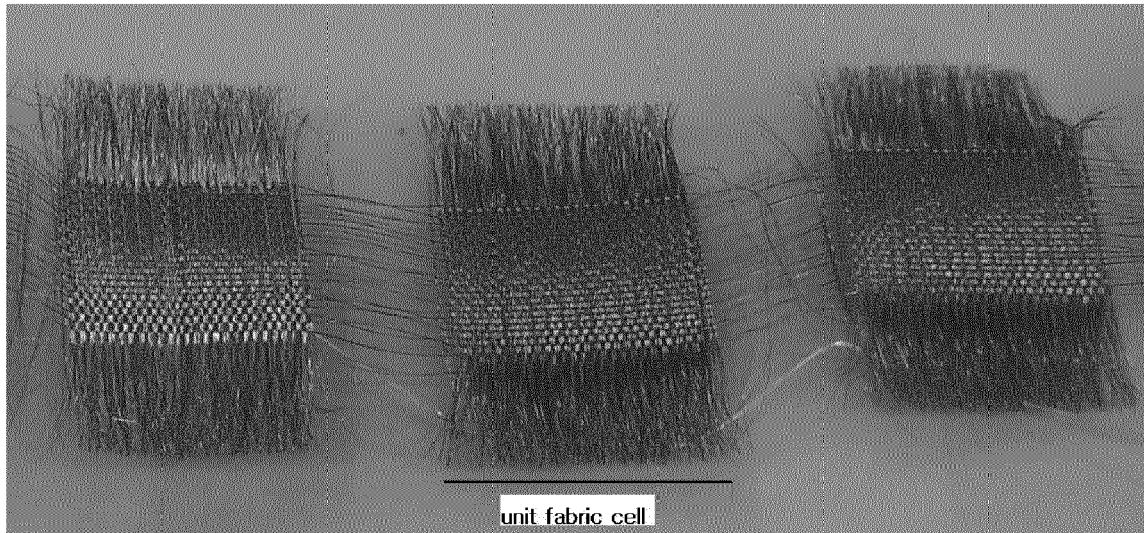


FIG. 2

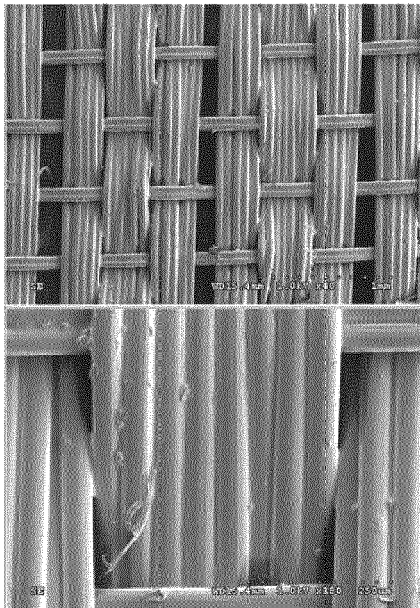


FIG. 3

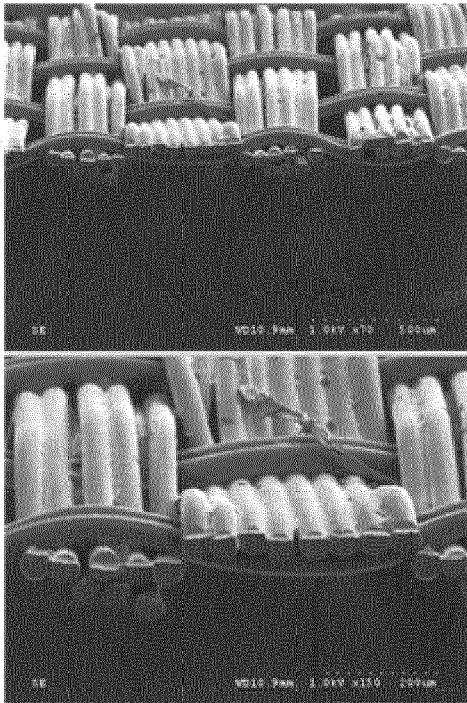


FIG. 4

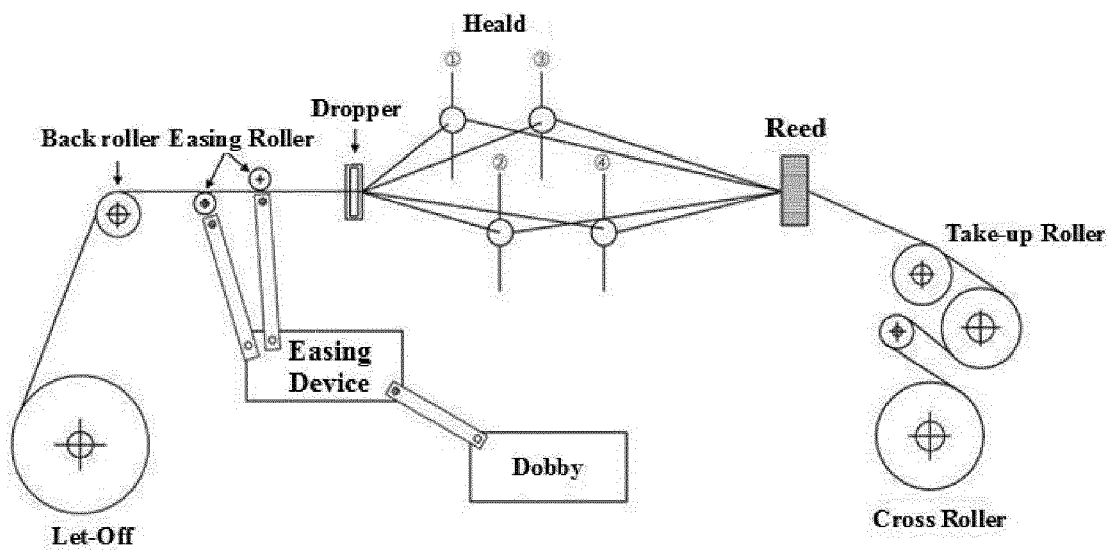


FIG. 5

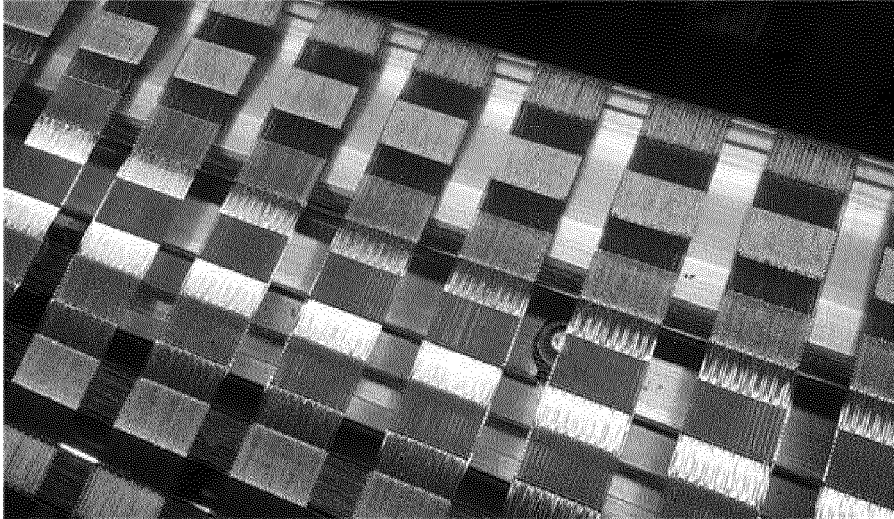
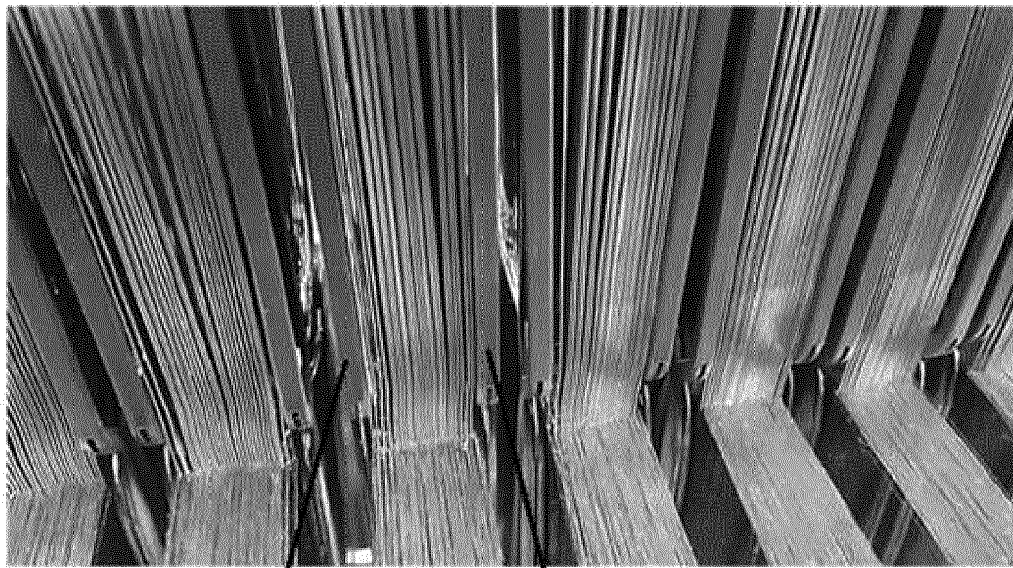


FIG. 6



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EUROPEAN SEARCH REPORT

Application Number
EP 17 15 0284

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EPO FORM 1503 03.82 (P04C01)

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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 17 July 2017	Examiner Hausding, Jan
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

**ANNEX TO THE EUROPEAN SEARCH REPORT
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5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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