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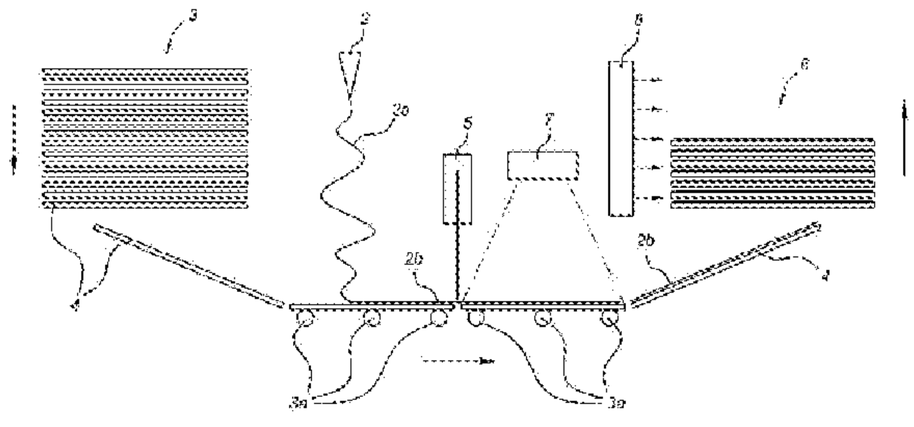
(54) Method and device for depositing a fiber material layer on a carrier

(57) Method and device for depositing a fiber material layer (2b) on a carrier, such as using an electrospinning process. The device includes a deposition unit (2) positioned remote from the carrier during operation, and the deposition unit (2) is arranged for forming the fiber material layer (2b) on the carrier in a continuous manner. A carrier feed unit (3) is provided for feeding the carrier in a transport direction with a predetermined speed (v_b), wherein the carrier comprises a plurality of carrier plates (4). A cutting unit (5) is present and arranged downstream from the deposition unit (2), the cutting unit (5) being arranged to cut the deposited fiber material layer (2b) in between two adjacent ones of the plurality of carrier plates (4).



NL B1 2023085

Method and device for depositing a fiber material layer on a carrier

Field of the invention

The present invention relates, in a first aspect to a method for depositing a fiber material layer on a carrier, the method comprising feeding the carrier in a transport direction with a predetermined speed, and forming the fiber material layer on the carrier in a continuous manner, the carrier moving in the transport direction. In a second aspect, the present invention relates to a device for depositing a fiber material layer on a carrier, the device comprising a deposition unit positioned remote from the carrier during operation, the deposition unit being arranged for forming the fiber material layer on the carrier in a continuous manner.

Background art

International patent publication WO2012/050682 discloses an electrospinning method for forming an integrated separator for lithium-ion batteries, using roll-to-roll processing of a carrier substrate. The separator is made of a porous electro-spun polymer material and has a nanofiber backbone structure.

Summary of the invention

The present invention seeks to provide an improved method and device for providing a fiber material layer, allowing reliable and large scale production of the fiber material layer.

According to the present invention, a method as defined above is provided, wherein the carrier comprises a plurality of carrier plates, and the method further comprises cutting the deposited fiber material layer in between two adjacent ones of the plurality of carrier plates. In a further aspect, a device as defined above is provided, the device further comprising a carrier feed unit for feeding the carrier in a transport direction with a predetermined speed, wherein the carrier comprises a plurality of carrier plates, and a cutting unit arranged downstream from the deposition unit, the cutting unit being arranged to cut the deposited fiber material layer in between two adjacent ones of the plurality of carrier plates. The present invention embodiments allow to post-process the fiber material layers on individual carrier plates, e.g. by stacking the individual carrier plates. This in turn allows to keep the fiber material layers unaffected, without compression and with the possibility to allow outgassing (i.e. evaporation of remaining solvents) in a sufficient manner.

Short description of drawings

The present invention will be discussed in more detail below, with reference to the attached drawings, in which

Fig. 1 shows a schematic diagram of a device for depositing a fiber material layer on a carrier according to an embodiment of the present invention;

Fig. 2 shows a detailed view of a stack of carrier plates as applied in the device embodiment of Fig. 1; and

Fig. 3 shows a perspective view of two adjacent carrier plates subjected to a cutting step.

Description of embodiments

The present invention relates to a method and device for depositing a fiber material layer on a carrier in a generic sense, allowing to be used in large scale fiber material deposition processes to enhance the (fiber) product reproducibility and improved automation of such processes. Examples of the deposition techniques wherein the present invention embodiments may be advantageously applied are electrospinning, electro-spraying and melt-printing (e.g. a melt electro writing (MEW) process).

Bulk production of fibers into a flat 'matt' structure is e.g. done by spinning onto a roll-to-roll carrier as a continuous process. Roll-to-roll carriers however have some drawbacks when it comes to maintaining the integrity of the produced fibrous structures. The collection of the freshly spun fibers onto a roll causes the fibers to become compressed between successive layers on the roll which can cause unwanted deformation of the mesh structure. The compression also causes the fibrous layer to attach to the successive carrier layer, which causes damage of the structure at the unwinding of the roll. Moreover, rolling up successive layers causes suffocation of the evaporation of the remaining solvent inside the freshly spun fibers. This results in an uneven drying course inside the fiber matt and may cause unwanted (severe) morphology changes of the fibers and mesh structure. Finally, the collection of freshly spun fibers onto a roll also causes the matt to set in a bended form which may cause bulging or wrinkling of the matt when flattened later, which can be very undesirable in post-processing steps.

In the present invention method and device embodiments, the rolls are replaced by a feed of individual carrier plates 4, e.g. by means of a sheet or plate feeder and sheet or plate collector. The process applied is e.g. electro-spinning wherein a fiber 2a is spun onto the carrier plates 4 in a continuous fashion and as such, creates an endless fiber matt or fiber material layer 2b. Directly after the spinning process the endless fiber matt is cut between successive carrier plates 4 to enable the separation of the carrier plates 4 with fiber material layer 2b and to prevent any stress in the fiber material layer 2b due to the further handling of the carrier plates 4.

An exemplary embodiment of a device according to the present invention is shown schematically in Fig. 1. A carrier feed unit 3 is provided, which holds a stack of carrier plates 4, and is arranged for feeding a (generic) carrier in a transport direction (shown with the arrow in the drawing) with a predetermined speed v_b. The carrier comprises a plurality or sequence of (adjacent) carrier plates 4. As shown in this exemplary embodiment, the individual carrier plates 4 are transported using rollers 3a, which may be controlled to keep the predetermined speed v_b and a distance s between adjacent carrier plates 4 (see also Fig. 3 discussed below) constant. As an alternative to rollers 3a, e.g. a conveyor belt or sprocket wheels may be used.

A deposition unit 2 is shown schematically in Fig. 1, which in this exemplary embodiment is an electrospinning assembly which during operation provides a single endless fiber 2a onto a target, i.e. the carrier plates 4 as shown, thus forming the fiber material layer 2b. Furthermore, a

cutting unit 5 is present, which is arranged to cut through the fiber material layer 2b in order to obtain individual carrier plates 4 with a fiber material layer 2b on top of it.

In the Fig. 1 exemplary embodiment, further (optional) units are present, such as an inspection unit 7, a drying unit 8 and a stacking unit 6, the functioning of which will be explained below referring to further embodiments of the present invention.

In a generic embodiment, the present invention relates to a device for depositing a fiber material layer on a carrier, the device comprising a deposition unit 2 positioned remote from (e.g. above as indicated in the Fig. 1 embodiment, but deposition can also be from below) the carrier during operation, the deposition unit 2 being arranged for forming the fiber material layer 2b layer on the carrier in a continuous manner. A carrier feed unit 3 is provided for feeding the carrier in a transport direction with a predetermined speed v_b. wherein the carrier comprises a plurality of carrier plates 4. A cutting unit 5 is arranged downstream from the deposition unit 2, the cutting unit 5 being arranged to cut the deposited fiber material layer 2b in between two adjacent ones of the plurality of carrier plates 4. In an even more generic sense, the present invention relates to a method for depositing a fiber material layer on a carrier, the method comprising feeding the carrier in a transport direction with a predetermined speed, forming the fiber material layer on the carrier in a continuous manner, the carrier moving in the transport direction, wherein the carrier comprises a plurality of carrier plates 4. The method further comprises cutting the deposited fiber material layer in between two adjacent ones of the plurality of carrier plates 4. It is noted that using this method, or operating this device, a fiber material layer 2b (e.g. a layer of electro-spun material) is deposited onto the plurality of carrier plates 4, wherein the fiber material layer 2b has a predetermined lateral strength in the transport direction (before being cut). All present invention embodiments provide the advantage that the individual carrier plates 4 with fiber material layer 2b can be processed further individually, such that no bending or suffocation of the freshly formed fiber material layer 2b occurs, easy drying can be provided, and more easy outgassing of solvents, etc. can be accomplished.

In a further embodiment, the device further comprises a stacking unit 6 positioned downstream from the cutting unit 5, the stacking unit 6 being arranged to stack adjacent ones of the plurality of carrier plates 4. In analogy, the present invention method embodiments may further comprise stacking adjacent ones of the plurality of carrier plates 4 after the cutting. This allows to provide a compact, small footprint device, and by properly controlling both the carrier feed unit 3 and the stacking unit 6, it is possible to cater for timing variations in further processing steps of the individual carrier plates 4 (e.g. drying, see below).

This can even be enhanced at the input side of the device by adding a further optional feature, wherein the carrier feed unit 3 comprises a de-stacking unit, the de-stacking unit being arranged for taking a carrier plate 4 from a stack of carrier plates 4 and forming the plurality of carrier plates 4. De-stacking units as such are well known to the person skilled in the art in various implementation schemes, and can be adapted to specifically suit the dimensions of the carrier plates 4 as used in the present invention embodiments. In an associated method embodiment, feeding the carrier comprises taking a carrier plate 4 from a stack of carrier plates 4 and forming the plurality of carrier plates 4. In addition to providing an efficient, compact, small footprint device

on the input side, it is noted that in the end it would be possible that the stack of carrier plates 4 can be re-used after e.g. removing the individual fiber material layers 2b and cleaning the carrier plates 4.

As shown in more detail in the cross-sectional view in Fig. 2 of a stack of carrier plates 4 provided with a fiber material layer 2b (in the stacking unit 6), the carrier plates 4 can be stacked with an inter-stack distance d. By stacking the carrier plates 4 coated with fiber material layer 2b in a separated manner with distance d, it is ensured that the fiber material layer 2b cannot be compressed, suffocated and/or induced by bending stresses.

This is further ensured in a further method embodiment, further comprising stacking adjacent ones of the plurality of carrier plates 4 with an inter-stack distance d, the inter-stack distance d being larger than the sum of a thickness t_c of an individual carrier plate 4 plus a thickness t_f of the fiber material layer 2b. The inter-stack distance d will provide space between carrier plates 4 to allow drying/outgassing/etc. of the fiber material layer 2b. Stacking the carrier plates 4 in a separated manner also creates (in a small footprint) a sort of drying 'tunnel', and, additionally or alternatively, can also provide a buffer from which the carrier plates 4 can be fed into an automated post-processing scheme.

In a further embodiment, cutting is performed using a mechanical cutting method, e.g. using moving knives or razor blades. Alternatively, cutting is performed using a contactless cutting method. An example thereof is a material ablation cutting technique, such as laser cutting. In an even further alternative, abrasive cutting methods may be applied, such as waterjet cutting.

As the cutting must be performed between successive moving carrier plates 4 during operation of the device (which cannot be periodically stopped), the cutting unit 5 follows the plate speed v_b during the cut with cutting speed v_c. This can e.g. be accomplished by implementing a "flying saw" approach where the cutting unit 5 (more specifically an actual cutting element of the cutting unit 5) moves along with the carrier plates 4 in a synchronized way during the cut. This is shown schematically in Fig. 3.

In an embodiment of the present invention, the plurality of carrier plates 4 comprise a rigid (or stiff) material, e.g. a metal. This allows easy, proper and reliable handling of the individual (and sequence) of carrier plates 4, such as during (de-)stacking.

Using rigid individual carrier plates 4 also enables improved inline quality control steps, such as thickness measurement of the individual (e.g. electrospun) fiber material layer 2b. In a further device embodiment, to this end, the device further comprises an inspection unit 7 positioned downstream from the cutting unit 5, the inspection unit 7 being arranged for inspecting the fiber material layer 2b on individual ones of the plurality of carrier plates 4.

In the associated method embodiment, the method further comprises inspecting the fiber material layer 2b on individual ones of the plurality of carrier plates 4 after the cutting. In a first alternative, inspecting comprises a thickness measurement. If the individual carrier plate 4 thickness t_c is known, allows to perform a precise measurement of the thickness t_c of the fiber material layer 2b thereon, e.g. using laser distance measurement. Additionally or alternatively, inspecting comprises image analysis. Using this embodiment can be applied e.g. for detecting mesh

defects in the fiber material layer 2b. The inspection measurements can be even further enhanced if, according to a further embodiment, individual ones of the plurality of the carrier plates 4 comprise individual identification codes, e.g. a readable, bar or QR code. In this manner, each carrier plate 4 can have a specific ID code in combination with pre-identified carrier thickness t_c information. Subtracting the exact carrier thickness t_c on the measurement location makes a precise determination of the thickness t_f of the fiber material layer 2b possible. It is noted that these type of inspection steps are very hard to achieve in a roll-to-roll situation of depositing a fiber material layer on a carrier.

The carrier plates 4 can also have specific features especially adapted for production and/or post processing of the fiber material layer 2b. In one embodiment, the plurality of carrier plates 4 comprise a predetermined pattern, e.g. etched, coated or metallic patterns, which e.g. allows to collect fibers in specific directions. In a further embodiment, the plurality of carrier plates 4 comprise a surface which is compatible with post-processing of the fiber material layer 2b. The surface of each carrier plate 4 can e.g. be of a material insensitive to post-processing, or have a coating or surface finish which is compatible with the post-processing. Compatible with the post-processing is to be understood broadly, and includes being inert to, or resistant/insensitive to post-processing techniques. The post-processing e.g. comprises using a laser cutting technique to obtain specific geometries out of the fiber material layer 2b on the surface of the carrier plates 4. In an even further embodiment, the plurality of carrier plates 4 comprise a surface layer, e.g. in the form of an anti-stick or Teflon layer, which allows to easily separate the fiber material layer 2b from the carrier plate 4. Alternatively or additionally, the carrier plates 4 are pre-treated, by e.g. smoothing of the surface.

Other examples of post-processing steps would be incorporated product handling, quality inspection, and/or scrap management (e.g. excluding a carrier plate 4 from stacking and/or post-processing when a mesh defect is detected in the fiber material layer 2b.

In a specific further embodiment, the method further comprises drying the plurality of carrier plates 4, e.g. after stacking the carrier plates. The device can accordingly further comprise a drying unit 8 positioned downstream from the cutting unit 5, the drying unit 8 being arranged to enhance drying of the fiber material layer 2b on individual ones of the plurality of carrier plates 4.As such, drying units for drying deposited material on a carrier plate are known to the person skilled in the art. The drying unit 20 can be arranged to be operative on a single carrier plate 4 (directly downstream of the cutting unit 5), or on a stack of carrier plates 4, such as when the stack is in the stacking unit 6 (see Fig. 1). Depending on the exact deposition process type and type of fiber material layers 2 being formed using the present invention embodiments, specific adaptations of the drying unit 8 can be implemented.

In the above, exemplary embodiments of the present invention have been described with reference to the drawings, which may also be described by the following numbered and interrelated embodiments.

Embodiment 1. Method for depositing a fiber material layer (2b) on a carrier, the method comprising

feeding the carrier in a transport direction with a predetermined speed,

forming the fiber material layer (2b) on the carrier in a continuous manner, the carrier moving in the transport direction,

wherein the carrier comprises a plurality of carrier plates (4), and the method further comprises

cutting the deposited fiber material layer (2b) in between two adjacent ones of the plurality of carrier plates (4).

Embodiment 2. Method according to embodiment 1, further comprising stacking adjacent ones of the plurality of carrier plates (4) after the cutting.

Embodiment 3. Method according to embodiment 2, further comprising stacking adjacent ones of the plurality of carrier plates (4) with an inter-stack distance (d), the inter-stack distance (d) being larger than the sum of a thickness (tc) of an individual carrier plate (4) plus a thickness (tf) of the fiber material layer (2b).

Embodiment 4. Method according to any one of embodiments 1-3, wherein feeding the carrier comprises taking a carrier plate (4) from a stack of carrier plates (4) and forming the plurality of carrier plates (4).

Embodiment 5. Method according to any one of embodiments 1-4, wherein cutting is performed using a mechanical cutting method.

Embodiment 6. Method according to any one of embodiments 1-4, wherein cutting is performed using a contactless cutting method.

Embodiment 7. Method according to any one of embodiments 1-6, wherein the method further comprises inspecting the fiber material layer (2b) on individual ones of the plurality of carrier plates (4) after the cutting.

Embodiment 8. Method according to any one of embodiments 1-7, wherein inspecting comprises a thickness measurement.

Embodiment 9. Method according to any one of embodiments 1-7, wherein inspecting comprises image analysis.

Embodiment 10. Method according to any one of embodiments 1-9, wherein individual ones of the plurality of the carrier plates (4) comprise individual identification codes.

Embodiment 11. Method according to any one of embodiments 1-10, wherein the plurality of carrier plates (4) comprise a rigid material.

Embodiment 12. Method according to any one of embodiments 1-11, wherein the plurality of carrier plates (4) comprise a predetermined pattern.

Embodiment 13. Method according to any one of embodiments 1-12, wherein the plurality of carrier plates (4) comprise a surface which is compatible with post-processing of the fiber material layer (2b).

Embodiment 14. Method according to any one of embodiments 1-13, wherein the plurality of carrier plates (4) comprise a surface layer.

Embodiment 15. Method according to any one of embodiments 1-14, wherein the method further comprises drying the plurality of carrier plates (4).

Embodiment 16. Device for depositing a fiber material layer (2b) on a carrier, the device comprising

a deposition unit (2) positioned remote from the carrier during operation, the deposition unit (2) being arranged for forming the fiber material layer (2b) on the carrier in a continuous manner,

a carrier feed unit (3) for feeding the carrier in a transport direction with a predetermined speed (vb), wherein the carrier comprises a plurality of carrier plates (4), and

a cutting unit (5) arranged downstream from the deposition unit (2), the cutting unit (5) being arranged to cut the deposited fiber material layer (2b) in between two adjacent ones of the plurality of carrier plates (4).

Embodiment 17. The device according to embodiment 16, further comprising

a stacking unit (6) positioned downstream from the cutting unit (5), the stacking unit (6) being arranged to stack adjacent ones of the plurality of carrier plates (4).

Embodiment 18. The device according to embodiment 16 or 17, wherein the carrier feed unit (3) comprises a de-stacking unit, the de-stacking unit being arranged for taking a carrier plate (4) from a stack of carrier plates (4) and forming the plurality of carrier plates (4).

Embodiment 19. The device according to any one of embodiments 16-18, further comprising

an inspection unit (7) positioned downstream from the cutting unit (5), the inspection unit (7) being arranged for inspecting the fiber material layer (2b) on individual ones of the plurality of carrier plates (4).

Embodiment 20. The device according to any one of embodiments 16-19, further comprising

a drying unit (8) positioned downstream from the cutting unit (5), the drying unit (8) being arranged to enhance drying of the fiber material layer (2b) on individual ones of the plurality of carrier plates (4).

The present invention has been described above with reference to a number of exemplary embodiments as shown in the drawings. Modifications and alternative implementations of some parts or elements are possible, and are included in the scope of protection as defined in the appended claims.

CONCLUSIES

1. Werkwijze voor het deponeren van een vezelmateriaallaag (2b) op een drager, waarbij de werkwijze omvat

het toevoeren van de drager in een transportrichting met een vooraf bepaalde snelheid,

het op een continue wijze vormen van de vezelmateriaallaag (2b) op de drager, waarbij de drager in de transportrichting beweegt,

waarbij de drager een veelvoud van draagplaten (4) omvat, en waarbij de werkwijze verder omvat het snijden van de gedeponeerde vezelmateriaallaag (2b) tussen twee aangrenzende draagplaten van het veelvoud van draagplaten (4).

2. Werkwijze volgens conclusies 1, verder omvattende het stapelen van aangrenzende draagplaten van het veelvoud van draagplaten (4) na het snijden.

3. Werkwijze volgens conclusie 2, verder omvattende het stapelen van aangrenzende draagplaten van het veelvoud van draagplaten (4) met een tussenstapelafstand (d), waarbij de tussenstapelafstand (d) groter is dan de som van een dikte (t_c) van een afzonderlijke draagplaat (4) plus een dikte (t_f) van de vezelmateriaallaag (2b).

4. Werkwijze volgens één van de conclusies 1-3, waarbij het toevoeren van de drager omvat het opnemen van een draagplaat (4) uit een stapel van draagplaten (4) en het vormen van het veelvoud van draagplaten (4).

5. Werkwijze volgens één van de conclusies 1-4, waarbij het snijden wordt uitgevoerd met een mechanische snijwerkwijze.

6. Werkwijze volgens één van de conclusies 1-4, waarbij het snijden wordt uitgevoerd met een contactloze snijwerkwijze.

7. Werkwijze volgens één van de conclusies 1-6, waarbij de werkwijze verder omvat het inspecteren van de vezelmateriaallaag (2b) op afzonderlijke draagplaten van het veelvoud van draagplaten (4) na het snijden.

8. Werkwijze volgens één van de conclusies 1-7, waarbij het inspecteren een diktemeting omvat.

9. Werkwijze volgens één van de conclusies 1-7, waarbij het inspecteren beeldanalyse omvat.

10. Werkwijze volgens één van de conclusies 1-9, waarbij afzonderlijke draagplaten van het veelvoud van draagplaten (4) individuele identificatiecodes omvatten.

11. Werkwijze volgens één van de conclusies 1-10, waarbij het veelvoud van draagplaten (4) een stijf materiaal omvat.

12. Werkwijze volgens één van de conclusies 1-11, waarbij het veelvoud van draagplaten (4) een vooraf bepaald patroon omvat.

13. Werkwijze volgens één van de conclusies 1-12, waarbij het veelvoud van draagplaten (4) een oppervlak omvat dat compatibel is met nabewerking van de vezelmateriaallaag (2b).

14. Werkwijze volgens één van de conclusies 1-13, waarbij het veelvoud van draagplaten (4) een oppervlaktelaag omvat.

15. Werkwijze volgens één van de conclusies 1-14, waarbij de werkwijze verder omvat het drogen van het veelvoud van draagplaten (4).

16. Inrichting voor het deponeren van een vezelmateriaallaag (2b) op een drager, waarbij de inrichting omvat
een depositie-eenheid (2) die tijdens bedrijf op afstand van de drager is gepositioneerd, waarbij de depositie-eenheid (2) is ingericht voor het op een continue wijze vormen van de vezelmateriaallaag (2b) op de drager,
een dragertoevoereenheid (3) voor het toevoeren van de drager in een transportrichting met een vooraf bepaalde snelheid (v_b), waarbij de drager een veelvoud van draagplaten (4) omvat, en
een snijeenheid (5) die stroomafwaarts van de depositie-eenheid (2) is opgesteld, waarbij de snijeenheid (5) is ingericht om de gedeponeerde vezelmateriaallaag (2b) tussen twee aangrenzende draagplaten van het veelvoud van draagplaten (4) door te snijden.

17. Inrichting volgens conclusie 16, verder omvattende
een stapeleenheid (6) die stroomafwaarts van de snijeenheid (5) is gepositioneerd, waarbij de stapeleenheid (6) is ingericht om aangrenzende draagplaten van het veelvoud van draagplaten (4) te stapelen.

18. Inrichting volgens conclusie 16 of 17, waarbij de dragertoevoereenheid (3) een ontstapeleenheid omvat, waarbij de ontstapeleenheid is ingericht voor het opnemen van een draagplaat (4) uit een stapel draagplaten (4) en het vormen van het veelvoud van draagplaten (4).

19. Inrichting volgens één van de conclusies 16-18, verder omvattende
een inspectie-eenheid (7) die stroomafwaarts van de snijeenheid (5) is gepositioneerd, waarbij de inspectie-eenheid (7) is ingericht voor het inspecteren van de vezelmateriaallaag (2b) op afzonderlijke draagplaten van het veelvoud van draagplaten (4).

20. Inrichting volgens één van de conclusies 16-19, verder omvattende een droogeenheid (8) die stroomafwaarts van de snijeenheid (5) is gepositioneerd, waarbij de droogeenheid (8) is ingericht om het drogen van de vezelmateriaallaag (2b) op individuele draagplaten van het veelvoud van draagplaten (4) te verbeteren.

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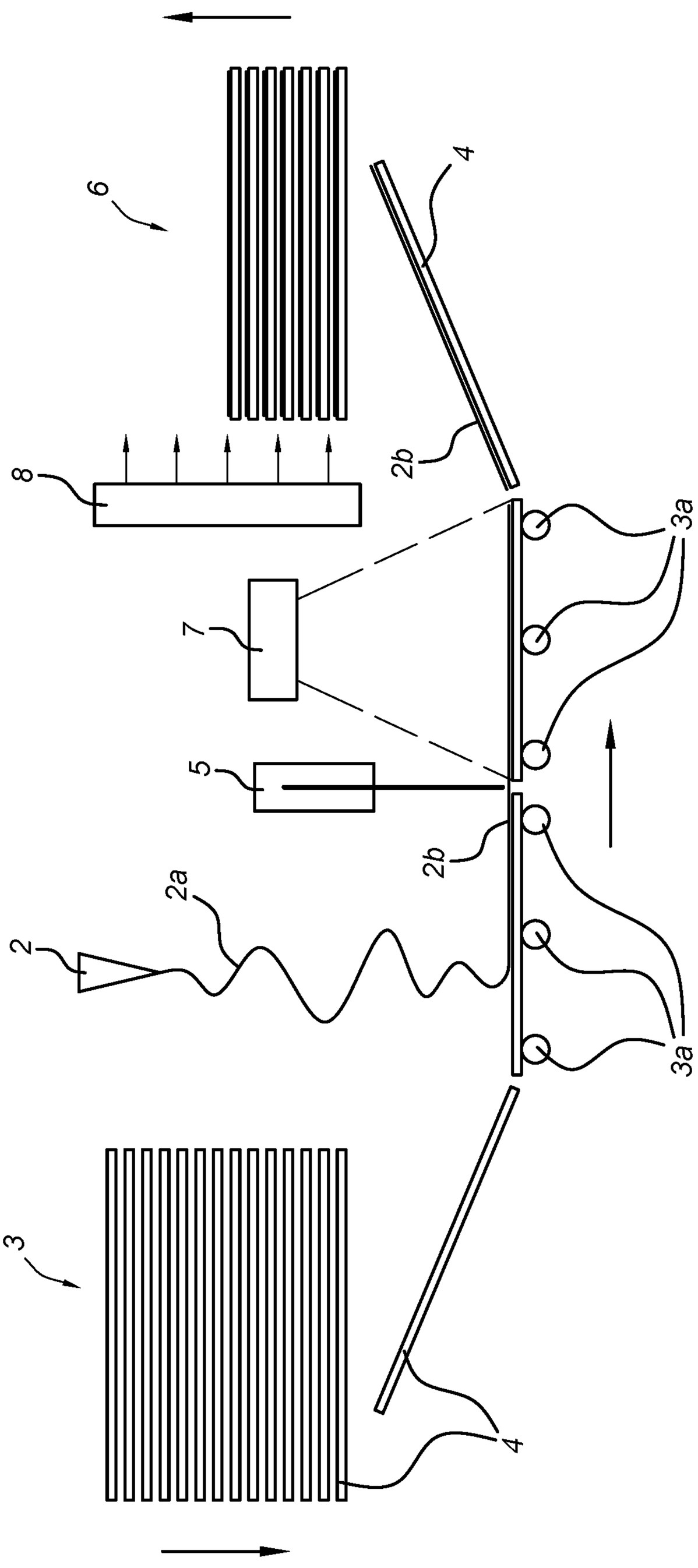


Fig. 1

Fig. 2

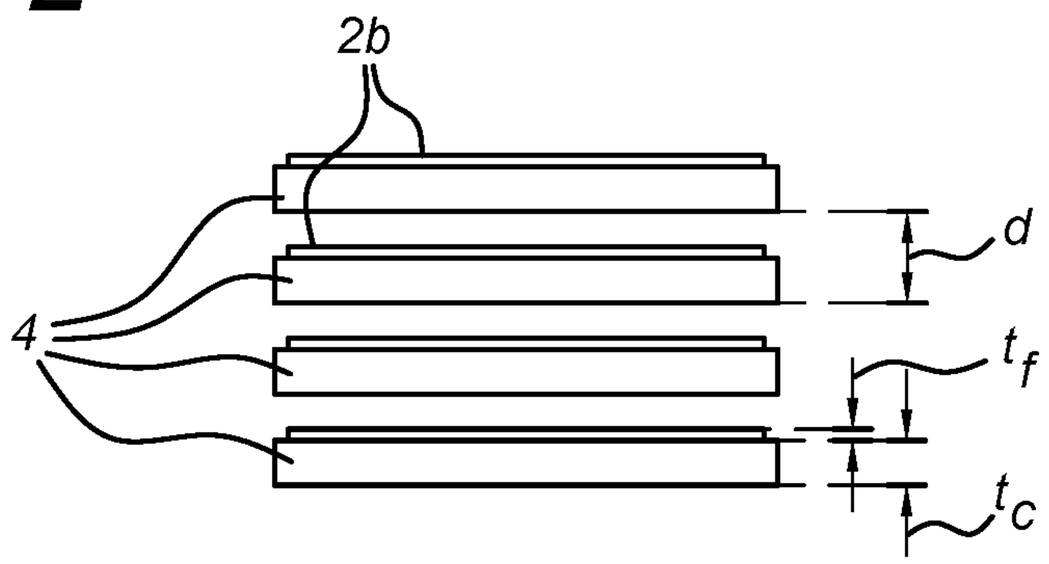
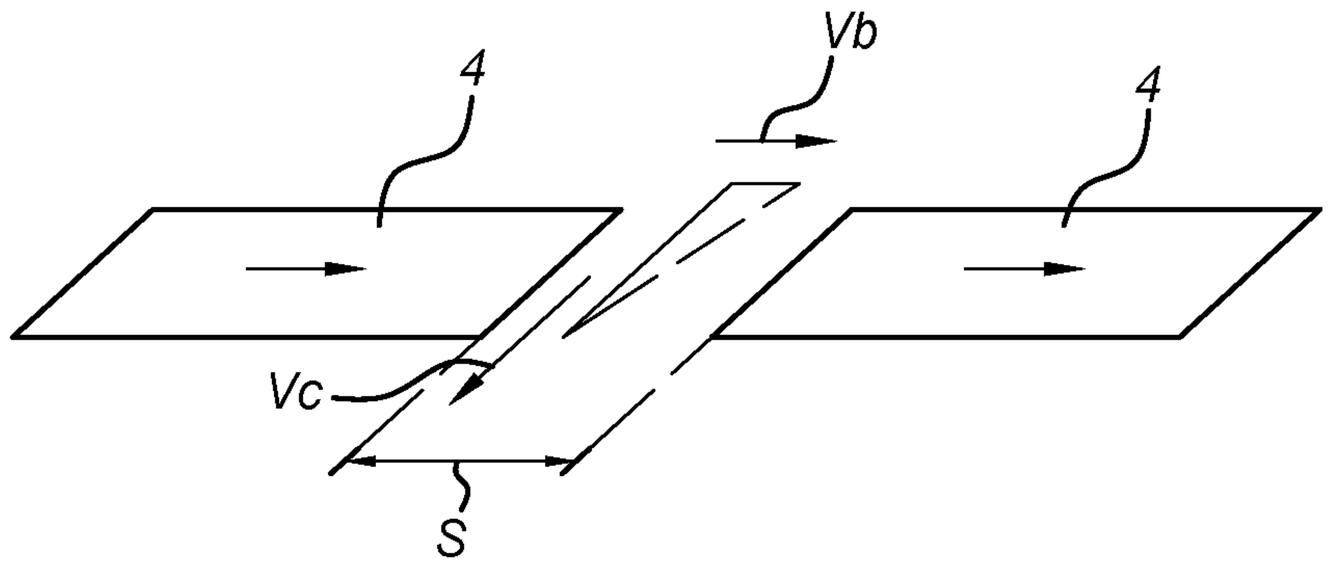


Fig. 3



SAMENWERKINGSVERDRAG (PCT)

RAPPORT BETREFFENDE NIEUWHEIDSONDERZOEK VAN INTERNATIONAAL TYPE

IDENTIFICATIE VAN DE NATIONALE AANVRAGE	KENMERK VAN DE AANVRAGER OF VAN DE GEMACHTIGDE **P6084572NL**
Nederlands aanvraag nr. **2023085**	Indieningsdatum **08-05-2019**
	Ingeroepen voorrangsdatum

Aanvrager (Naam)

INNOVATIVE MECHANICAL ENGINEERING TECHNOLOGIES B.V.

Datum van het verzoek voor een onderzoek van internationaal type	Door de Instantie voor Internationaal Onderzoek aan het verzoek voor een onderzoek van internationaal type toegekend nr.
25-05-2019	**SN73750**

I. CLASSIFICATIE VAN HET ONDERWERP (bij toepassing van verschillende classificaties, alle classificatiesymbolen opgeven)

Volgens de internationale classificatie (IPC)

Zie onderzoeksrapport

II. ONDERZOCHTE GEBIEDEN VAN DE TECHNIEK

Onderzochte minimumdocumentatie

Classificatiesysteem	Classificatiesymbolen
IPC	**Zie onderzoeksrapport**

Onderzochte andere documentatie dan de minimum documentatie, voor zover dergelijke documenten in de onderzochte gebieden zijn opgenomen

III. ☐	**GEEN ONDERZOEK MOGELIJK VOOR BEPAALDE CONCLUSIES**	(opmerkingen op aanvullingsblad)
IV. ☐	**GEBREK AAN EENHEID VAN UITVINDING**	(opmerkingen op aanvullingsblad)

ONDERZOEKSRAPPORT BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE

Nummer van het verzoek om een onderzoek naar de stand van de techniek
NL 2023085

A. CLASSIFICATIE VAN HET ONDERWERP
INV. D01D5/00 H01M2/14 D04H1/728
ADD.

Volgens de Internationale Classificatie van octrooien (IPC) of zowel volgens de nationale classificatie als volgens de IPC.

B. ONDERZOCHTE GEBIEDEN VAN DE TECHNIEK

Onderzochte miminum documentatie (classificatie gevolgd door classificatiesymbolen)
D01D H01M D04H

Onderzochte andere documentatie dan de mimimum documentatie, voor dergelijke documenten, voor zover dergelijke documenten in de onderzochte gebieden zijn opgenomen

Tijdens het onderzoek geraadpleegde elektronische gegevensbestanden (naam van de gegevensbestanden en, waar uitvoerbaar, gebruikte trefwoorden)
EPO-Internal, WPI Data

C. VAN BELANG GEACHTE DOCUMENTEN

Categorie °	Geciteerde documenten, eventueel met aanduiding van speciaal van belang zijnde passages	Van belang voor conclusie nr.
X A	WO 2019/052881 A1 (BOSCH GMBH ROBERT [DE]) 21 maart 2019 (2019-03-21) * figuren 3, 4 * -----	1,5-16, 19,20 2-4,17, 18
A	WO 2013/050088 A1 (LI TEC BATTERY GMBH [DE]; LEGNER STEFFEN [DE]) 11 april 2013 (2013-04-11) * samenvatting * -----	1-20
A,D	WO 2012/050682 A2 (APPLIED MATERIALS INC [US]; ORILALL MAHENDRA C [US] ET AL.) 19 april 2012 (2012-04-19) in de aanvraag genoemd * conclusie 9; figuur 16 * -----	1-20

☐ Verdere documenten worden vermeld in het vervolg van vak C.

☒ Leden van dezelfde octrooifamilie zijn vermeld in een bijlage

° Speciale categorieën van aangehaalde documenten

"A" niet tot de categorie X of Y behorende literatuur die de stand van de techniek beschrijft

"D" in de octrooiaanvrage vermeld

"E" eerdere octrooi(aanvrage), gepubliceerd op of na de indieningsdatum, waarin dezelfde uitvinding wordt beschreven

"L" om andere redenen vermelde literatuur

"O" niet-schriftelijke stand van de techniek

"P" tussen de voorrangsdatum en de indieningsdatum gepubliceerde literatuur

"T" na de indieningsdatum of de voorrangsdatum gepubliceerde literatuur die niet bezwarend is voor de octrooiaanvrage, maar wordt vermeld ter verheldering van de theorie of het principe dat ten grondslag ligt aan de uitvinding

"X" de conclusie wordt als niet nieuw of niet inventief beschouwd ten opzichte van deze literatuur

"Y" de conclusie wordt als niet inventief beschouwd ten opzichte van de combinatie van deze literatuur met andere geciteerde literatuur van dezelfde categorie, waarbij de combinatie voor de vakman voor de hand liggend wordt geacht

"&" lid van dezelfde octrooifamilie of overeenkomstige octrooipublicatie

Datum waarop het onderzoek naar de stand van de techniek van internationaal type werd voltooid	Verzenddatum van het rapport van het onderzoek naar de stand van de techniek van internationaal type
28 januari 2020	

Naam en adres van de instantie	De bevoegde ambtenaar
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Saunders, Thomas

Formulier PCT/ISA/201 (tweede blad) (Januari 2004)

ONDERZOEKSRAPPORT BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE

Informatie over leden van dezelfde octrooifamilie

Nummer van het verzoek om een onderzoek naar de stand van de techniek
NL 2023085

In het rapport genoemd octrooigeschrift	Datum van publicatie	Overeenkomend(e) geschrift(en)	Datum van publicatie
WO 2019052881 A1	21-03-2019	DE 102017216133 A1	14-03-2019
		WO 2019052881 A1	21-03-2019
WO 2013050088 A1	11-04-2013	DE 102011115118 A1	11-04-2013
		EP 2764561 A1	13-08-2014
		WO 2013050088 A1	11-04-2013
WO 2012050682 A2	19-04-2012	CN 103168384 A	19-06-2013
		JP 6227411 B2	08-11-2017
		JP 2013539186 A	17-10-2013
		KR 20130108594 A	04-10-2013
		TW 201230453 A	16-07-2012
		US 2012082884 A1	05-04-2012
		US 2015372271 A1	24-12-2015
		WO 2012050682 A2	19-04-2012

WRITTEN OPINION

File No.	Filing date *(day/month/year)*	Priority date *(day/month/year)*	Application No.
SN73750	08.05.2019		NL2023085

International Patent Classification (IPC)
INV. D01D5/00 H01M2/14 D04H1/728

Applicant
INNOVATIVE MECHANICAL ENGINEERING TECHNOLOGIES B.V.

This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the application
- ☐ Box No. VIII Certain observations on the application

	Examiner
	Saunders, Thomas

Application number

WRITTEN OPINION

NL2023085

Box No. I Basis of this opinion

1. This opinion has been established on the basis of the latest set of claims filed before the start of the search.

2. With regard to any **nucleotide and/or amino acid sequence** disclosed in the application and necessary to the claimed invention, this opinion has been established on the basis of:

   a. type of material:

   ☐ a sequence listing

   ☐ table(s) related to the sequence listing

   b. format of material:

   ☐ on paper

   ☐ in electronic form

   c. time of filing/furnishing:

   ☐ contained in the application as filed.

   ☐ filed together with the application in electronic form.

   ☐ furnished subsequently for the purposes of search.

3. ☐ In addition, in the case that more than one version or copy of a sequence listing and/or table relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

4. Additional comments:

Box No. V Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty	Yes:	Claims	2-5, 7-10, 12, 13, 15, 17-20
	No:	Claims	1, 6, 11, 14, 16
Inventive step	Yes:	Claims	2-4, 17, 18
	No:	Claims	1, 5-16, 19, 20
Industrial applicability	Yes:	Claims	1-20
	No:	Claims	

2. Citations and explanations

see separate sheet

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Reference is made to the following documents:

D1 WO 2019/052881 A1 (BOSCH GMBH ROBERT [DE]) 21 maart 2019 (2019-03-21)

D2 WO 2013/050088 A1 (LI TEC BATTERY GMBH [DE]; LEGNER STEFFEN [DE]) 11 april 2013 (2013-04-11)

D3 WO 2012/050682 A2 (APPLIED MATERIALS INC [US]; ORILALL MAHENDRA C [US] ET AL.) 19 april 2012 (2012-04-19)in de aanvraag genoemd

2. Novelty

The present application does not meet the criteria of patentability, because the subject-matter of claims 1, 6, 11, 14 and 16 is not new.

2.1 D1 discloses (cf. Figures 3, 4) a method for laser cutting an endless web of battery separator material into individual membranes. The step of depositing a fibrous material onto a moving support is implicitly disclosed, since this is the standard way to form a battery separator material (see e.g. D1).

Laser cutting (96) takes place on the surface a rotating roll (92) provided with a series of adjacent segments (70). This can be considered as an extension of the moving support on which the separator material is formed, the roll being a moving support travelling in a machine direction and the segments defining support plates for the material. Cutting takes place in between adjacent segments.

The segments implicitly comprise a rigid material and must include a surface layer of some kind, even if the surface layer is the same material as the rest of the segment.

3. Inventive Step

The present application does not meet the criteria of patentability, because the subject-matter of claims 5, 7-10, 12, 13, 15, 19 and 20 does not involve an inventive step.

3.1 Dependent claims 5, 7-10, 12, 13, 15, 19 and 20 concern very minor changes to the method of claim 1 and apparatus of claim 16 which would be considered to be straight-forward adaptations to the method and apparatus disclosed in D1, based on the common general knowledge of the skilled person, as expressed by e.g. D1-D3, as well as simple engineering common sense. Consequently, these claims also lack an inventive step.

3.2 The combination of the features of dependent claims 2-4, 17 and 18 is neither known from, nor rendered obvious by, the available prior art.

There is absolutely no incentive for the skilled person to remove the segments from the roll in D1 and then stack them, hence the embodiments relating to plate stacking systems are novel and inventive.