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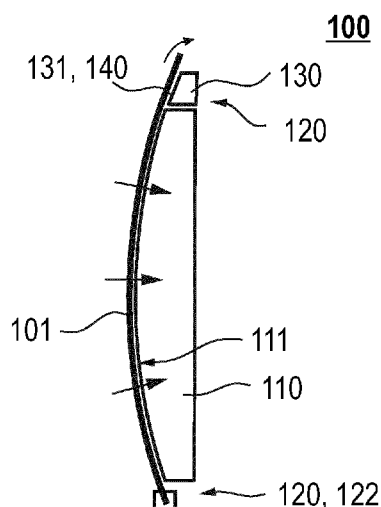


FIG. 1A

(57) Abstract: A holding arrangement (100) for holding a substrate (101) is described. The holding arrangement includes a substrate support (110) having a substrate support surface (111) configured for supporting the substrate (101); and a substrate tensioning device (120) configured for applying a force between the substrate (101) and the substrate support surface (111), wherein the substrate tensioning device (120) comprises at least one element (130) having a surface (131) with an adhesive arrangement (140) configured for attaching the substrate (101).



**HOLDING ARRANGEMENT FOR HOLDING A SUBSTRATE, CARRIER
INCLUDING THE HOLDING ARRANGEMENT, METHOD FOR HOLDING
A SUBSTRATE, AND METHOD FOR RELEASING A SUBSTRATE**

TECHNICAL FIELD

5 [0001] Embodiments of the present disclosure relate to substrate holding arrangements, substrate carriers, methods for holding a substrate, and methods for releasing a substrate. More specifically, embodiments of the present disclosure relate to holding arrangements and carriers for holding substrates having a thickness of less than 1 mm, particularly during substrate processing under vacuum conditions.
10 Further, embodiments of the present disclosure relate to methods of holding substrates having a thickness of less than 1 mm as well as to methods of releasing such substrates from a carrier after substrate processing.

BACKGROUND

[0002] Techniques for layer deposition on a substrate include, for example, thermal
15 evaporation, chemical vapor deposition (CVD) and physical vapor deposition (PVD) such as sputtering deposition. A sputter deposition process can be used to deposit a material layer on the substrate, such as a layer of an insulating material. During the sputter deposition process, a target having a target material to be deposited on the substrate is bombarded with ions generated in a plasma region to dislodge atoms of
20 the target material from a surface of the target. The dislodged atoms can form the material layer on the substrate. In a reactive sputter deposition process, the dislodged atoms can react with a gas in the plasma region, for example, nitrogen or oxygen, to form an oxide, a nitride or an oxinitride of the target material on the substrate.

[0003] Coated materials can be used in several applications and in several technical
25 fields. For instance, coated materials may be used in the field of microelectronics, such as for generating semiconductor devices. Also, substrates for displays can be

coated using a PVD process. Further applications include insulating panels, organic light emitting diode (OLED) panels, substrates with thin film transistors (TFTs), color filters, substrates with functional films for batteries, substrates with solid state batteries or the like.

5 [0004] The tendency toward larger and also thinner substrates is challenging with respect to holding such substrates during substrate processing, e.g. during a deposition process. In particular, conventional substrate support systems which hold a substrate on the substrate edges, e.g. by clamping mechanisms, can introduce undesired forces which can introduce bulging on the substrate, e.g. due to forces that
10 push the substrate edge towards the center of the substrate. Bulging can, in turn, cause problems due to the increasing likelihood of breakage. Further, also releasing a thin large area substrate from a substrate support system without damaging the substrate is challenging.

[0005] In light of the foregoing, there is a need to provide holding arrangements,
15 substrate carriers, methods for holding a substrate, and methods for releasing a substrate that overcome at least some of the problems in the art.

SUMMARY

[0006] In light of the above, a holding arrangement for holding a substrate, a carrier for holding a substrate, a method for holding a substrate, and a method for
20 releasing a substrate are provided. Further aspects, benefits, and features of the present disclosure are apparent from the claims, the description, and the accompanying drawings.

[0007] According to an aspect of the present disclosure, a holding arrangement for holding a substrate is provided. The holding arrangement includes a substrate support
25 having a substrate support surface configured for supporting the substrate. Further, the holding arrangement includes a substrate tensioning device configured for applying a force between the substrate and the substrate support surface. The

substrate tensioning device includes at least one element having a surface with an adhesive arrangement configured for attaching the substrate.

[0008] According to another aspect of the present disclosure, a carrier for holding a substrate is provided. The carrier includes a carrier body and a holding arrangement
5 according to any of the embodiments described herein, wherein the holding arrangement is mounted on the carrier body.

[0009] According to yet another aspect of the present disclosure, a method for holding a substrate is provided. The method includes supporting a substrate by a substrate support having a substrate support surface configured for supporting the
10 substrate. Further, the method includes applying a force between the substrate and the substrate support surface by using a substrate tensioning device including at least one element having a surface with an adhesive arrangement configured for attaching the substrate.

[0010] According to a further aspect of the present disclosure, a method for
15 releasing a substrate is provided. The method includes moving at least one element having a surface with an adhesive arrangement configured for attaching the substrate relative to a surface of the substrate to which the adhesive arrangement is attached.

[0011] Embodiments are also directed at apparatuses for carrying out the disclosed methods and include apparatus parts for performing each described method aspect.
20 These method aspects may be performed by way of hardware components, a computer programmed by appropriate software, by any combination of the two or in any other manner. Furthermore, embodiments according to the disclosure are also directed at methods for operating the described apparatus. The methods for operating the described apparatus include method aspects for carrying out every function of the
25 apparatus.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] So that the manner in which the above recited features of the present disclosure can be understood in detail, a more particular description of the disclosure, briefly summarized above, may be had by reference to embodiments. The accompanying drawings relate to embodiments of the disclosure and are described in the following:

- FIGS. 1A and 1B show schematic cross-sectional side views of a holding arrangement according to embodiments described herein;
- FIG. 2 shows a detailed schematic cross-sectional side view of a portion of a holding arrangement according to further embodiments described herein;
- FIG. 3A shows schematic cross-sectional side view of a portion of a holding arrangement according to further embodiments described herein;
- FIG. 3B shows a detailed view of the at least one element having an adhesive arrangement according to embodiments described herein;
- FIGS. 4A and 4B show schematic cross-sectional side views of holding arrangements according to further embodiments described herein;
- FIG. 5 shows a schematic cross-sectional side view of a holding arrangement described herein for illustrating the principle of the method for releasing a substrate according to embodiments described herein;
- FIG. 6 shows a top view of an exemplary implementation of the at least one element including a first roller and a second roller;
- FIG. 7A shows a schematic front view of a carrier according to embodiments described herein;
- FIG. 7B shows a schematic cross sectional side view of the carrier shown in FIG. 7A;

- FIG. 7C shows a schematic cross sectional side view of a carrier according to further embodiments described herein;
- FIG. 8 shows a flow chart illustrating a method for holding a substrate according to embodiments described herein; and
- 5 FIG. 9 shows a flow chart illustrating a method for releasing a substrate according to embodiments described herein.

DETAILED DESCRIPTION OF EMBODIMENTS

[0013] Reference will now be made in detail to the various embodiments, one or more examples of which are illustrated in each figure. Each example is provided by
10 way of explanation and is not meant as a limitation. For example, features illustrated or described as part of one embodiment can be used on or in conjunction with any other embodiment to yield yet a further embodiment. It is intended that the present disclosure includes such modifications and variations.

[0014] Within the following description of the drawings, the same reference
15 numbers refer to the same or to similar components. Generally, only the differences with respect to the individual embodiments are described. Unless specified otherwise, the description of a part or aspect in one embodiment can apply to a corresponding part or aspect in another embodiment as well.

[0015] Before various embodiments of the present disclosure are described in more
20 detail, some aspects with respect to some terms and expressions used herein are explained.

[0016] In the present disclosure, a “holding arrangement for holding a substrate” is to be understood as an arrangement configured for holding a substrate as described herein. In particular, the holding arrangement can be configured for holding a large
25 area substrate in a vertical state. More particularly, a holding arrangement as described herein can be understood as an arrangement configured for holding a

substrate having a thickness of less than 500 μm , particularly less than 300 μm ; more particularly less than 200 μm . Typically, the holding arrangement according to the present disclosure is configured to be used under atmospheric conditions as well as under vacuum conditions. Particularly, the holding arrangement may be configured
5 such that the substrate front side of the substrate held by the holding arrangement is free of contact with any part of the holding arrangement.

[0017] In the present disclosure, a “substrate support” can be understood as a support structure which is configured for supporting a substrate as described herein. Typically, the substrate support is part of the holding arrangement as described
10 herein. In particular, a substrate support according to the present disclosure may be configured for supporting a substrate in a substantially vertical orientation, e.g., during a layer deposition process. As used throughout the present disclosure, “substantially vertical” can be understood particularly when referring to the substrate orientation, to allow for a deviation from the vertical direction or orientation of $\pm 20^\circ$
15 or below, e.g. of $\pm 10^\circ$ or below. Typically, the substrate support as described in the present disclosure is configured for supporting a backside of the substrate. Accordingly, the substrate support is typically configured such that a front side of the substrate can be processed, e.g. be coated in a deposition process. Particularly, the substrate support may be configured such that the substrate front side of the substrate
20 supported by the substrate support is free of contact with any part of the substrate support.

[0018] In the present disclosure, a “substrate tensioning device” can be understood as a device which is configured for applying a tension to a substrate as described herein. In particular, the substrate tensioning device can be configured such that upon
25 tensioning the substrate, a force between the substrate and a substrate support surface is generated. Accordingly, the substrate can be pressed onto the substrate support surface by applying a tension to the substrate by employing the substrate tensioning device as described herein. Typically, the substrate tensioning device includes at least one element having a surface with an adhesive arrangement which is configured
30 for attaching the substrate. The at least one element having the adhesive arrangement

can be used to apply the tension to the substrate, e.g. by moving the at least one element with the adhesive arrangement to which the substrate is attached. The surface of the least one element with the adhesive arrangement can be a flat surface as exemplarily shown in FIG.1 A or a curved surface as exemplarily shown in
5 FIGS. 1B, 2 and 5.

[0019] In the present disclosure, an “adhesive arrangement” is to be understood as an arrangement which is configured for providing an adhesive force for attaching a substrate as described herein. In particular, the adhesive arrangement can be configured such that the adhesive force between the adhesive arrangement and the
10 substrate is strong enough for applying a tension to the substrate when the adhesive arrangement to which the substrate is attached is moved. More specifically, the adhesive arrangement as described herein may include a dry adhesive material. For instance, the dry adhesive material can be configured for providing the adhesive force by van der Waals forces as outlined herein.

15 [0020] In the present disclosure, a “carrier for holding a substrate” is to be understood as a carrier which is configured for holding a substrate as described herein, particularly a substrate having a thickness of less than 500 μm , particularly less than 300 μm ; more particularly less than 200 μm . According to the present disclosure, the carrier includes a holding arrangement as described herein. Typically,
20 the substrate held or supported by the carrier as described herein includes a front surface and a back surface, wherein the front surface is a surface of the substrate being processed, for example on which a material layer is to be deposited.

[0021] In the present disclosure, the term “substrate” is to be understood as a thin substrate, particularly a substrate having a thickness D selected from a range between
25 a lower limit of $D_L \geq 5 \mu\text{m}$, particularly a lower limit of $D_L \geq 20 \mu\text{m}$, more particularly a lower limit of $D_L \geq 40 \mu\text{m}$ and an upper limit of $D_U \leq 200 \mu\text{m}$, particularly an upper limit of $D_U \leq 300 \mu\text{m}$, more particularly an upper limit of $D_U \leq 500 \mu\text{m}$. In particular, the substrate can be made of any material suitable for material deposition. For instance, the substrate can be made of a material selected

from the group consisting of glass (for instance soda-lime glass, borosilicate glass etc.), metal, polymer, ceramic, compound materials, carbon fiber materials, mica or any other material or combination of materials which can be coated by a deposition process.

5 [0022] According to some embodiments, the substrate can be a “large area substrate” and may be used for display manufacturing. Alternatively, the substrate can be a small substrate having a size of at least 50 mm × 50 mm. For example, the substrate may have a size of DIN A5, DIN A4, or DIN A3. For instance, the substrate may be a glass or plastic substrate. For example, substrates as described
10 herein shall embrace substrates which are typically used for an LCD (Liquid Crystal Display), a PDP (Plasma Display Panel), and the like. For instance, a “large area substrate” can have a main surface with an area of 0.5 m² or larger, particularly of 1 m² or larger. In some embodiments, a large area substrate can be GEN 4.5, which corresponds to about 0.67 m² of substrate (0.73x0.92m), GEN 5, which corresponds
15 to about 1.4 m² of substrate (1.1 m x 1.3 m), GEN 7.5, which corresponds to about 4.29 m² of substrate (1.95 m x 2.2 m), GEN 8.5, which corresponds to about 5.7 m² of substrate (2.2 m x 2.5 m), or even GEN 10, which corresponds to about 8.7 m² of substrate (2.85 m × 3.05 m). Even larger generations such as GEN 11 and GEN 12 and corresponding substrate areas can similarly be implemented.

20 [0023] FIGS. 1A and 1B show schematic side views of a holding arrangement 100 according to embodiments described herein. The holding arrangement 100 for holding a substrate 101 includes a substrate support 110 having a substrate support surface 111 configured for supporting the substrate 101. For instance, the substrate support surface 111 can be concave, as exemplarily shown in FIGS. 1A and 1B.
25 Further, the holding arrangement 100 includes a substrate tensioning device 120 configured for applying a force between the substrate 101 and the substrate support surface 111. The substrate tensioning device includes at least one element 130 having a surface 131 with an adhesive arrangement 140 configured for attaching the substrate 101.

[0024] Accordingly, beneficially an improved holding arrangement for thin substrates, i.e. substrates having a thickness between 5 μm and 500 μm is provided. In particular, by providing a holding arrangement having a substrate tensioning device as described herein, an improved contact between the substrate and the substrate support can be provided. More specifically, by employing a holding arrangement as described herein, a backside of the substrate can be pressed onto the substrate support such that a substantially homogeneous contact force between the backside of the substrate and the substrate support can be realized.

[0025] With exemplary reference to FIGS. 1A and 1B, according to some embodiments, which can be combined with other embodiments described herein, the substrate tensioning device 120 may include a substrate fixation element 122 configured for fixing one end of the substrate to the substrate support 110. Accordingly, when the at least one element 130 with the adhesive arrangement 140 to which the substrate 101 is attached is moved, e.g. rotated as exemplarily indicated with bowed arrow at the top of FIGS. 1A and 1B, a tension to the substrate 101 can be applied. By applying a tension to the substrate, a contact force between the backside of the substrate and the substrate support can be realized, as exemplarily indicated by the arrows pointing towards the substrate support 110 in FIGS. 1A and 1B. Alternatively, a tension to the substrate may be applied by pulling one end of the substrate over the at least one element 130 with the adhesive arrangement 140, such that when the pulling force is released the tension to the substrate is maintained by the attachment of the substrate 101 to the adhesive arrangement 140.

[0026] For example, the substrate fixation element 122 may be provided at a lower end of the substrate support 110 and the at least one element 130 with the adhesive arrangement 140 may be provided at an upper end of the substrate support, as exemplarily shown in FIGS. 1A and 1B. Alternatively, the substrate fixation element 122 may be provided at the upper end of the substrate support 110 and the at least one element 130 with the adhesive arrangement 140 may be provided at the lower end of the substrate support (not explicitly shown). As another alternative, not explicitly shown, the substrate fixation element 122 may be provided at a first side,

e.g. a left side, of the substrate support 110 and the at least one element 130 with the adhesive arrangement 140 may be provided at a second side, e.g. a right side, opposite to the first side of the substrate support. Accordingly, an improved holding arrangement can be provided which is configured for improved contact between the substrate and the substrate support, particularly improved thermal contact between the substrate and the substrate support.

[0027] According to some embodiments, which can be combined with any other embodiments described herein, the substrate support 110 can be a backing plate, e.g. a backing plate of solid material, as exemplarily shown in FIGS. 1 A and 1B. In particular, the backing plate may have a concave support surface configured for supporting the substrate. For instance, the backing plate may be configured to provide a thermal mass. Accordingly, the backing plate may be a thermal backing plate. For instance, the backing plate can include and/or be made of aluminum, aluminum alloys, titanium, alloys thereof, stainless steel or the like. According to some embodiments, which can be combined with other embodiments described herein, the backing plate can be configured to be heated or cooled. For example, the backing plate may be provided with an active cooling and/or an active heating.

[0028] According to some embodiments, which can be combined with any other embodiments described herein, the substrate support 110, e.g. the backing plate, may be provided with a gas supply 115 for supplying a gas G, particularly an inert gas like argon (Ar) or helium He, between the substrate 101 and the substrate support 110, as exemplarily shown in FIG. 2. For instance, the gas supply 115 may include a recess pattern 116 on the substrate support surface 111 for providing the gas between the substrate 101 and the substrate support 110. Further, the gas supply 115 may include a piping 117 provided in the interior of the substrate support 110. For instance, the piping 117 may include one or more conduits configured for providing the gas between the substrate 101 and the substrate support 110, particularly to the recess pattern 116, as exemplarily shown in FIG. 2. Accordingly, an enhanced and homogenized thermal contact between the substrate and the substrate support can be provided.

[0029] With exemplary reference to FIG. 1A, according to some embodiments, which can be combined with any other embodiments described herein, the surface 131 of the at least one element 130 with the adhesive arrangement 140 can be a flat surface. Alternatively, the surface 131 of the at least one element 130 with the adhesive arrangement 140 can be a curved surface, as exemplarily shown in FIGS. 1B and 2. For instance, the at least one element 130 can be a segment of a cylinder, as exemplarily shown in FIGS. 1B and 2. Alternatively, the at least one element can be a cylinder or a roller, as exemplarily shown in FIG. 3A. Typically, the at least one element 130 is configured to be rotatable around a rotation axis 133. In particular, the rotation axis 133 can be a horizontal rotation axis. More specifically, the rotation axis 133 may be parallel to a backside 101A of the substrate 101. According to another embodiment (not explicitly shown) which can be combined with other embodiments described herein, the rotation axis 133 can be a vertical rotation axis, particularly in an embodiment in which the substrate fixation element 122 may be provided at a left side of the substrate support 110 and the at least one element 130 with the adhesive arrangement 140 may be provided at a right side of the substrate support.

[0030] According to some embodiments, which can be combined with any other embodiments described herein, the adhesive arrangement 140 may include a plurality of filaments 141, as exemplarily shown in FIGS. 2, 3A and 3B. For instance, the filaments can be or include nanotubes, for instance carbon nanotubes. Additionally or alternatively, the plurality of filaments 141 can be made of or include a polymeric material, particularly a synthetic polymeric material. Each of the plurality filaments can be a substantially longitudinal member. Specifically, each of the plurality filaments can have one dimension that is larger than the remaining two dimensions. In particular, the longest dimension of the filaments can be the length of the filament. That is, the filaments can be elongated along a length direction.

[0031] As exemplarily shown in FIGS. 2, 3A and 3B, each filament of the plurality of filaments 141 can be attached with one end to the surface 131 of the at least one element 130. In particular, each filament of the plurality of filaments 141 can extend away from the surface 131 of the at least one element 130. Accordingly, each

filament of the plurality of filaments 141 can have a second end that is free. Typically, the second end of a filament of the plurality of filaments 141 is configured to be attachable to the substrate 101. More specifically, the second ends of the filaments, particularly of each filament, of the plurality of filaments 141 can be configured to adhere to the substrate 101 by van der Waals forces as outlined herein. According to some embodiments which can be combined with any other embodiments described herein, the adhesive arrangement 140 may be provided on a specific portion of the at least one element 130, for example on a segment of a cylindrical element, as exemplarily shown in FIG. 3A. Alternatively, the adhesive arrangement 140 may be provided on the complete surface of the at least one element 130, for instance on the complete outer circumferential surface of the cylindrical element (not explicitly shown).

[0032] According to some embodiments, which can be combined with any other embodiments described herein, the adhesive arrangement 140 may include a dry adhesive material configured for attaching the substrate 101. For instance, the dry adhesive material can be a synthetic setae material. The adhesive capabilities of the dry adhesive material, specifically of the synthetic setae material, can be related to the adhesive properties of a gecko foot. The natural adhesive capability of the gecko foot allows the animal to adhere to many types of surfaces under most conditions. The adhesive capability of the gecko foot is provided by numerous hair-type extensions, called setae, on the feet of the gecko. It is noted here that the term “synthetic setae material” can be understood as a synthetic material which emulates the natural adhesive capability of the gecko foot and which includes similar adhesive capabilities to the gecko foot. Moreover, the term “synthetic setae material” can be synonymously used with the term “synthetic gecko setae material” or with the term “gecko tape material”. However, the present disclosure is not limited thereto and other dry adhesive materials suitable for holding the substrate can be used.

[0033] According to some embodiments, which can be combined with any other embodiments described herein, the dry adhesive material, for example the synthetic setae material, can be inorganic. According to some embodiments described herein,

the dry adhesive material can be substantially 100% inorganic. Moreover, the microstructure of the dry adhesive material can include nanotubes. According to some embodiments described herein, the microstructure of the dry adhesive material includes carbon nanotubes.

5 [0034] According to embodiments, which can be combined with any other embodiments described herein, the dry adhesive material can be a gecko adhesive. For example, the gecko adhesive may be a gecko tape or a gecko element.

[0035] In the context of the present disclosure, a “gecko adhesive” can be understood as an adhesive that mimics the ability of geckos’ feet to adhere to
10 surfaces, such as for example vertical surfaces. In particular, the dry adhesive material of the adhesive arrangement 140 as described herein can be configured to adhere to the substrate 101 due to van der Waals forces between the dry adhesive material and a surface of the substrate 101, particularly a backside 101A of the substrate 101. However, the present disclosure is not limited thereto and other
15 adhesives suitable for attaching the substrate can be used.

[0036] According to embodiments, which can be combined with any other embodiments described herein, the adhesive force provided by the dry adhesive material can be sufficient for attaching the substrate as described herein. In particular, the dry adhesive material can be configured to provide an adhesive force
20 of about 20 mN/cm² or more, particularly 30 mN/cm² or more, more particularly 50 mN/cm² or more, for instance at least 0.2 N/cm².

[0037] With exemplary reference to FIG. 3B showing an enlarged view of the at least one element 130 shown in FIG. 3A, according to some embodiments, which can be combined with any other embodiments described herein, the plurality of
25 filaments 141 are arranged on the surface 131 of the at least one element 130 with an inclination angle α (alpha) of less than 90° relative to a surface tangent T on the surface 131 of the at least one element 130. As exemplarily shown in FIG. 3B, a surface tangent T according to the present disclosure is to be understood as a tangent

T which is perpendicular to a surface normal N at the location at which the respective filament is attached to the surface 131 of the at least one element 130.

[0038] In particular, the inclination angle α (alpha) of the individual filaments relative to a surface tangent T at the respective attachment positions of the individual filaments to the surface 131 of the at least one element 130 can be selected from a range between a lower limit of $\alpha_L \geq 20^\circ$, particularly a lower limit of $\alpha_L \geq 30^\circ$, more particularly a lower limit of $\alpha_L \geq 40^\circ$ and an upper limit of $\alpha_U \leq 60^\circ$, particularly an upper limit of $\alpha_U \leq 70^\circ$; more particularly an upper limit of $\alpha_U \leq 70^\circ$. According to some specific examples, the inclination angle α (alpha) of the individual filaments of the plurality of filaments relative to the surface tangent T can be $\alpha = 30^\circ$, particularly $\alpha = 45^\circ$, more particularly 60° .

[0039] A configuration of the adhesive arrangement having a plurality of filaments with an inclination angle α (alpha) as specified herein can be beneficial for tensioning the substrate since a substrate pulling force can be increased.

[0040] With exemplary reference to FIG. 4A, according to embodiments which can be combined with other embodiments described herein, the at least one element 130 with the adhesive arrangement 140 may be provided at an upper end 110A of the substrate support 110 and a substrate fixation element 122 may be provided at a lower end 110B of the substrate support 110. Alternatively, the at least one element 130 with the adhesive arrangement 140 may be provided at the lower end 110B of the substrate support 110 and the substrate fixation element 122 may be provided at an upper end 110A of the substrate support 110 (not explicitly shown).

[0041] With exemplary reference to FIG. 4B, according to some embodiments which can be combined with other embodiments described herein, the substrate tensioning device 120 may include a first element 130A having an adhesive arrangement as described herein and a second element 130B having an adhesive arrangement as described herein. In particular, the first element 130A can be provided at an upper end 110A of the substrate support 110 and the second element 130B can be provided at a lower end 110B of the substrate support 110. In order to

avoid unnecessary repetition, it is to be understood that the first element 130A and the second element 130B can be configured according to the at least one element 130, as described herein.

5 [0042] With reference to FIG. 5 showing a schematic cross-sectional side view of a holding arrangement according to embodiments described herein, the principle of a method for releasing a substrate is described. In particular, for releasing the substrate 101 from the holding arrangement, the at least one element 130 with the adhesive arrangement 140 is moved relative to the surface of the substrate 101 to which the adhesive arrangement 140 is attached. For instance, one end of the substrate 101 can
10 be fixed by a fixation element, e.g. a clamping device 150, and the at least one element with the adhesive arrangement can then be moved relative to the surface of the substrate 101 to which the adhesive arrangement 140 is attached. The clamping device 150 may be a mechanical clamp configured for gripping an edge of the substrate, as schematically indicated in Fig. 5.

15 [0043] For example, the at least one element 130 may be moved relative to the substrate by a rotational movement 183 around the rotational axis 133 of the at least one element 130. Additionally or alternatively, the at least one element may be moved relative to the substrate by a translational movement, for example by a horizontal movement 182 and/or a vertical movement 181, as exemplarily indicated
20 in FIG. 5. Accordingly, by moving the at least one element with the adhesive arrangement 140 relative to the surface of the substrate 101 to which the adhesive arrangement 140 is attached, a buckling of the plurality of filaments of the adhesive arrangement 140 can be initiated such that the substrate can be released from the adhesive arrangement 140.

25 [0044] Accordingly, the at least one element 130 according to embodiments described herein can be provided with a driving mechanism configured for providing at least one motion selected from a rotational movement 183 around the rotational axis 133 of the at least one element 130, a transversal horizontal movement, a transversal vertical movement or any combination thereof.

[0045] According to some embodiments which can be combined with other embodiments described herein, the at least one element 130 may include at least one first roller 151 and at least one second roller 152, as exemplarily shown in FIG. 6. In particular, in FIG. 6 a top view of an exemplary implementation of the at least one element 130 is illustrated in which the at least one element 130 includes a sequence of a first roller and a second roller, as indicated by the dotted line in the middle of FIG. 6. Typically, the at least one first roller 151 and the at least one second roller 152 are separated by a gap 155. Further, the at least one first roller 151 and the at least one second roller 152 may be provided with an adhesive arrangement 140, as described herein. In particular, as exemplarily shown in FIG. 6, the at least one first roller 151 and the at least one second roller 152 may include an adhesive arrangement 140 having a plurality of filaments 141 as described herein.

[0046] As exemplarily indicated in FIG. 6, the at least one first roller 151 may be configured to be moved in a first transversal direction 151B and the at least one second roller 152 may be configured to be moved in a second transversal direction 152B. Typically, the first transversal direction 151B and the second transversal direction 152B are in line with the rotational axis 133 of the at least one first roller 151 and the at least one second roller 152. In particular, the first transversal direction 151B may be opposite to the second transversal direction 152B. For instance, the at least one first roller 151 and the at least one second roller 152 may be provided with a transversal moving mechanism configured for moving providing a transversal movement along the rotational axis 133, e.g. in the first transversal direction 151B and/or the second transversal direction 152B.

[0047] Accordingly, by moving the at least one first roller 151 in the first transversal direction 151B and the at least one second roller 152 in second transversal direction 152B, particularly in an alternating manner, an Euler buckling of the plurality of filaments can be initiated which can be beneficial for releasing the substrate from the adhesive arrangement provided on the at least one first roller 151 and the at least one second roller 152.

[0048] Additionally or alternatively, the at least one first roller 151 can be configured to be rotatable in a first rotation direction 151A and the at least one second roller 152 is configured to be rotatable in a second rotation direction 152A, wherein the first rotation direction 151A is different from the second rotation direction 152A. For instance, a first drive configured for driving the at least one first roller 151 in the first rotation direction 151A may be provided and a second drive configured for driving the at least one second roller 152 in the second rotation direction 152A may be provided.

[0049] Accordingly, by rotating the at least one first roller 151 in the first rotation direction 151A and the at least one second roller 152 in the second rotation direction 152A, particularly in an alternating manner, a Euler buckling of the plurality of filaments can be initiated which can be beneficial for releasing the substrate from the adhesive arrangement provided on the at least one first roller 151 and the at least one second roller 152.

[0050] FIGS. 7A and 7B show a schematic front view and a schematic cross sectional side view of a carrier according to embodiments described herein. Typically, the carrier 200 includes a carrier body 210 and a holding arrangement 100 according to any of the embodiments described herein. As exemplarily shown in FIGS. 7A and 7B, typically the holding arrangement 100 is mounted on the carrier body 210.

[0051] According to embodiments, which can be combined with any other embodiments described herein, the carrier 200 is configured to carry the holding arrangement 100 as described herein, for instance during substrate processing, particularly vacuum processing. In particular, substrate processing may include a layer deposition process such as a thermal evaporation deposition process, a chemical vapor deposition (CVD) process or a physical vapor deposition (PVD) process, e.g. sputtering deposition.

[0052] As exemplarily shown in FIGS 7A and 7B, the carrier body 210 may be configured as a frame configured for carrying the holding arrangement 100 as

described herein. In particular, the carrier body 210 may have an aperture opening 222 configured for receiving the holding arrangement 100 as described herein. According to some embodiments, the carrier body 210 can include and/or be made of aluminum, aluminum alloys, titanium, alloys thereof, stainless steel or the like.

5 According to some embodiments, which can be combined with other embodiments described herein, the carrier body 210 can include two or more elements such as a top bar, sidebars and a bottom bar. The two or more elements can define the aperture opening 222, as exemplarily shown in FIGS. 7A and 7B.

[0053] With exemplary reference to FIG. 7C, according to an alternative
10 embodiment of the carrier, which can be combined with any other embodiments described herein, the carrier body 210 may be provided at a backside of the substrate support 110. Accordingly, beneficially the risk of particle contamination on the front side 101B of the substrate 101 can be reduced or even eliminated since all hardware components of the carrier, e.g. the carrier body 210 which may include transportation
15 devices for transporting the carrier through a processing chamber, are provided behind the substrate surface to be processed.

[0054] FIG. 8 shows a flow chart illustrating a method 300 for holding a substrate according to embodiments described herein. According to embodiments, which can be combined with any other embodiments described herein, the method 300 includes
20 supporting 310 a substrate by a substrate support 110 having a substrate support surface 111 configured for supporting the substrate 101. Further, the method 300 includes applying 320 a force between the substrate 101 and the substrate support surface 111 by using 330 a substrate tensioning device 120 including at least one element 130 having a surface 131 with an adhesive arrangement 140 configured for
25 attaching the substrate 101. In particular, the method 300 for holding a substrate may include using a holding arrangement 100 according to any of the embodiments described herein. More specifically, the method 300 for holding a substrate may include employing a substrate support 110 as described herein and a substrate tensioning device 120 as described herein.

[0055] Accordingly, beneficially an improved method for holding thin substrates, i.e. substrates having a thickness between 5 μm and 500 μm is provided. In particular, embodiments of the method for holding a substrate as described herein provide for an improved contact between the substrate and the substrate support. In particular, a method for holding a substrate is provided with which a substantially homogeneous contact force between the backside of the substrate and the substrate support can be realized.

[0056] According to embodiments of the method 300 for holding a substrate, which can be combined with any other embodiments described herein, applying a force between the substrate 101 and the substrate support surface 111 includes pulling the substrate 101 on an end portion of the substrate 101. For instance, pulling the substrate 101 on an end portion of the substrate 101 may include using a substrate tensioning device as described herein.

[0057] FIG. 9 shows a flow chart illustrating a method 400 for releasing a substrate according to embodiments described herein. According to embodiments, which can be combined with any other embodiments described herein, the method 400 includes moving the at least one element 130 having a surface 131 with an adhesive arrangement 140 configured for attaching the substrate 101 relative to a surface of the substrate 101 to which the adhesive arrangement 140 is attached.

[0058] According to embodiments of the method 400 for releasing a substrate, which can be combined with any other embodiments described herein, the adhesive arrangement 140 includes a plurality of filaments 141 and the method further includes initiating Euler buckling of the plurality of filaments 141.

[0059] In particular, moving the at least one element 130 relative to a surface of the substrate 101 to which the adhesive arrangement 140 of the at least one element 130 is attached may include any movement of the at least one element as described herein. For instance, the movement of the at least one element 130 can be a rotational movement 183 and/or a horizontal movement 182 and/or a vertical movement 181, as exemplarily described in connection with FIG. 5. Additionally or

alternatively, the movement of the at least one element 130 may include moving the at least one first roller 151 and the at least one second roller 152, as exemplarily described with respect to FIG. 6.

5 [0060] Accordingly, beneficially an improved method for releasing thin substrates, i.e. substrates having a thickness between 5 μm and 500 μm is provided, such that damaging of the substrate during releasing can substantially be avoided.

10 [0061] Thus, in view of the embodiments described herein, it is to be understood that an improved holding arrangement for holding a substrate, an improved carrier for supporting a substrate, an improved method for holding a substrate, and an improved method for releasing a substrate are provided, particularly for thin large area substrates as described herein.

[0062] While the foregoing is directed to embodiments of the disclosure, other and further embodiments of the disclosure may be devised without departing from the basic scope thereof, and the scope thereof is determined by the claims that follow.

15 [0063] In particular, this written description uses examples to disclose the disclosure, including the best mode, and also to enable any person skilled in the art to practice the described subject-matter, including making and using any devices or systems and performing any incorporated methods. While various specific embodiments have been disclosed in the foregoing, mutually non-exclusive features
20 of the embodiments described above may be combined with each other. The patentable scope is defined by the claims, and other examples are intended to be within the scope of the claims if the claims have structural elements that do not differ from the literal language of the claims, or if the claims include equivalent structural elements with insubstantial differences from the literal language of the claims.

25

CLAIMS

1. A holding arrangement (100) for holding a substrate (101), comprising:
 - a substrate support (110) having a substrate support surface (111) configured for supporting the substrate (101); and
 - 5 - a substrate tensioning device (120) configured for applying a force between the substrate (101) and the substrate support surface (111), wherein the substrate tensioning device (120) comprises at least one element (130) having a surface (131) with an adhesive arrangement (140) configured for attaching the substrate (101).
- 10 2. The holding arrangement (100) according to claim 1, wherein the substrate support (110) is a backing plate, and wherein the substrate support surface (111) is concave.
3. The holding arrangement (100) according to claim 1 or 2, wherein the surface (131) with the adhesive arrangement (140) is a curved surface.
- 15 4. The holding arrangement (100) according to any one of claims 1 to 3, wherein the at least one element (130) is rotatable around a rotation axis (133), particularly wherein the rotation axis (133) is horizontal.
5. The holding arrangement (100) according to any one of claims 1 to 4, wherein the adhesive arrangement (140) includes a plurality of filaments (141).
- 20 6. The holding arrangement (100) according to claim 5, wherein the plurality of filaments (141) are arranged on the surface (131) of the at least one element (130) with an inclination angle α (alpha) of less than 90° relative to a surface tangent T on the surface (131) of the at least one element (130).

7. The holding arrangement (100) according to any one of claims 1 to 6, wherein the adhesive arrangement (140) comprises a dry adhesive material configured for attaching the substrate (101).
- 8 The holding arrangement (100) according to claim 7, wherein the dry adhesive
5 material is a synthetic setae material and/or a Gecko adhesive.
9. The holding arrangement (100) according to any one of claims 1 to 8, wherein the at least one element (130) is provided at an upper end (110A) of the substrate support (110) and/or at a lower end (110B) of the substrate support (110).
10. The holding arrangement (100) according to any one of claims 1 to 9, wherein the
10 at least one element (130) comprises at least one first roller (151) and at least one second roller (152), wherein the at least one first roller (151) is configured to be moved in a first transversal direction (151B), wherein the at least one second roller (152) is configured be moved in a second transversal direction (152B), and wherein the first transversal direction (151B) is different from the second
15 transversal direction (152B).
11. A carrier (200) for supporting a substrate, comprising:
 - a carrier body (210); and
 - a holding arrangement (100) according to any one of claims 1 to 10, wherein the holding arrangement (100) is mounted on the carrier body (210).
- 20 12. A method (300) for holding a substrate (101), comprising:
 - supporting (310) a substrate by a substrate support (110) having a substrate support surface (111) configured for supporting the substrate (101); and
 - applying (320) a force between the substrate (101) and the substrate support surface (111) by using (330) a substrate tensioning device (120) comprising at

least one element (130) having a surface (131) with an adhesive arrangement (140) configured for attaching the substrate (101).

13. The method (300) according to claim 12, wherein applying (320) a force between the substrate (101) and the substrate support surface (111) comprises pulling (321)
5 the substrate (110) on an end portion of the substrate (110).
14. A method (400) for releasing a substrate (101), comprising:
- moving (410) at least one element (130) having a surface (131) with an adhesive arrangement (140) configured for attaching the substrate (101) relative to a surface of the substrate (101) to which the adhesive arrangement (140) is attached.
- 10 15. The method (400) according to claim 14, wherein the adhesive arrangement (140) includes a plurality of filaments (141), and wherein the method further comprises initiating (420) Euler buckling of the plurality of filaments (141).

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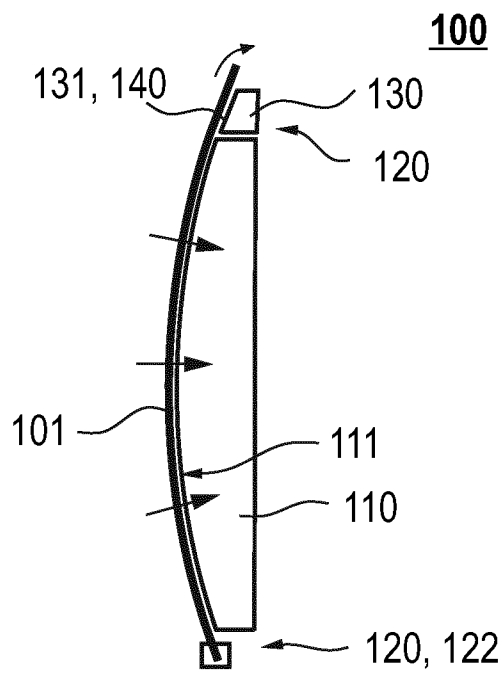


FIG. 1A

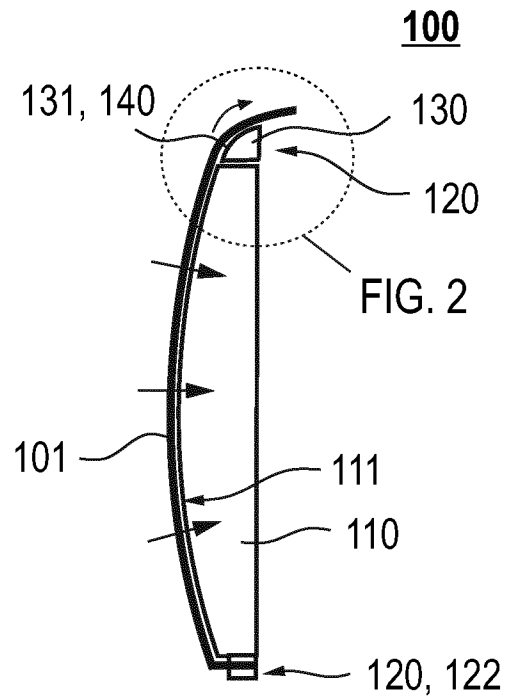


FIG. 1B

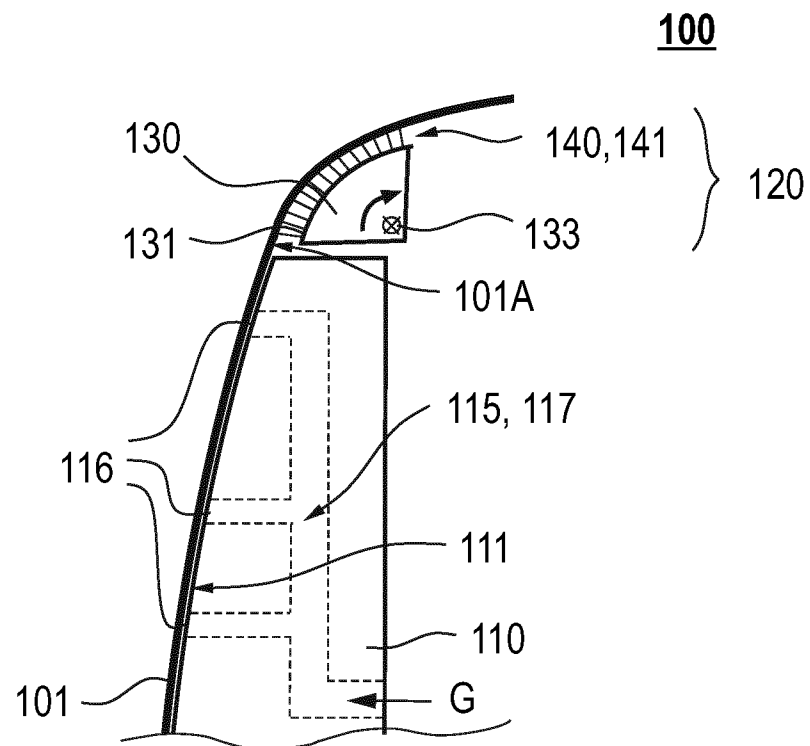


FIG. 2

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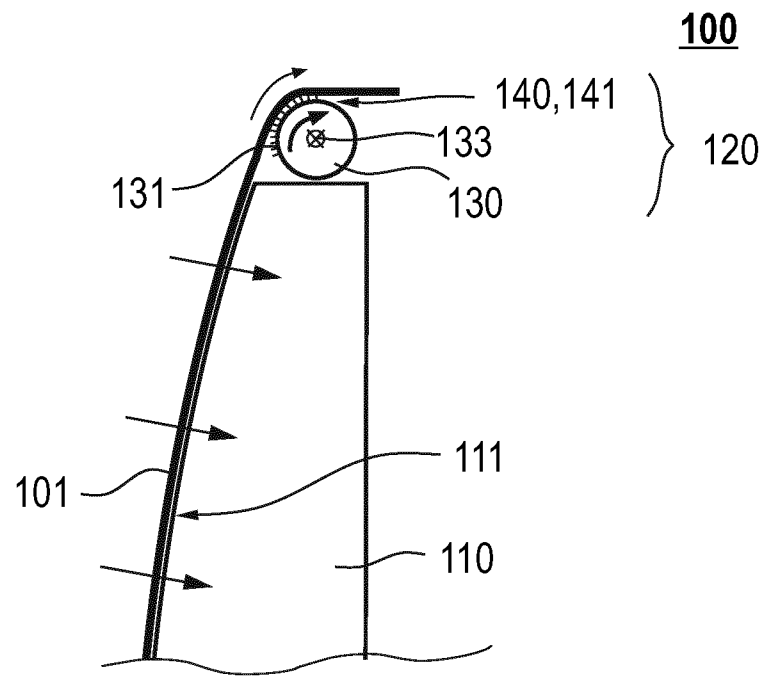


FIG. 3A

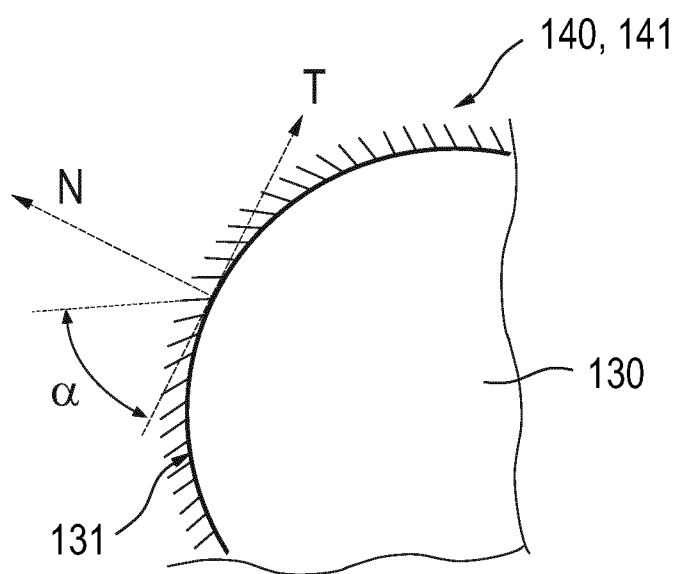


FIG. 3B

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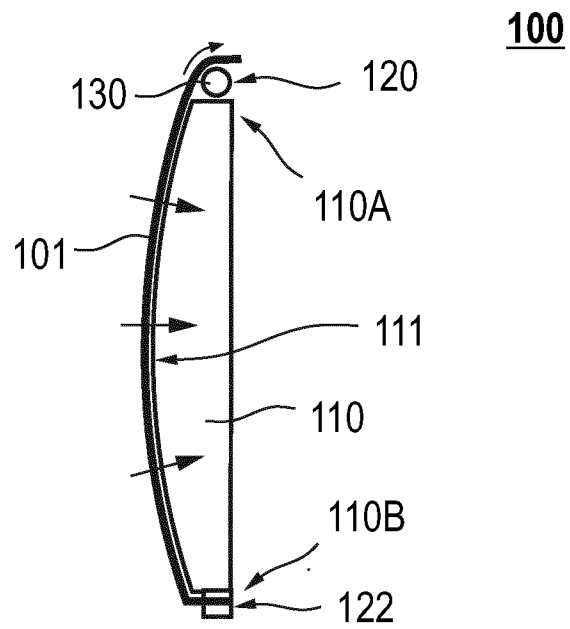


FIG. 4A

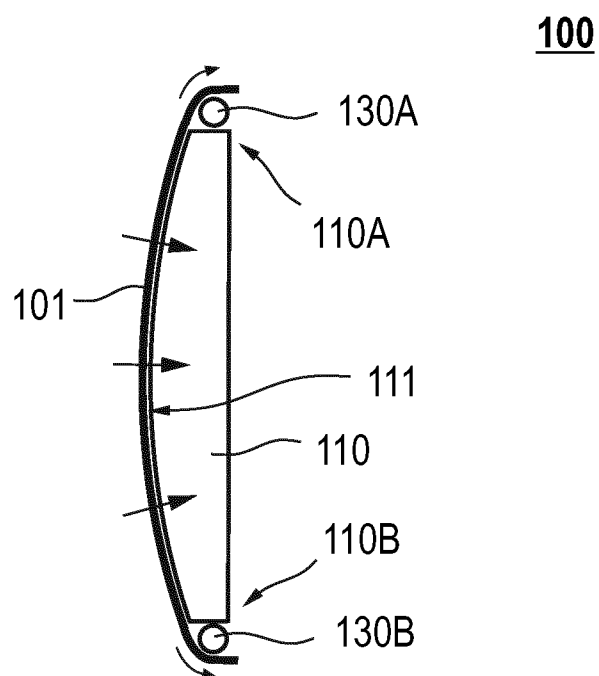


FIG. 4B

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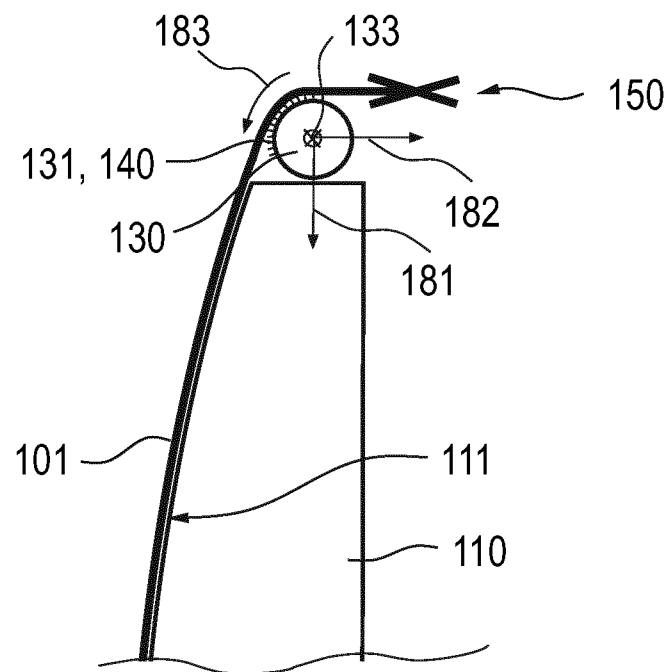


FIG. 5

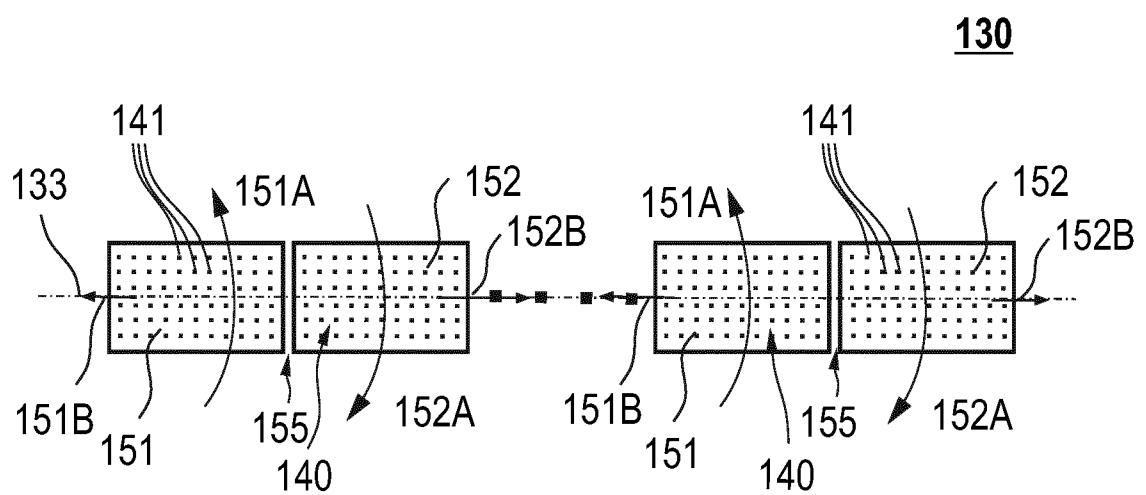


FIG. 6

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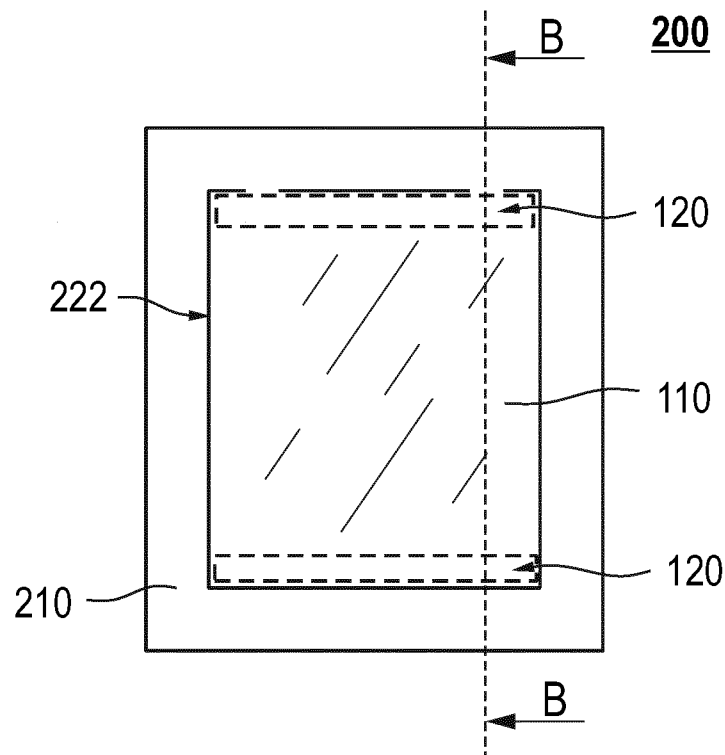


FIG. 7A

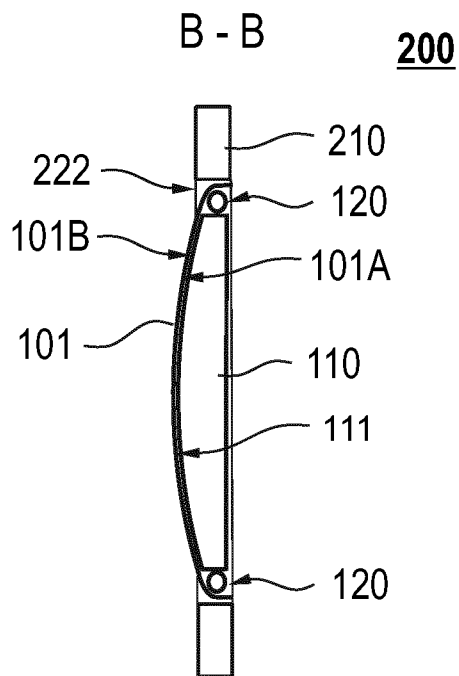


FIG. 7B

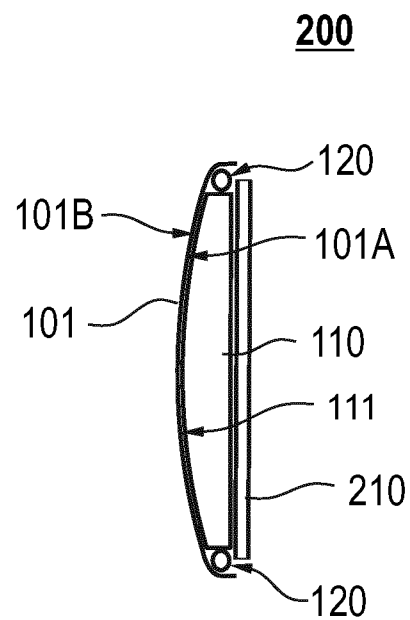


FIG. 7C

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300

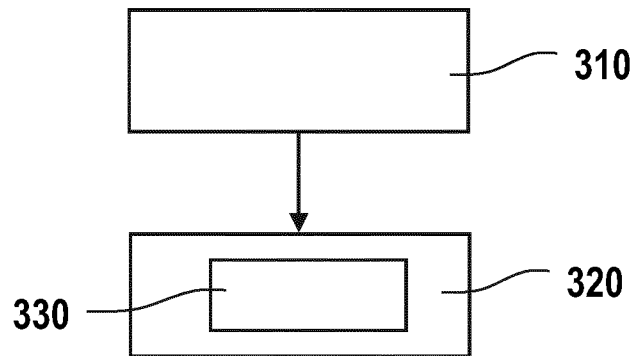


FIG. 8

400

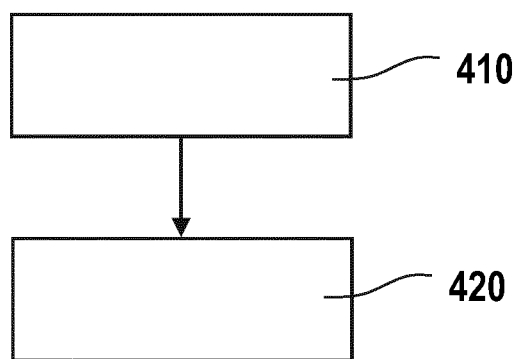


FIG. 9

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2016/080290

A. CLASSIFICATION OF SUBJECT MATTER

INV. C23C14/50 C23C16/458 B65G49/06
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

C23C B65G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2016/180449 A1 (APPLIED MATERIALS INC [US]; LAU SIMON [DE]) 17 November 2016 (2016-11-17)	14, 15
Y	the whole document	1-13
Y	JP 2015 229796 A (CANON TOKKI CORP) 21 December 2015 (2015-12-21) paragraphs [0032], [0054]; figure 3	1-13
Y	JP 2007 009255 A (KONICA MINOLTA HOLDINGS INC) 18 January 2007 (2007-01-18) paragraph [0037]; figure 3	1-13
X	US 2009/280244 A1 (MITCHELL DANIEL B [CA] ET AL) 12 November 2009 (2009-11-12) page 3, paragraph 30 - paragraph 33; figure 6	1-3, 12



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

18 July 2017

Date of mailing of the international search report

27/07/2017

Name and mailing address of the ISA/

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Authorized officer

Schuhmacher, Jörg

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2016/080290

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2016180449	A1	17-11-2016	NONE

JP 2015229796	A	21-12-2015	CN 105316640 A 10-02-2016
			JP 2015229796 A 21-12-2015
			KR 20150140562 A 16-12-2015

JP 2007009255	A	18-01-2007	NONE

US 2009280244	A1	12-11-2009	NONE
